Nways Multiprotocol Switched Services

Configuring Protocols and Features

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Note

Before using this document, read the general information under “Notices” on page xxiii.

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Preface

This manual contains the information you will need to use the command interface for configuration and operation of the IBM Nways Multiprotocol Switched Services (MSS) or your A-MSS Server Module, hereafter referred to as “the router”, installed on your IBM Multiprotocol Switched Services (MSS). With the help of this manual, you should be able to perform the following processes and operations:

- Configure, monitor, and use the Multiprotocol Switched Services (MSS) base code on your IBM Nways Multiprotocol Switched Services (MSS) or your A-MSS Server Module
- Configure, monitor, and use the interfaces and Link Layer software supported by your router.

Who Should Read This Manual: This manual is intended for persons who install and manage computer networks. Although experience with computer networking hardware and software is helpful, you do not need programming experience to use the protocol software.

Conventions Used in This Manual

The following conventions are used in this manual to show command syntax and program responses:

1. The abbreviated form of a command is shown in the following example:

   reload

   In this example, you can enter either the whole command (reload) or its abbreviation (re).

2. Keyword choices for a parameter are enclosed in brackets and separated by the word or. For example:

   ```
   command [keyword1 or keyword2]
   ```

   Choose one of the keywords as a value for the parameter.

3. Three periods following an option mean that you enter additional data (for example, a variable) after the option. For example:

   time host ...

   In this example, you enter the IP address of the host in place of the periods, as explained in the description of the command.

4. In information displayed in response to a command, defaults for an option are enclosed in brackets immediately following the option. For example:

   ```
   Media (UTP/STP) [UTP]
   ```

   In this example, the media defaults to UTP unless you specify STP.

5. Keyboard key combinations are indicated in text in the following ways:

   -
     - **Ctrl-P**
     - **Ctrl -**

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- Names of keyboard keys are indicated like this: **Enter**

MSS Server Library

The following hard copy publications are shipped with the product. The manuals in this list are also included in displayable softcopy form on the Multiprotocol Switched Services (MSS) Softcopy Library CD-ROM (SK2T-0378). This CD-ROM is shipped with initial orders for the MSS Server.

The reference cards, the International Program License Agreement, and the safety information booklet are shipped in hard copy only and are not included on the CD-ROM.

- *IBM 8210 Nways Multiprotocol Switched Services (MSS) Server Setup and Problem Determination Guide,* GA27-4140
- *IBM 8210 Nways Multiprotocol Switched Services (MSS) Server Operations Reference Card,* GX27-4017
- *IBM Multiprotocol Switched Services (MSS) Server Configuration and Operations Guide,* SC30-3821
- *CAUTION: Safety Information - Read This First,* SD21-0030
- *International Program License Agreement*
- *IBM Nways Multiprotocol Switched Services (MSS) Server Module Reference Card,* GX27-4018
- *IBM Nways Multiprotocol Switched Services (MSS) Server Module Setup and Problem Determination Guide,* GA27-4141

The following publications are not shipped in hard copy, but are offered in soft copy form on the Multiprotocol Switched Services (MSS) Softcopy Library CD-ROM (SK2T-0378). All of these manuals can be separately ordered in hard copy form through your IBM marketing representative.

- *IBM Multiprotocol Switched Services (MSS) Server Introduction and Planning Guide,* GC30-3820
- *IBM Multiprotocol Switched Services (MSS) Server Interface Configuration and Software User's Guide,* SC30-3818
- *Multiprotocol Switched Services (MSS) Configuring Interfaces and Features,* SC30-3819
- *Event Logging System Messages Guide,* SC30-3682
- *IBM 8210 Nways Multiprotocol Switched Services (MSS) Server Service and Maintenance Manual,* GY27-0354
- *IBM 8210 Multiprotocol Switched Services Server (MSS) Server Module Installation and Initial Configuration Guide* GA27–4141

Summary of Changes For Version 2.1

The following are the new functions in this release:

- Support for Fast Token Ring (FasTR)
- Support for MPOA clients and server
- Support for DLSw

- Support for APPN and Banyan VINES over FDDI
- Support for LAN Emulation version 2
- Support for Broadcast Manager IPX Server Farms
- Support for High Performance Routing (HPR) over IP
- Support for Quality of Service (QOS) version 2
- Support for enhanced LAN Emulation Client (LEC) security and other PVLAN enhancements
- Support for Classical IP Peer Redundancy
- Support for Distributed IP Redundant Gateways
- Support for VLAN Port Filtering
- Support for Duplicate MAC addresses in a single emulated LAN (ELAN).

The technical changes and additions are indicated by a vertical line (|) to the left of the change.

Under Reconstruction

This edition begins a number of editorial changes to this book and the other software books that will:

- Reorganize the material
- Remove any unneccessary and redundant information
- Improve retrievability
- Add additional clarification to some information

This effort will take a number of editions. Please help us during this effort by reporting any corrections using the Reader's Comment Form in the back of the book.

Getting Help

At any of the prompts just described, you can obtain help in the form of a listing of the commands available at that level. To do this, type **?** (the **help** command), and then press **Enter**. Use **?** to list the commands that are available from the current level. You can usually enter a **?** after a specific command name to list its options. For example, the following information appears if you enter **?** at the * prompt:

```
*?

DIAGS hardware diagnostics

DIVERT output from process
FLUSH output from process
HALT output from process
INTERCEPT character is
LOGOUT
MEMORY statistics
RELOAD

STATUS of process(es)
TALK to process
TELNET to IP-Address
```

Exiting a Lower-Level Environment

The multiple-level nature of the software places you in secondary, tertiary, and even lower level environments as you configure or operate the 8210. To return to the next higher level, enter the **exit** command. To get to the secondary level, continue entering **exit** until you receive the secondary level prompt (either `Config>` or `+`).

For example, to exit the IP protocol configuration process:

```
IP config> exit
Config>
```

If you need to get to the primary level (OPCON), enter the intercept character (**Ctrl P** by default).

Features Supported by the MSS Client and MSS Domain Client

Table 0-1 on page xxix shows what interfaces, protocols, and services are supported by the MSS Client and the MSS Domain Client. Use this list to determine what information in this book applies to your MSS Family Client

Table 0-1. Interfaces, Protocols, and Services Supported by MSS Client and MSS Domain Client

Feature	MSS Client	MSS Domain Client
Interfaces		
Token-Ring LAN Emulation client	yes	no
Ethernet LAN Emulation Client	yes	no
Token-Ring Proxy LAN Emulation Client	yes	no
LAN Switch Token-Ring interface	yes	yes
LAN Switch Ethernet interface	yes	yes
FasTR over ATM	yes	no
Protocols and Features		
Classical IP	yes	no
IP	yes	yes
Banyan VINES	yes	yes
AppleTalk	yes	yes
IPX	yes	yes
Source-Route Bridging	yes	yes
NHRP	yes	no
LAN Network Manager	yes	yes
MPOA	yes	no
PVLAN	yes	yes (on Token-Ring only)
CIP ARP Server Redundancy	yes	no
QoS LAN Emulation Client	yes	no
MARS Client	yes	no
OSPF/MOSPF	yes	yes
RIP	yes	yes
RIP2	yes	yes
DVMRP	yes	yes
BGP	yes	yes

Configuring and Monitoring Bridge Functions

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Chapter 1. Bridging Basics

This chapter discusses basic information about bridges and bridging operation. The chapter includes the following sections:

- "Bridging Overview"
- "Bridging and Routing" on page 1-2
- "Types of Bridges" on page 1-4
- "Basic Bridge Operation" on page 1-5
- "MAC Bridge Frame Formats" on page 1-7

Bridging Overview

A bridge is a device that links two or more local area networks. The bridge accepts data frames from each connected network and then decides whether to forward each frame based on the medium access control (MAC) header contained in the frame. Bridges originally linked two or more homogeneous networks. The term *homogeneous* means that the connected networks use the same bridging method and media types. Examples of these would be networks supporting the source routing bridging method ***only*** or transparent bridging algorithm ***only*** (these methods will be explained later).

Current bridges also allow communication between non-homogeneous networks. *Non-homogeneous* refers to networks that can mix different bridging methods and can also offer more configuration options. Figure 1-1 on page 1-2 illustrates examples of simple and complex bridging configurations.

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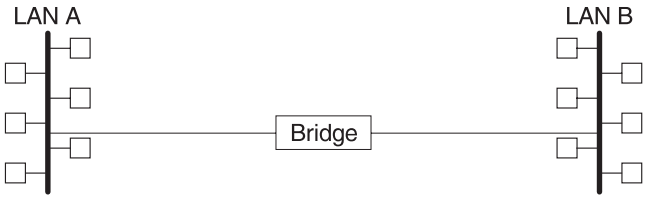
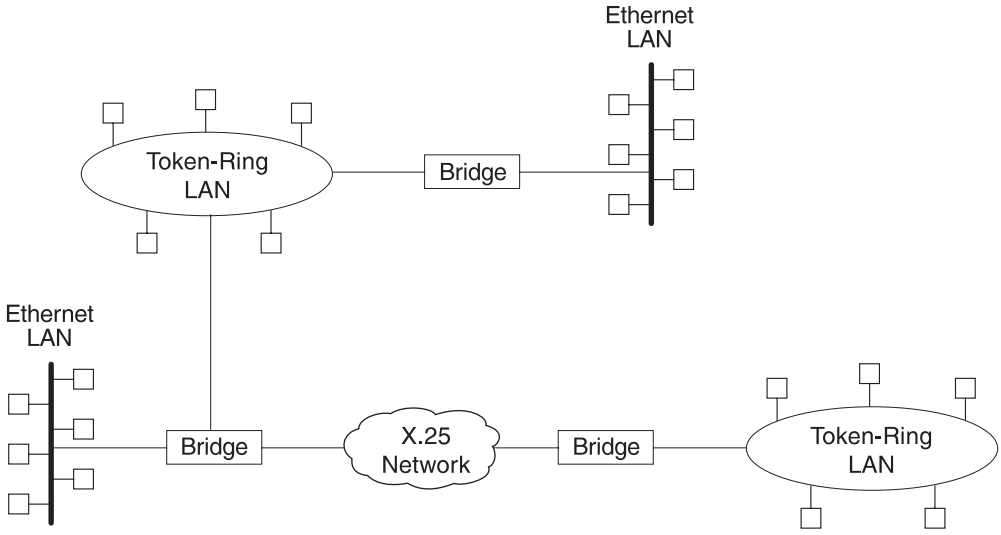


Simple Bridge Connecting Two Homogeneous (Ethernet) LANs



Complex Bridging Configuration Connecting Different LAN Technologies

Figure 1-1. Simple and Complex Bridging Configuration

Bridging and Routing

The 8210 can perform both bridging and routing. Protocol filtering is the process that determines whether the incoming data is routed or bridged.

Protocol Filtering

When processing an incoming data packet, the following actions occur:

- Packets are routed if a specific protocol forwarder is globally enabled
- Packets are filtered if you configure specific protocol filters
- Packets that are not routed or filtered are candidates for bridging, depending on the destination medium access control (MAC) address.

Table 1-1 on page 1-3 shows how the “Bridge or Route?” question is answered based on the destination address contents.

Table 1-1. Route/Bridge Decision Table

If the Destination MAC Address in the Received Frame Contains:	The Bridge takes this action:
Bridge Address	The bridge passes the frame to the configured protocol that routes the frame.
Multicast or Broadcast Address	If there is a configured protocol in the frame, the frame is routed. Otherwise, the frame is bridged.
Unicast	The frame is bridged.

Routing and Bridging on a Per-Interface Basis

For IP, IPX, NHRP, and AppleTalk, the following rules apply for routing or bridging over a specific interface:

- Packets are routed if a specific protocol is configured for the receiving interface
- Packets are filtered if you configure specific protocol filters on the receiving interface
- Packets that are not routed or filtered are candidates for bridging, depending on the destination medium access control (MAC) address.

Router Connections

Connecting at Layer 3 with a router allows connectivity and path selection between end stations located in distant geographical areas. Using routing protocols, you can select the best path for connecting distant and diverse LANs. Because of the variety of network and subnetwork configuration options available to you in large networks, connecting LANs through the Network Layer is usually the preferred method. Network-layer protocols have also proven to be very efficient in moving information in large and diverse network configurations.

Bridge Connections

Connecting at Layer 2 with a bridge provides connectivity across a physical link. This connection is essentially “transparent” to the host connected on the network.

Note: Source routing bridges are not considered completely “transparent.” See Chapter 2, “Bridging Methods” on page 2-1 in this guide for more information on source routing and transparent bridges.

The Link Layer maintains physical addressing schemes (versus logical at Layer 3), line discipline, topology reporting, error notification, flow control, and ordered delivery of data frames. Isolation from upper-layer protocols is one of the advantages of bridging. Because bridges function at the Link Layer, they are not concerned with looking at the protocol information that occurs at the upper layers. This provides for lower processing overhead and fast communication of network layer protocol traffic. Because bridges are not concerned with Layer 3 information, they can also forward different types of protocol traffic (for example, IP or IPX) between two or more networks (as routers do).

Bridges can also filter frames based on Layer 2 fields. This means that the bridge can be configured to accept and forward only frames of a certain type or ones that

originate from a particular network. This ability to configure filters is very useful for maintaining effective traffic flow.

Bridges are advantageous when dividing large networks into manageable segments. The advantages of bridging in large networks can be summed up as follows:

- Bridging lets you isolate specific network areas, giving them less exposure to major network problems.
- Filtering lets you regulate the amount of traffic that is forwarded to specific segments.
- Bridges allow communication among a larger number of internetworking devices than would be supported on any single LAN connected to a bridge.
- Bridging eliminates node limitation (the total number of nodes on a segment). Local network traffic is not passed on to all of the other connected networks.
- Bridges extend the connected “length” of a LAN by allowing the connection of distant LAN segments. Bridges connect two LAN segments at layer 2 so that larger networks can be formed. This overcomes the congestion problems with too many stations on an Ethernet and the 256-station limit in the token-ring architecture.

Bridges versus Routers

Internetworking devices such as bridges and routers have similar functions in that they connect network segments. However, each device uses a different method to establish and maintain the LAN-to-LAN connections. Routers connect LANs at Layer 3 (Network Layer) of the OSI model while bridges connect LANs at Layer 2 (Link Layer).

Types of Bridges

The following sections describe specific types of bridges and how they can be classified by their hardware and software capabilities.

Simple Bridges

Simple bridges consist of two or more linked network interfaces connecting local area networks (Figure 1-1 on page 1-2). Bridges interconnect separate local area networks (LANs) by relaying data frames between the separate MAC (medium access control) entities of the bridged LANs.

The main functions of a simple bridge can be summarized as follows:

- The bridge reads all data frames transmitted on LAN A and receives those addressed to LAN B. Simple bridges make no changes to the content or format of the data frames that they receive. They also do not encapsulate frames with any additional headers.

  Most simple bridges contain routing addressing and routing intelligence. At a minimum, the bridge must know which addresses are on each connected network so that it can know which frames to pass on.
- The bridge retransmits the data frames addressed to LAN B on to LAN B using the MAC protocol for that LAN. Bridges should have enough buffer space to

meet peak data traffic demands because data frames may arrive faster than the bridge can transmit them.

- The bridge does the same for LAN B-to-LAN A data frame traffic.

Complex Bridges

Complex bridges carry out more sophisticated functions than simple bridges. These functions may include the bridge maintaining status information on the other bridges. This information includes the communication path cost as well as the number of hops required to reach each connected network. Periodic exchanges of information between bridges update all bridge information. These types of exchanges allow for dynamic routing between bridges.

Complex bridges can also modify frames and recognize and transmit packets from different LAN technologies (for example, Token-Ring, and Ethernet). In this case the bridge is sometimes referred to as a *translational* bridge.

The adaptive source routing transparent (ASRT) bridge is the IBM 8210's implementation of bridge technology. The ASRT Bridge is a collection of software components capable of several of the bridging options just described and more. All of these functions are explained in greater detail later in this chapter.

Local Bridges

Local bridges provide connections among several LAN segments in the same geographical area. An example of this would be a bridge used to connect the various LANs located in your company's main headquarters.

Remote Bridges

Remote bridges connect multiple LAN segments in different geographical areas. An example of this would be bridges used to the connect LANs located in your company's main headquarters to LANs in other branch offices around the country. Because of the geographical differences, this configuration moves from a local area network configuration to a wide area network (WAN) configuration.

Remote bridges can differ from local bridges in several ways. One major difference is in the speed at which data is transmitted. WAN connections may be slower than LAN connections. This difference in speed can make quite a difference when running time-sensitive applications. Another difference is in the physical way in which remote and local bridges are connected to LANs. In local bridges, the connections are made through local cabling media (for example, Ethernet, Thinet). Remote bridge connections are made over the serial lines.

Basic Bridge Operation

According to the IEEE 802 LAN standard, all station addresses are specified at the MAC level. At the Logical Link Control (LLC) level, only SAP (Service Access Point) addresses are designated. Accordingly, the MAC level is the level at which the bridge functions. The following examples explain how bridging functions proceed at this level.

Operation Example 1: Local Bridge Connecting Two LANs

Figure 1-2 shows a two-port bridge model connecting end stations on two separate LANs. In this example, the local bridge connects LANs with identical LLC and MAC layers (that is, two token-ring LANs). Conceptually, you can think of the bridge as a data link relay that forwards frames between the media access control (MAC) sublayers and physical channels of the attached LANs, thus providing data link connectivity between them.

To summarize the bridging process, the bridge captures MAC frames whose destination addresses are not on the local LAN (that is, the LAN connected to the interface receiving the transmitted frame). It then forwards them to the appropriate destination LAN. Throughout this process, there is a dialogue between the peer LLC entities in the two end-stations. Architecturally, the bridge need not contain an LLC layer because the function of the LLC layer is to merely relay MAC frames that come from upper levels of the OSI model.

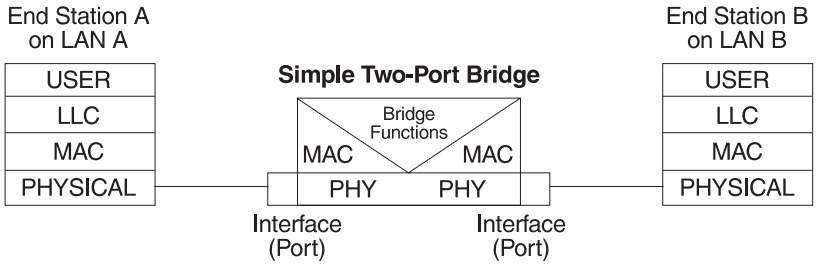


Figure 1-2. Two-Port Bridge Connecting Two LANs

Operation Example 2: Remote Bridging Over a Serial Link

Figure 1-3 shows a pair of bridges connected over a serial link. These remote bridges connect LANs with identical LLC and MAC layers (that is, two token-ring LANs).

To summarize, the bridge captures a MAC frame whose destination address is not on the local LAN and then sends it to the appropriate destination LAN via the bridge on that LAN. Throughout this process, there is a dialogue between the peer LLC entities in the two end stations. Architecturally, the bridge need not contain an LLC layer because the function of the LLC layer is to merely relay MAC frames that come from upper levels of the OSI model.

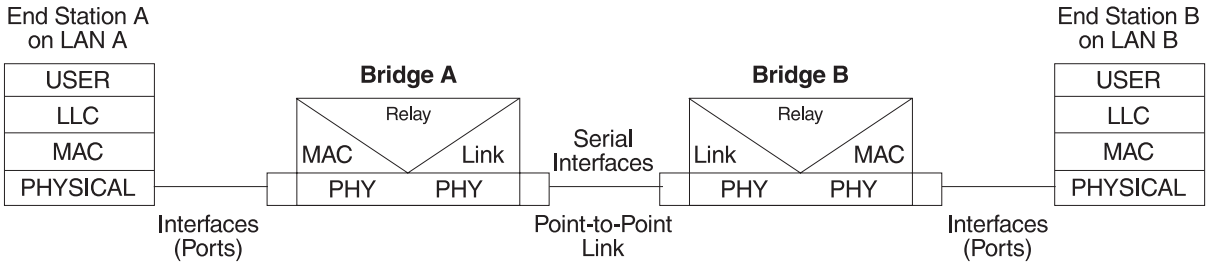


Figure 1-3. Bridging Over a Point-to-Point Link

Data is encapsulated as the bridges communicate data over the serial link. Figure 1-4 on page 1-7 illustrates the encapsulation process.

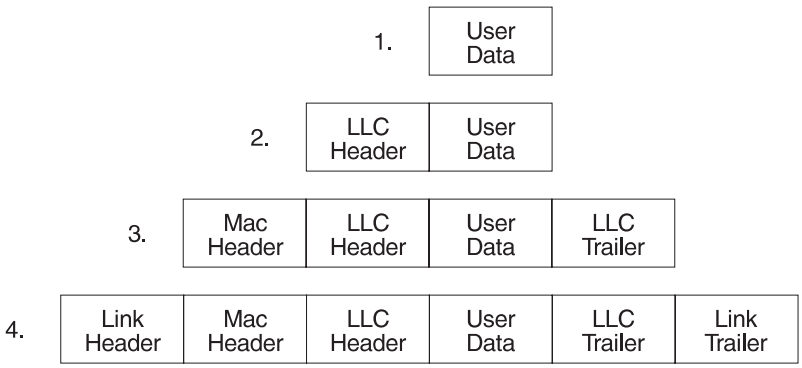


Figure 1-4. Data Encapsulation Over a Point-to-Point Link

Encapsulation proceeds as follows:

1. End station A provides data to its LLC.
2. LLC appends a header and passes the resulting data unit to the MAC level.
3. MAC then appends a header (3) and trailer to form a MAC frame. Bridge A captures the frame.
4. Bridge A does not strip off the MAC fields because its function is to relay the intact MAC frame to the destination LAN. In the point-to-point configuration, however, the bridge appends a link layer (for example, HDLC) header and trailer and transmits the MAC frame across the link.

When the data frame reaches Bridge B (the target bridge), the link fields are stripped off and Bridge B transmits the *original, unchanged* MAC frame to its destination, end station B.

MAC Bridge Frame Formats

As mentioned, bridges interconnect LANs by relaying data frames, specifically MAC frames, between the separate MAC entities of the bridged LANs. MAC frames provide the necessary “Where?” information for frame forwarding in the form of source and destination addresses. This information is essential for the successful transmission and reception of data.

IEEE 802 supports three types of MAC frames: CSMA/CD (802.3), token bus (802.4), and token-ring (802.5). Figure 1-5 on page 1-8 shows the MAC frame formats supported by the bridge. The specific frames are detailed in the following section.

Note: A separate frame format is used at the LLC level. This frame is then embedded in the appropriate MAC frame.

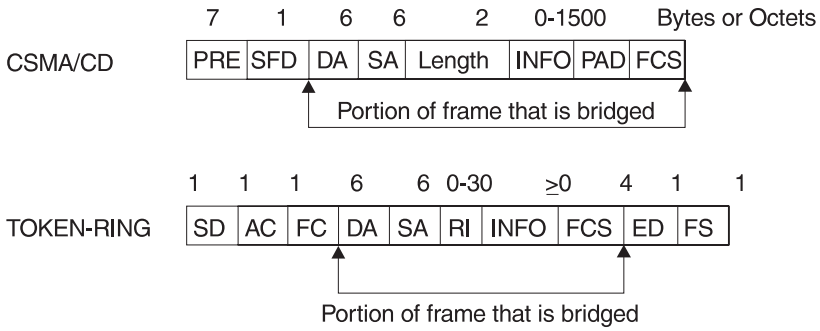


Figure 1-5. Examples of MAC Frame Formats

CSMA/CD (Ethernet) MAC Frames

The following information describes each of the fields found in CSMA/CD (Ethernet) MAC frames:

- *Preamble (PRE)*. A 7-byte pattern used by the receiving end-station to establish bit synchronization and then locate the first bit of the frame.
- *Start Frame Delimiter (SFD)*. Indicates the start of the frame.

The portion of the frame that is actually bridged consists of the following fields:

- *Destination Address (DA)*. Specifies the end-station for which the frame is intended. This address may be a unique physical address (one destination), a multicast address (a group of end-stations as a destination), or a global address (all stations as the destination), or a global address (all stations as the destination). The format is 48-bit (6 octets) and must be the same for all stations on that particular LAN.
- *Source Address (SA)*. Specifies the end-station that transmitted the frame. The format must be the same as the destination address format.
- *Length*. Specifies the number of LLC bytes that follow.
- *Info (INFO)*. Embedded fields created at the LLC level that contain service access point information, control information, and user data.
- *Pad*. Sequence of bytes that ensures that the frame is long enough for proper collision detection (CD) operation.
- *Frame Check Sequence (FCS)*. A 32-bit cyclic redundancy check value. This value is based on all fields, starting with the destination address.

Token-Ring MAC Frames

The following information describes each of the fields in token-ring MAC frames:

- *Starting Delimiter (SD)*. Unique 8-bit pattern that indicates the start of the frame.
- *Access Control (AC)*. Field with the format PPPTMRRR where PPP and RRR are 3-bit priority and reservation variables, M is the monitor bit, and T indicates that this is either a token or a data frame. If it is a token frame, the only other field is the ending delimiter (ED).
- *Frame Control (FC)*. Indicates if this is an LLC data frame. If not, bits in this field control operation of the token-ring MAC protocol.

The portion of the frame that is actually bridged consists of the following fields:

- *Destination Address (DA)*. Same as CSMA/CD and token bus.
- *Source Address (SA)*. Identifies the specific station that originated the frame. This field can be either a 2- or 6-octet address. Both address lengths carry a routing information indicator (RII) bit that indicates if a routing information field (RIF) is present in the frame after the source address, as follows:

  RII=1 Routing information field is present.
  RII=0 Routing information field is not present.

  This field is explained in more detail in “Source Route Bridging (SRB)” on page 2-10.
- *Routing Information Field (RIF)*. The RIF is required for the source routing protocol. It consists of a 2-octet routing control field and a series of 2-octet route designator fields. This field is explained in more detail in “Source Route Bridging (SRB)” on page 2-10.
- *Info (INFO)*. Embedded fields created at the LLC level that contain service access point information, control information, and user data.
- *Frame Check Sequence (FCS)*. A 32-bit cyclic redundancy check value. This value is based on all fields, starting with the destination address.

Finally, the *End Delimiter (ED)* contains the error detection (E) bit, and the intermediate frame (I) bit. The I bit indicates that this is not the final frame of a multiple frame transmission. The *Frame Status (FS)* contains the address recognized (A) and frame copied (C) bits.

Chapter 2. Bridging Methods

This chapter describes the methods of bridging supported by the adaptive source routing transparent (ASRT) bridge. Each section gives an overview of a specific technology and is followed by a description of the data frames supported by that technology. The chapter includes the following sections:

- "Transparent Bridging"
- "Source Route Bridging (SRB)" on page 2-10
- "Source Routing Transparent (SRT) Bridge" on page 2-17
- "ASRT Bridge Overview" on page 2-19
- " Adaptive Source Routing Transparent Bridge (ASRT) (SR-TB Conversion)" on page 2-20

Transparent Bridging

The transparent bridge is also commonly known as a spanning tree bridge (STB). The term *transparent* refers to the fact that the bridge silently forwards non-local traffic to attached LANs in a way that is *transparent* or unseen to the user. End station applications do not know about the presence of the bridge. The bridge learns about the presence of end stations by listening to traffic passing by. From this listening process it builds a database of end station addresses attached to its LANs.

For each frame it receives, the bridge checks the frame's destination address against the ones in its database. If the frame's destination is an end station on the same LAN, the frame is not forwarded. If the destination is on another LAN, the frame is forwarded. If the destination address is not present in the database, the frame is forwarded to all the LANs that are connected to the bridge except the LAN from which it originated.

All transparent bridges use the spanning tree protocol and algorithm. The spanning tree algorithm produces and maintains a loop-free topology in a bridged network that might contain loops in its physical design. In a mesh topology where more than one bridge is connected between two LANs, *looping* occurs. In such cases, data packets bounce back and forth between two LANs on parallel bridges. This creates a redundancy in data traffic and produces the phenomenon known as looping.

When looping occurs, you must configure the local and/or remote LAN to remove the physical loop. With spanning tree, a self-configuring algorithm allows a bridge to be added anywhere in the LAN without creating loops. When the new bridge is added, the spanning tree protocol automatically reconfigures all bridges on the LAN into a single loop-free *spanning tree*.

A spanning tree never has more than one active data route between two end stations, thus eliminating data loops. For each bridge, the algorithm determines which bridge ports can forward data and which ones must be blocked to form a loop-free topology. The features that spanning tree provides include:

- *Loop detection*. Detects and eliminates physical data link loops in extended LAN configurations.

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- *Automatic backup of data paths*. The bridges connecting to the redundant paths enter backup mode automatically. When a primary bridge fails, a backup bridge becomes active.
- *User configurability*. Lets you tailor your network topology. Sometimes the default settings do not produce the desired network topology. You can adjust the bridge priority, port priority, and path cost parameters to shape the spanning tree to your network topology.
- *Seamless interoperability*. Allows LAN interoperability without configuration limitations caused by diverse communications environments.
- *Bridging of non-routing protocols*. Provides cost-effective bridging of non-routing protocols.

Routers and Transparent Bridges

During the operation of a router equipped with the spanning tree option, bridge and router software run concurrently. In this mode, the router is a bridge and a router.

During this operation, the following actions occur:

- Packets are routed if a specific protocol forwarder is globally enabled
- Packets are filtered if you configure specific protocol filters
- Packets that are not routed or filtered are candidates for bridging, depending on the destination medium access control (MAC) address.

Network Requirements

Transparent Bridge implements a spanning tree bridge that conforms to the IEEE 802.1D standard. All transparent bridges (such as Ethernet and Token-Ring) on the network must be 802.1D spanning tree bridges. This spanning tree protocol is not compatible with bridges implementing the proprietary Digital Equipment Corporation spanning tree protocol used in some older bridges.

Transparent Bridge Operation

In a mesh topology where more than one bridge is connected between two LANs, a looping phenomenon can occur where two LANs bounce packets back and forth over parallel bridges. A loop is a condition where multiple data paths exist between two LANs. The spanning tree protocol operating automatically eliminates loops by blocking redundant paths.

During startup, all participating bridges in the network exchange Hello bridge protocol data units (BPDUs) which provide configuration information about each bridge. BPDUs include information such as the bridge ID, root ID, and root path cost. This information helps the bridges to unanimously determine which bridge is the root bridge and which bridges are the designated bridges for LANs to which they are connected.

Of all the information exchanged in the HELLO messages, the following parameters are the most important for computing the spanning tree:

- *Root Bridge ID*. The root bridge ID is the bridge ID of the bridge. The root bridge is the designated bridge for all the LANs to which it is connected.
- *Root Path Cost*. The sum total of the designated path costs to the root via this bridge's root port. This information is transmitted by both the root bridge and

the designated bridges to update all bridges on path information if the topology changes.

- *Bridge ID*. A unique ID used by the spanning tree algorithm to determine the spanning tree. Each bridge in the network is assigned a unique bridge identifier.
- *Port ID*. The ID of the port from which the current HELLO BPDU message was transmitted.

With this information available, the spanning tree begins to determine its shape and direction and then creates a logical path configuration. This process can be summarized as follows:

1. A root bridge for the network is selected by comparing the bridge IDs of each bridge in the network. The bridge with the lowest ID (that is, highest value) wins.
2. The spanning tree algorithm then selects a designated bridge for each LAN. If more than one bridge is connected to the same LAN, the bridge with the smallest path cost to the root is selected as the designated bridge. In the case of duplicate path costs, the bridge with the lowest bridge ID is selected as the designated bridge.
3. The non-designated bridges on the LANs put each port that has not been selected as a root port into a BLOCKED state. In the BLOCKED state, a bridge still listens to Hello BPDUs so that it can act on any changes that are made in the network (for example, designated bridge fails) and change its state from BLOCKED to FORWARDING (that is, it will be forwarding data).

Through this process, the spanning tree algorithm reduces a bridged LAN network of arbitrary topology into a single spanning tree. With the spanning tree, there is never more than one active data path between any two end stations, thus eliminating data loops. For each bridge on the network, the spanning tree determines which bridge ports to block from forming loops.

This new configuration is bounded by a time factor. If a designated bridge fails or is physically removed, other bridges on the LAN detect the situation when they do not receive Hello BPDUs within the time period set by the bridge maximum age time. This event triggers a new configuration process where another bridge is selected as the designated bridge. A new configuration is also created if the root bridge fails.

Shaping the Spanning Tree

When the spanning tree uses its default settings the spanning tree algorithm generally provides acceptable results. The algorithm, however, may sometimes produce a spanning tree with poor network performance. In this case you can adjust the bridge priority, port priority, and path cost to shape the spanning tree to meet your network performance expectations. The following examples explain how this is done.

Figure 2-1 on page 2-4 shows three LANs networked using three bridges. Each bridge is using default bridge priority settings for its spanning tree configuration. In this case, the bridge with the lowest physical address is chosen as the root bridge because the bridge priority of each bridge is the same. In this example, this is Bridge 2.

The newly configured spanning tree stays intact due to the repeated transmissions of Hello BPDUs from the root bridge at a preset interval (bridge hello time). Through this process, designated bridges are updated with all configuration information. The designated bridges then regenerate the information from the Hello BPDUs and distribute it to the LANs for which they are designated bridges.

Table 2-1. Spanning Tree Default Values

Bridge 1	**Bridge 2**	**Bridge 3**
Bridge Priority: 32768 Address: 00:00:90:00:00:10 **Port 1** Priority: 128 Path Cost: 100 **Port 2** Priority: 128 Path Cost: 17857 **Port 3** Priority: 128 Path Cost: 17857	Bridge Priority: 32768 Address: 00:00:90:00:00:01 **Port 1** Priority: 128 Path Cost: 100 **Port 2** Priority: 128 Path Cost: 17857 **Port 3** Priority: 128 Path Cost: 17857	Bridge Priority: 32768 Address: 00:00:90:00:00:05 **Port 1** Priority: 128 Path Cost: 100 **Port 2** Priority: 128 Path Cost: 17857 **Port 3** Priority: 128 Path Cost: 17857

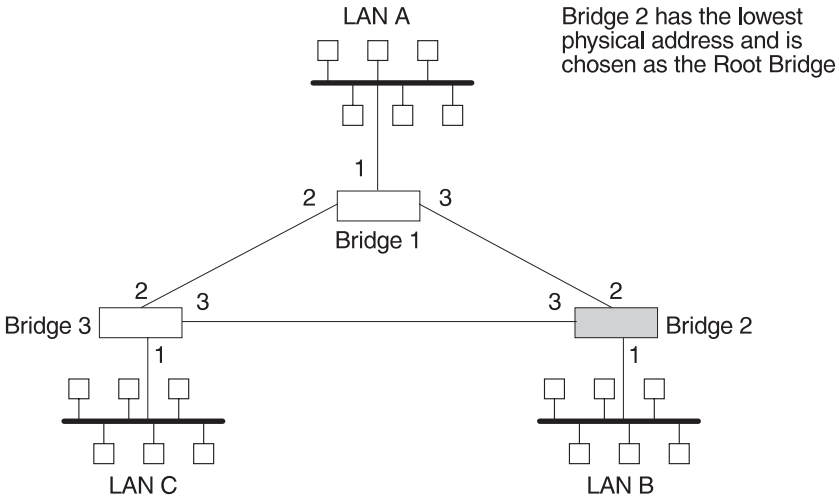

Figure 2-1. Networked LANs Before Spanning Tree

The spanning tree algorithm designates the port connecting Bridge 1 to Bridge 3 (port 2) as a backup port and blocks it from forwarding frames that would cause a loop condition. The spanning tree created by the algorithm using the default values in Table 2-1 is shown in Figure 2-2 on page 2-5 as the heavy lines connecting Bridge 1 to Bridge 2, and then Bridge 2 to Bridge 3. The root bridge is Bridge 2.

This spanning tree results in poor network performance because the workstations on LAN C can get to the file server on LAN A only indirectly through Bridge 2 rather than using the direct connection between Bridge 1 and Bridge 3.

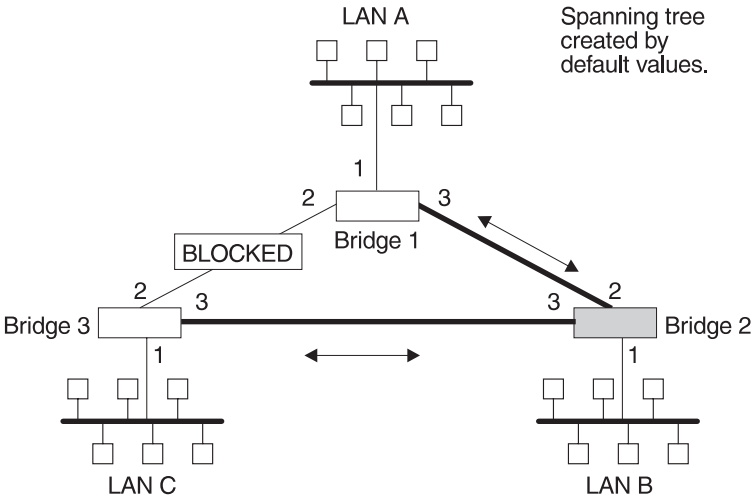

Figure 2-2. Spanning Tree Created With Default Values

Normally, this network uses the port between Bridge 2 and Bridge 3 infrequently. Therefore you can improve network performance by making Bridge 1 the root bridge of the spanning tree. You can do this by configuring Bridge 1 with the highest priority of 1000. The spanning tree that results from this modification is shown in Figure 2-3 as the heavy lines connecting Bridge 1 to Bridge 3 and Bridge 1 to Bridge 2. The root bridge is now Bridge 1. The connection between Bridge 2 and Bridge 3 is now blocked and serves as a backup data path.

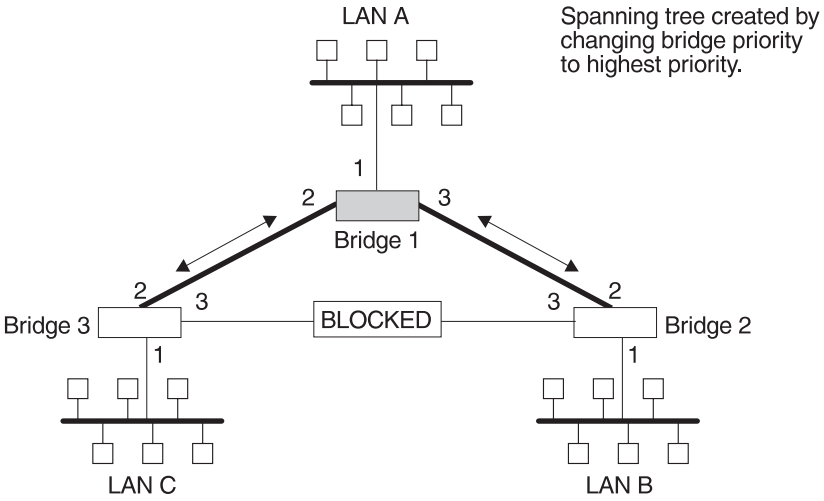

Figure 2-3. User-Adjusted Spanning Tree

Spanning Tree Bridges and Ethernet Packet Format Translation

The 8210 Spanning Tree Bridge protocol provides packet forwarding for the bridging routers in accordance with IEEE Standard 802.1D-1990 Media Access Control (MAC) bridges. The protocol also provides appropriate header translation for Ethernet packets.

An Ethernet/IEEE 802.3 network can simultaneously support the Ethernet data link layer and the IEEE 802.2 data link layer, based on the value of the length/type field in the MAC header. The bridge must translate to and from Ethernet format to

provide transparency across mixed LAN types. The algorithm used is based on emerging IEEE standards.

The basic approach consists of translating Ethernet packets to IEEE 802.2 Unnumbered Information (UI) packets using the IEEE 802 SNAP SAP. The SNAP Protocol Identifier has the organization-unique identifier (OUI) of 00-00-00, with the last 2 bytes being the Ethernet *type* value.

IBM RT Feature for SNA Traffic

Some IBM personal computers (IBM RT PC running AIX or any PC running OS/2 EE) encapsulate SNA within Ethernet Type 2 packets instead of using IEEE 802.3 Ethernet encapsulation. This requires a special Ethertype header that contains the length of the MAC user data followed by the IEEE 802.2 (LLC) header.

The processing of these frames can be enabled/disabled on a per-port basis. In the enabled mode, the bridge learns the source station's behavior. When frames are targeted for such stations, the bridge generates the correct frame format. If there is no information about the station's behavior, (as with multicast or unknown stations), the bridge produces duplicate frames, one in IEEE 802.3 and IEEE 802.2 format, and the other with the IBM-RT header.

UB Encapsulation of XNS Frames

XNS Ethernet frames use Ethertype 0x0600. When translated to token-ring format, these frames get SNAP as specified in IEEE 802.1H. Because some Token-Ring end stations use the Ungermann-Bass OUI in the SNAP for such frames, there is a configuration switch to activate this encapsulation. The switch to activate this encapsulation is set with the **frame token_ring_SNAP** command.

Transparent Bridging and ATM

The ATM interface forwards transparent frames from Ethernet and Token-Ring networks, provided bridging is enabled on the virtual channel connection (VCC). IP tunneling does not have to be used.

Hello BPDUs are generated and transmitted for each VCC configured for transparent bridging. The spanning tree protocol allows ATM VCCs that have not been designated as part of the active data path to be BLOCKED, thereby eliminating loops.

Transparent Bridge Terminology and Concepts

This section reviews the terms and concepts commonly used in transparent bridging.

Aging Time

The length of time (age) before a dynamic entry is removed from the filtering database when the port with the entry is in the forwarding state. If dynamic entries are not referenced by the aging time, they are deleted.

Bridge
A protocol-independent device that connects local area networks (LANs). These devices operate at the data link layer, storing and forwarding data packets between LANs.

Bridge Address
The least significant 6-octet part of the bridge identifier used by the spanning tree algorithm to identify a bridge on the network. The bridge address is set to the MAC address of the lowest-numbered port by default. You can override the default address by using the **set bridge** configuration command.

Bridge Hello Time
The bridge hello time specifies how often a bridge sends out Hello BPDUs (containing bridge configuration information) when it becomes the root bridge in the spanning tree. This value is useful only for the root bridge because it controls the hello time for all bridges in the spanning tree. Use the **set protocol bridge** command to set the bridge hello time.

Bridge Forward Delay
The amount of time a bridge port spends in the listening state as well as the learning state. The forward delay is the amount of time the bridge port listens in order to adjust the spanning tree topology. It is also the amount of time the bridge spends learning the source address of every packet that it receives while the spanning tree is configuring. This value is useful only for the root bridge because it controls the forward delay for all bridges in the spanning tree.

The root bridge conveys this value to all bridges. This time is set with the **set protocol bridge** command. The procedure for setting this parameter is discussed in the next chapter.

Bridge Identifier
A unique identifier that the spanning tree algorithm uses to determine the spanning tree. Each bridge in the network must have a unique bridge identifier.

The bridge identifier consists of two parts: a least-significant 6-octet bridge address and a most-significant 2-octet bridge priority. By default, the bridge address is set to the MAC address of the lowest-numbered port. You can override the default address with the **set bridge** configuration command.

Bridge Maximum Age
The amount of time that spanning tree protocol information is considered valid before the protocol discards the information and a topology changes. All the bridges in the spanning tree use this age to time out the received configuration information in their databases. This allows a uniform timeout for every bridge in the spanning tree. Use the **set protocol bridge** command to set the bridge maximum age.

Bridge Priority
The most significant 2-octet part of the bridge identifier set by the **set protocol bridge** command. This value indicates the chances of each bridge becoming the root bridge of the network. In setting the bridge priority, the spanning tree algorithm chooses the bridge with the highest priority value to be the root bridge of the spanning tree. A bridge with the lowest numerical value has the highest priority value.

Designated Bridge

The bridge that claims to be the closest to the root bridge on a specific LAN. This closeness is measured according to the accumulated path cost to the root bridge.

Designated Port

The port ID of the designated bridge attached to the LAN.

Filtering and Permanent Databases

Databases that contain information about station addresses that belong to specific port numbers of ports connected to the LAN.

The filtering database is initialized with entries from the permanent database. These entries are permanent and survive power on/off or system resets. You can add or delete these entries through the spanning tree configuration commands. Entries in the permanent database are stored as static random access memory (SRAM) records, and the number of entries is limited by the size of SRAM.

Note: You can also add entries (static) by using the monitoring commands but these ***do not*** survive power on/off and system resets.

The filtering database also accumulates entries learned by the bridge (dynamic entries) which have an aging time associated with them. When entries are not referenced over a certain time period (age time), they are deleted. Static entries are ageless, so dynamic entries cannot overwrite them.

Entries in the filtering and permanent databases contain the following information:

- *Address*. The 6-byte MAC address of the entry
- *Port Map*. Specifies all port numbers associated with that entry
- *Type of Entry*. Specifies one of the following types:
  - Reserved Entries. Reserved by the IEEE 802.1d committee.
  - Registered Entries. Consist of unicast addresses belonging to communications hardware attached to the box or multicast addresses enabled by protocol forwarders.
  - Permanent Entries. Entered by the user in the configuration process. They survive power on/off and system resets.
  - Static Entries. Entered by the user in the monitoring process. They do not survive power on/off and system resets and are ageless.
  - Dynamic Entries. Dynamically learned by the bridge. They do not survive power on/off and system resets and have an associated age.
  - Free. Locations in database that are free to be filled by address entries.
- *Address Age (dynamic entries only)*. Resolution of time period at which address entries are ticked down before being discarded. You can set this value.

Make changes to the permanent database through the spanning tree configuration commands and make changes to the filtering database through the GWCON monitoring process.

Parallel Bridges
Two or more bridges connecting the same LANs.

Path Cost
Each port interface has an associated path cost which is the relative value of using this port to reach the root bridge in a bridged network. The spanning tree algorithm uses the path cost to compute a path that minimizes the cost from the root bridge to all other bridges in the network topology. The sum total of all the designated costs and the path cost of the root port is called the root path cost.

Port
The bridge's connection to each attached LAN or WAN. A bridge must have at least two ports to function as a bridge.

Port ID
A 2-octet port identifier. The most-significant octet represents the port priority and the least-significant octet represents the port number. Both port number and port priority are user-assignable. The port ID must be unique within the bridge.

Port Number
A user-assigned 1-octet part of the port ID whose value represents the attachment to the physical medium. A port number of zero is not allowed.

Port Priority
The second 1-octet part of the port ID. This value represents the priority of the port that the spanning tree algorithm uses in making comparisons for port selection and blocking decisions.

Resolution
The time factor by which dynamic entries are ticked down as they age within the database. The range is 1 to 60 seconds.

Root Bridge
The bridge selected as the *root* of the spanning tree because it possesses the highest priority bridge ID. This bridge is responsible for keeping the spanning tree intact by regularly emitting Hello BPDUs (containing bridge configuration information). The root bridge is the designated bridge for all the LANs to which it is connected.

Root Port
The port ID of a bridge's port that offers the lowest cost path to the root bridge.

Spanning Tree
A topology of bridges such that there is one and only one data route between any two end stations.

Transparent Bridging
This type of bridging involves a mechanism that is *transparent* to end stations applications. Transparent bridging interconnects local area network segments by bridges designated to forward data frames through a spanning tree algorithm.

Source Route Bridging (SRB)

Source routing is a method of forwarding frames through a bridged network in which the source station identifies the route that the frame will follow. In a distributed routing scheme, routing tables at each bridge determine the path that data takes through the network. By contrast, in a source routing scheme, the source station defines the entire route in the transmitted frame.

The source routing bridge (SRB) provides local bridging over 4 and 16 Mbps token-rings, as shown in Figure 2-4. It can also connect remote LANs through a telecommunications link operating at speeds up to E1.

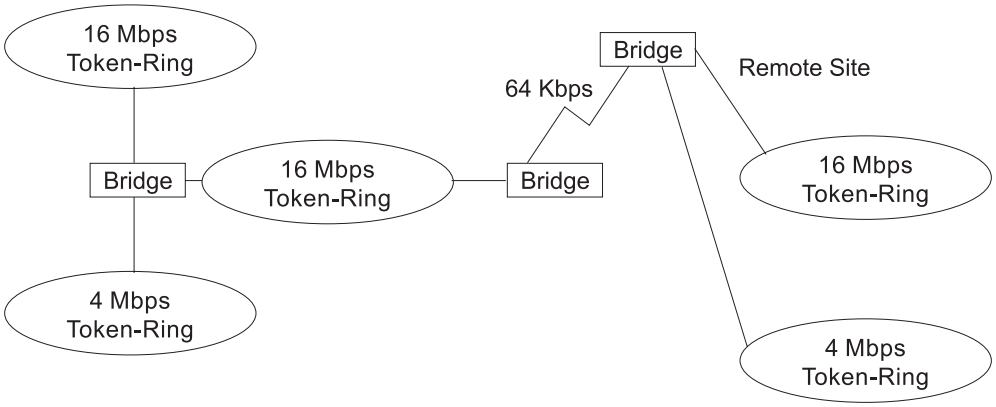

Figure 2-4. Example of Source Routing Bridge Connectivity

Among its features, the source routing bridge provides:

- *Bridge compatibility*. You can use the bridge to connect IBM PC LANs running systems such as OS/2, PC LAN Manager, and NetBIOS. The bridge can also carry IBM SNA traffic between PC LANs and mainframes.
- *Performance and speed*. Because bridging occurs at the data link layer instead of the network layer, packet conversion and address table maintenance are not necessary. This requires less overhead and permits higher speed routing decisions.
- *Bridge tunneling*. By encapsulating source routing packets, the bridge/router dynamically routes these packets through internetworks to the desired destination end station without degradation or network size restrictions.

  Source routing end stations see this path as a single hop, regardless of the network complexity. This helps overcome the usual seven-hop distance limit encountered in source routing configurations. This feature also lets you connect source routing end stations across non-source routing media (for example, Ethernet networks).

Source Routing Bridge Operation

As mentioned, the source station defines the entire route in the transmitted frame in a source routing configuration. The source routing bridge is dynamic. Both end stations and bridges participate in the route discovery and forwarding process. The following steps describe this process:

1. A source station sends out a frame and finds that the frame's destination is not on its own (local) segment or ring.

2. The source station builds a *route discovery* broadcast frame and transmits it onto the local segment.
3. All bridges on the local segment capture the route discovery frame and send it over their connected networks.

   As the route discovery frame continues its search for the destination end station, each bridge that forwards it adds its own bridge number and segment number to the routing information field (RIF) in the frame. As the frame continues to pass through the bridged network, the RIF compiles a list of bridge and segment number pairs describing the path to the destination.

   When the broadcast frame finally reaches its destination, it contains the exact sequence of addresses from source to destination.
4. When the destination end station receives the frame, it generates a response frame including the route path for communication. Frames that wander to other parts of the bridged network (accumulating irrelevant routing information in the meantime) never reach the destination end station and no station ever receives them.
5. The originating station receives the learned route path. It can then transmit information across this established path.

Source Routing Frames

As mentioned, bridges interconnect LANs by relaying data frames, specifically MAC frames, between the separate MAC entities of the bridged LANs. MAC frames provide the necessary “Where?” information in the form of source and destination addresses. This information is essential for the successful transmission and reception of data.

In source routing, the data frame forwarding decision is based on routing information within the frame. Before the frame is forwarded, end stations have obtained the route to the destination station by the *route discovery* process. The source station that originates the frame designates the route that the frame will travel by imbedding a description of the route in the routing-information field (RIF) of the transmitted frame. A closer look at the various types of source routing bridge frames will help to further explain how the bridge obtains and transmits this routing information.

Because source routing MAC frames contain routing information necessary for data communication over multi-ring environments, they differ slightly in format from the typical token-ring MAC frames. The presence of a “1” in the RII within the source address field indicates that a RIF containing routing information follows the source address. Figure 2-5 on page 2-12 provides a closer look at the format of the source address field of a source routing frame.

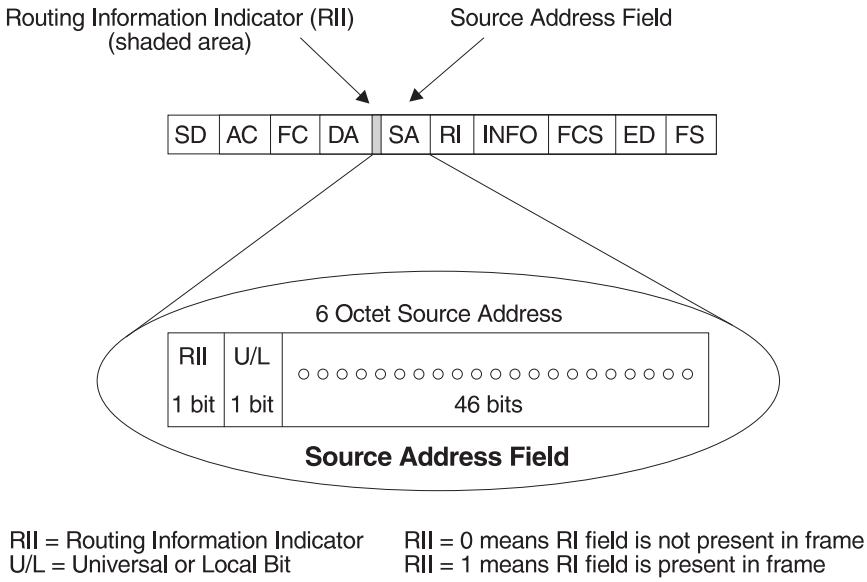

Figure 2-5. 802.5 Source Address Format

When the RII in the source address field is set to 1, a RIF is present after the source address. The RIF is required because it provides route information during source routing. It consists of a 2-octet routing control (RC) field and a series of 2-octet route designator (RD) fields. Figure 2-6 provides a closer look at the format of the Routing Information Field.

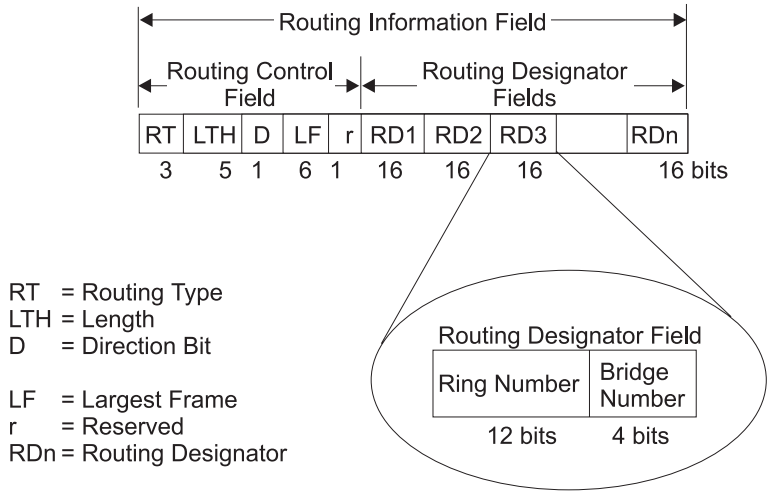

Figure 2-6. 802.5 Routing Information Field

The following information describes each field in the RIF:

- **Routing Type (RT)**.

  Indicates by bit settings if the frame is to be forwarded through the network along a specific route or along a route (or routes) that reaches all interconnected LANs. Depending on the bit settings in this field, the source routing frame can be identified as one of the following types:

  – All-paths explorer frame (explorer frame)
  – Spanning-tree explorer frame (explorer frame)
  – Specifically-routed frame (routing frame)

– Spanning-tree routed frame (routing frame)

All-paths explorer frames exist if the RT bits are set to 100. These frames are generated and routed along every non-repeating route in the network (from source to destination). This process results in as many frames arriving at the destination end station as there are different routes from the source end station. This routing type is the response to receiving a route discovery frame sent along the spanning tree to the present originating station using all the routes available. The forwarding bridges add routing designators to the frame.

A *spanning tree explorer frame* exists if the RT bits are set to 110. Only spanning tree bridges relay the frame from one network to another. This means that the frame appears only once on every ring in the network and therefore only once at the destination end station. A station initiating the route discovery process uses this frame type. The bridge adds routing designator fields to the frame. It can also be used for frames sent to stations using a group address, which is discussed more fully in the next section.

Specifically routed frames exist if the first RT bit is set to 0. When this is the case, the Route Designator (RD) fields containing specific routing information guide the frame through the network to the destination address. Once the frame reaches its destination and discovers a route path, the destination station returns a specifically routed frame (SRF) to the source station. The source station then transmits its data in a specifically routed frame.

- **Length bits (LTH)**. Indicates the length (in octets) of the RI field.
- **Direction bit (D)**. Indicates the direction the frame takes to traverse the connected networks. If this bit is set to 0, the frame travels the connected networks in the order in which they are specified in the routing information field (for example, RD1 to RD2 to... to RDn). If the direction bit is set to 1, the frame travels the networks in the reverse order.
- **Largest frame bits (LF)**. Indicates the largest frame size of the INFO field that can be transmitted between two communicating end stations on a specific route. The LF bits are meaningful only for STE and ARE frames. In specifically routed frames (SRFs), the bridge ignores the LF bits and cannot alter them. A station originating an explorer frame sets the LF bits to the maximum frame size it can handle. Forwarding bridges set the LF bits to the largest value that does not exceed the minimum of:
  - The indicated value of the received LF bits
  - The largest maximum service data unit (MSDU) size supported by the bridge
  - The largest MSDU size supported by the port from which the frame was received
  - The largest MSDU size supported by the port on which the frame is to be transmitted.

  If necessary, the destination station further reduces the LF value to indicate its maximum frame capacity.

  LF bit encoding is made up of a 3-bit base encoding and a 3-bit extended encoding (6 bits total). The SRT bridge (explained in a later section) contains an LF mode indicator allowing the bridge to select either base or extended LF bits. When the LF mode indicator is set to the *base mode*, the bridge sets the LF bits in explorer frames with the largest frame base values. When the LF

mode indicator is set to *extended mode*, the bridge sets the LF bits in explorer frames with the largest frame extended values.

- **Route designator fields (RDn)** indicates the specific route through the network according to the sequence of the RD fields. Each RD field contains a unique network 12-bit ring number and 4-bit bridge number that differentiates between two or more bridges when they connect the same two rings (parallel bridges). The last bridge number in the routing information field has a null value (all zeros).

The Spanning Tree Explore Option

The spanning tree explore feature lets you select a single route to a destination when your network has two or more bridges connecting the same LANs. With this feature enabled, only the bridges you select receive spanning tree explorer (STE) frames. Not to be confused with the spanning tree protocol, this option allows you to:

- Simulate a spanning tree network
- Balance traffic loads

Simulating a Spanning Tree Network

A spanning tree network contains a single data route between any two end stations. If your network uses two or more parallel bridges, such as those in Figure 2-7, you can manually configure a spanning tree in a network by preventing duplication of discovery frames onto the network. Without spanning tree explore enabled, if Station Q transmits a discovery frame to a Station R, both Bridge A and Bridge B retransmit that frame. Segment 2 then receives two copies of the same frame.

With spanning tree explore enabled, each LAN segment on the network receives only one copy of the transmitted frame. Only the bridges you select can receive STE frames, reducing the creation of redundant frames and lowering network overhead.

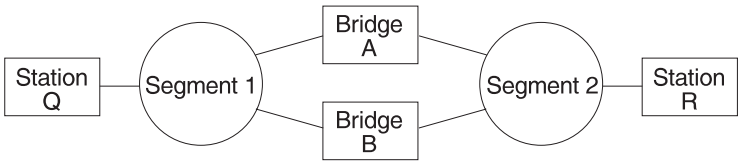

Figure 2-7. Example of Parallel Bridges

Balancing Traffic Loads

You can also use the spanning tree explore option for load balancing. For example, in Figure 2-8 on page 2-15, Bridge A is configured to accept STE frames over the interface connecting Segment 2. Bridge B is configured to accept STE frames over the interface connecting Segment 1. Traffic travels in the direction of the arrows. This configuration allows parallel bridges to share the traffic load.

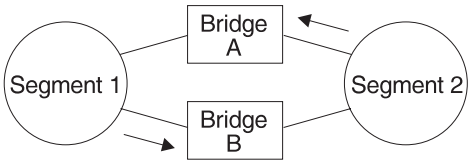

Figure 2-8. Using Spanning Tree Explore for Load Balancing

Note: For source routing to work, some end-node applications such as the IBM PC LAN program require you to enable spanning tree explore on attached interfaces. For parallel bridge configuration, the spanning tree explore option should be enabled only on one of the parallel interfaces. However no serious harm (other than some extra traffic) results from having too many interfaces enabled for the spanning tree.

If you use the spanning tree explore option and any bridge on the single-route path goes down, source routing traffic cannot reach its destination. You must manually reconfigure an alternate path.

Source Routing Bridging and ATM

The ATM interface forwards source-routed frames to and from the bridging forwarder provided source routing bridging is enabled on the virtual channel connection (VCC). A destination ring number is configured for each VCC. Some VCCs that are not part of the active data path are BLOCKED in order to maintain the loop-free topology.

Source Routing Bridge Terminology and Concepts

This section reviews the terms and concepts commonly used in source routing bridging.

Bridge Instance

The bridge instance identifies the sequence of a bridge defined in the software. For example, in a bridge with two configured bridges, the bridge instances would be 1 and 2.

Bridge instances within a single bridge are independent and do not communicate. For example, in Figure 2-9 on page 2-16, Station A cannot pass data to either station on Bridge Instance 2. It can pass frames only to Station B. In effect, the bridge instance allows you to create two separate networks. These networks do not communicate unless they physically interconnect at some other point.

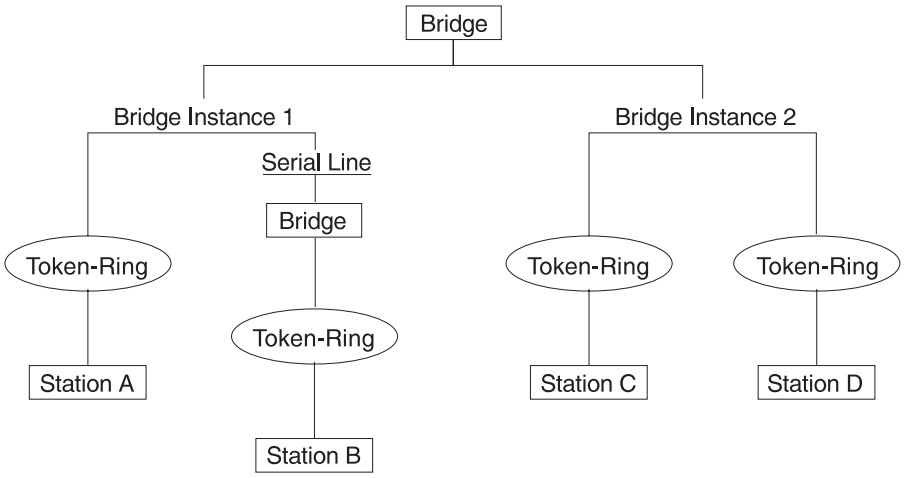

Figure 2-9. Bridge Instances within a Bridge

Bridge Number

The bridge number is a 4-bit hexadecimal value that identifies a bridge. Although bridges which are attached to the same ring can have the same bridge number, parallel bridges (bridges that are connected to the same two rings) must have unique bridge numbers.

Explorer Frames

The source routing bridge adds routing information to an explorer frame as it forwards the frame through the network to its destination end station. The explorer frame is used to discover routes. There are two types of explorer frames: all-routes explorer (ARE) frames and spanning-tree explorer (STE) frames. ARE frames are forwarded by all ports while STE frames are forwarded only by ports assigned to forward them by the spanning tree protocol.

Interface Number

The interface number identifies a “physical” interface within the hardware/product and must be tied to the “logical” interface that is understood by a bridge (that is a port). When you configure the router software, the router/bridge numbers the ports sequentially. To use the source routing bridge, you must use the port numbers to identify the interface that connects each network segment.

Route

The route is a path through a series of LANs and bridges for example, SRB bridges.

Route Discovery

Route discovery is the process by which a route is learned to a destination end station.

Segment Number

The segment number identifies each individual LAN, such as a single token-ring or serial line. A segment connects to the bridge, but can also operate independently.

Source Routing

Source routing is a bridging mechanism that routes frames through a multi-LAN network by specifying in the frame the route it will travel.

Source Routing Transparent (SRT) Bridge

Having worked hard to adopt standardized technologies (Ethernet and token-ring are both defined by IEEE), you may actually be forced back into the proprietary arena when trying to connect them. This is because bridges function differently in token-ring and Ethernet networks.

Aside from the differences such as bit-ordering, packet size, and acknowledgment bits, differences in bridging methods are another obstacle. Ethernet bridges use the transparent bridging method in which the bridges determine the route of the traffic through the network. Token-ring networks use transparent bridging only in some instances, so they generally depend on source routing as the primary bridging method.

Source routing cannot operate in a transparent environment because transparent packets contain no routing information. In this case, the bridge has no way of knowing whether to forward the packet. While transparent bridging can operate in a source routing environment, it does so without any routing information being passed to an end station. Significant information (for example, packet sizing) is missing and can potentially create problems.

IEEE has ratified an extension to the 802.1D transparent bridging standard called source routing transparent (SRT). SRT is a bridging technology that attempts to resolve a large part of the incompatibility inherent in bridging token-ring and Ethernet. It saves you the cost of installing multiple bridges and separate links to support the two types of traffic by adding a parallel bridging architecture (rather than an alternative) to the transparent bridging standard.

General Description

A source routing transparent (SRT) bridge is a MAC bridge that performs source routing when source routing frames with routing information are received and that performs transparent bridging when frames are received without routing information. In SRT, all the bridges between Ethernets and token-rings are transparent. The bridges operate at the MAC sublayer of the data link layer and are completely invisible to the end stations.

The SRT bridge distinguishes between the two types of frames by checking the value in the RII field of the frame (see “Source Routing Frames” on page 2-11 for more information). An RII value of 1 indicates that the frame is carrying routing information while a value of 0 in the RII indicates that no routing information is present. With this method, the SRT bridge forwards transparent bridging frames without any conversions to the outgoing media (including token-ring). Source routing frames are restricted to the source routing bridging domain.

The spanning tree protocol and algorithm forms a single tree involving all the networks connected by SRT bridges. The SRT-bridged network offers a larger domain of transparent bridging with sub-domain of source routing. Thus, transparent frames are capable of reaching to the farthest side of the SRT- and TB-bridged LAN while source routed frames are limited to only the SRT- and SRB-

bridged LAN. In the SRT bridging model, source routing and transparent bridging parts use the same spanning tree. In the SRT-bridged domain, end stations are responsible for answering the “Source Routing or Transparent Bridging” question.

Source Routing Transparent Bridge Operation and Architecture

With an SRT bridge, each bridge port receives and transmits frames to and from the attached local area networks using the MAC services provided by the individual MAC entity associated with that port. The MAC relay entity takes care of the MAC-independent task of relaying frames between bridge ports. If the received frame is not source-routed (RII = 0), then the bridge frame is forwarded or discarded using the transparent bridging logic. If the received frame is source-routed (RII = 1), then the frame is handled according to the source routing logic. This process is illustrated in Figure 2-10. The arrows represent the data path.

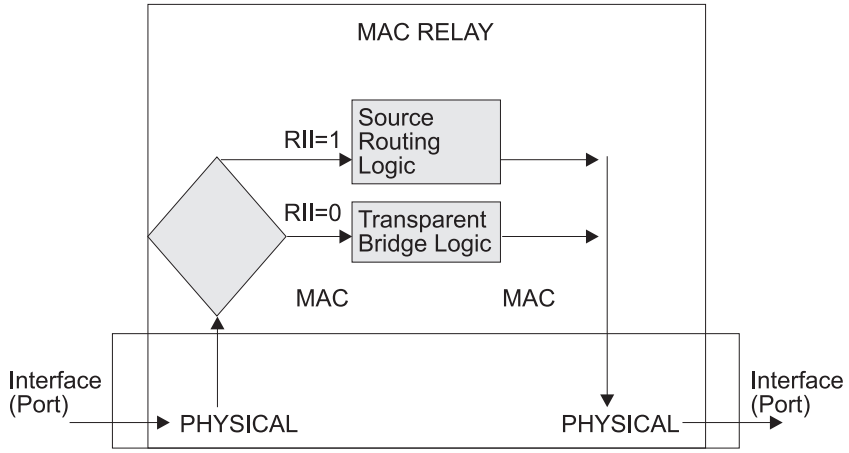

Figure 2-10. SRT Bridge Operation

SRT differentiates between source-routed and non-source-routed traffic on a frame-by-frame basis. If the packet is source-routed, the bridge forwards it as such. If it is a transparent bridge packet, the bridge determines the destination address and forwards the packet.

Source Routing Transparent Bridging and ATM

The ATM interface forwards source routed and transparent frames to and from the bridging forwarder provided SRT bridging is enabled on the virtual channel connection (VCC).

Source Routing Transparent Bridge Terminology

This section reviews the terms and concepts commonly used in SRT bridging.

Explorer Frames

The source routing bridge adds routing information to an explorer frame as it forwards the frame through the network to its destination end station. The explorer frame discovers routes. There are two types of explorer frames:

- All-routes explorer (ARE) frames
- Spanning-tree explorer (STE) frames

ARE frames are intended to be forwarded by all ports while STE frames are forwarded only by ports assigned to forward them by the spanning tree protocol.

Routing Information Field (RIF)

In source routing, the data frame forwarding decision is based on routing information within the frame. Before forwarding the frame, end stations obtain the route to the destination station by the *route discovery* process. The station that originates the frame (that is, the *source* station) designates the route that the frame will travel by imbedding a description of the route in the Routing Information Field (RIF) of the transmitted frame.

Routing Information Indicator (RII)

Because source routing MAC frames contain routing information necessary for data communication over multi-ring environments, their format differs slightly from the typical token-ring MAC frames. The presence of a 1 in the source address field called the Routing Information Indicator indicates that a Routing Information Field containing routing information follows the source address. The SRT bridge distinguishes between source-routed and non-source-routed frames by checking for a 1 or 0 value in the RII field.

Source Routing

A bridging mechanism that routes frames through a multi-LAN network by specifying in the frame the route it will travel.

Spanning Tree

A topology of bridges in which there is only one data route between any two end stations.

Transparent Bridging

A type of bridging that involves a mechanism that is transparent to end stations. Transparent bridging interconnects local area network segments by bridges designated to forward data frames through in a spanning tree algorithm.

ASRT Bridge Overview

The adaptive source routing transparent (ASRT) bridge is a software collection of several bridging options. The ASRT bridge software combines transparent bridging and source routing so that they function separately or can be combined as a single ASRT bridge. This extended function allows communication between a strict source routing end station and a transparent end station via an ASRT bridge. Depending on the set of configuration commands used, the ASRT bridge provides the following bridging options:

- Transparent bridge (STB)
- Source routing bridge (SRB)
- Source routing transparent bridge (SRT)
- Source routing—transparent bridge (SR-TB)

The ASRT bridge is modeled after the source routing transparent bridge described in IEEE 802.5M/Draft 6 (1991) of SRT. Modifications have been built into the ASRT bridge which provide users with extended function that goes beyond compliance with the SRT standard. The ASRT bridge allows compatibility with the installed base of source routing bridges, while still enabling them to link Ethernet, and token-ring LANs. ASRT also enhances basic SRT function in some additional, critical ways described in the following sections.

Adaptive Source Routing Transparent Bridge (ASRT) (SR-TB Conversion)

While source routing is still available in the SRT model, it is available only between adjacent source routing token-rings. Source routing-only bridges cannot coexist with SRT bridges that link Ethernet and token-ring LANs. Because a token-ring end node needs to communicate with an Ethernet node, it must be configured to omit RIFs. Also, if the end node is configured to omit RIFs, it cannot communicate through ordinary source routing bridges that require that RIF.

General Description

The source routing - transparent bridge (SR-TB) option interconnects networks using source routing bridging (source routing domain) and transparent bridging (transparent bridging domain). It transparently joins both domains. During operation, stations in both domains are not aware of the existence of each other or of the SR-TB bridge. From a station's point of view, any station on the combined network appears to be in its own domain.

The bridge achieves this function by converting frames from the transparent bridging domain to source routing frames before forwarding them to the source routing domain (and conversely). This is accomplished by the bridge maintaining a database of end-station addresses each with its Routing Information Field in the source routing domain. The bridge also conducts route discovery on behalf of the end stations present in the transparent bridging domain. The route discovery process is used to find the route to the destination station in the source routing domain. Frames sent to an unknown destination are sent in the spanning tree explorer (STE) format.

The SR-TB bridge anticipates three types of spanning trees:

- A spanning tree formed by transparent bridge domain
- A spanning tree formed by source routing bridge domain
- A special spanning tree of all SR-TB bridges

The following sections discuss the operation of the SR-TB bridge in more detail.

Source Routing-Transparent Bridge Operation

During SR-TB operation, a network is partitioned into a series of two or more separate domains. Each domain is made up of a collection of LAN segments interconnected by bridges all operating under a common bridging method. This allows networks comprised of two types of domains (depending on the bridging method):

- Source routing domains
- Transparent bridging domains

Figure 2-11 on page 2-21 shows an example of these domains. With separate domains, each source routing domain has a single-route broadcast topology set up for its bridges. Only bridges belonging to that source routing *spanning tree* are designated to forward single-route broadcast frames. In this case, frames that carry the single-route broadcast indicator are routed to every segment of the source routing domain. Only one copy of the frame reaches each segment because the source routing spanning tree does not allow multiple paths between any two stations in the domain.

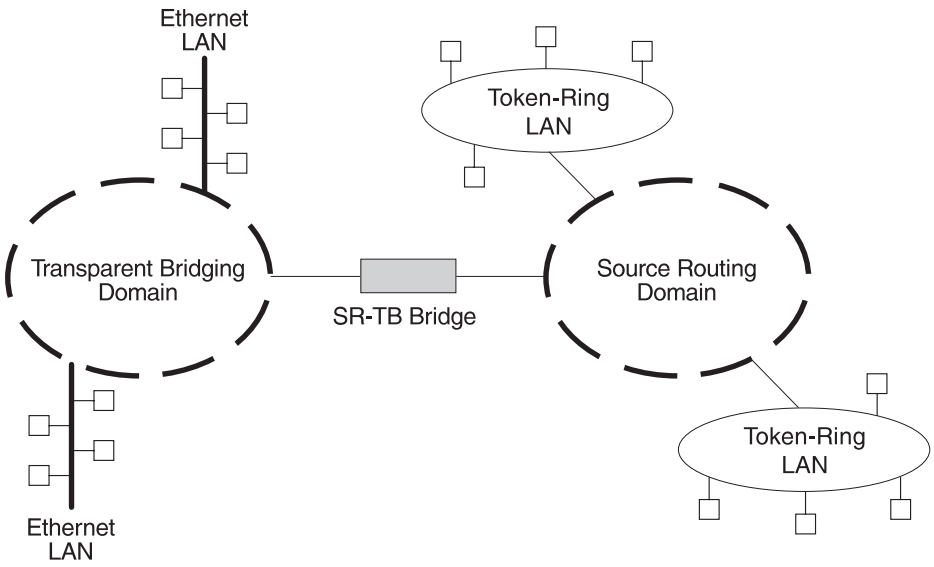

Figure 2-11. SR-TB Bridge Connecting Two Domains

Specific Source Routing and Transparent Bridging Operations

The SR-TB bridge is a *two-port device* with a MAC interface assigned to the LAN segment on the source routing side and another assigned to the LAN segment on the transparent bridging side. Each end station reads the appropriate MAC layer for its LAN segment. This means that bridging functions can be divided into two types of operations:

- Transparent bridging operations
- Source routing bridging operations

On the transparent bridging side, the SR-TB bridge operates the same as any other transparent bridge. The bridge keeps a table of addresses for stations it knows are transparent bridging stations. The SR-TB bridge observes the *inter-bridge* protocols necessary to create and maintain the network spanning tree because more than one SR-TB bridge joins different domains.

The SR-TB bridge forwards the frames received from its transparent bridging station to the source routing side of the bridge only if the destination address carried in the frame is not found in the bridge's transparent bridging side address table.

On the source routing bridging side, the SR-TB bridge combines the functions of a source routing bridge and a source routing end station in a specific way. As a source routing end station, the bridge maintains an association of destination addresses and routing information on the source routing side. It communicates either as an end station for applications in the bridge itself (for example, network management) or as an intermediary for stations on the transparent bridging side.

The SR-TB bridge forwards the frames received from its transparent bridging station to the source routing side of the bridge only if the destination address carried in the frame is not found in the bridge's transparent bridging side address table. Frames transmitted by the bridge's source routing station carry the routing information associated with the bridge, if such information is known and held by the bridge.

As a source routing bridge, the SR-TB bridge participates in the route discovery process and in the routing of frames already carrying routing information. The route designator unique to the SR-TB bridge consists of the LAN number of the individual LAN on its source routing side and the bridge's individual bridge number.

The bridge also maintains a single LAN number representing all of the LANs on the transparent bridging side. The SR-TB bridge treats each case of received and forwarded frames differently as described in Table 2-2.

Table 2-2 (Page 1 of 2). SR-TB Bridge Decision Table

Type of Frame Received	Action Taken by SR-TB Bridge
Non-routed frames received by the source routing station.	Does not copy or forward frames carrying routing information.
All-routes broadcast frame received by the source routing station.	Copies frame and sets A and C bits of the broadcast indicator in the repeated frame. If the destination address is in the transparent bridging table, the bridge forwards the frame without routing information on the transparent bridging network. Otherwise, the frame is not forwarded.
Single-route broadcast frame received by the source routing station. The bridge is not designated as single-route broadcast bridge.	Does not copy or forward the frame.
Single-route broadcast frame received by the source routing station. The bridge is designated as single-route broadcast bridge.	Copies frame, sets A and C bits in the broadcast indicator, removes the routing information from the frame, and forwards the modified frame to transparent bridging side. Adds its bridge number to the saved routing information field and the LAN number for transparent bridging side. Changes the broadcast indicator to non-broadcast, complements D-bit, and stores this routing information for the source address of the frame.
Non-broadcast frame received by the source routing station.	If frame carries specific route, bridge examines the routing information. If SR-TB bridge is part of the route and appears between the LAN number for the source routing side and LAN number for transparent bridge side, the bridge copies the frame and sets A and C bits in the repeated frame. Forwards frame to the transparent bridging side without routing information. If bridge does not already have a permanent route for the source address, it saves a copy of the routing information, complements D-bit, and stores saved routing information for the source address of the frame.

Table 2-2 (Page 2 of 2). SR-TB Bridge Decision Table

Type of Frame Received	Action Taken by SR-TB Bridge
Frame received from the transparent bridging side.	To forward frame to the source routing side, the bridge first determines if it has routing information associated with the destination address carried in the frame. If yes, the bridge adds routing information to the frame, sets the RII to 1, and queues the frame for transmission on the source routing side. If no, the bridge adds a routing control field to the frame containing an indicator for single-route broadcast and two route designators containing the first two LAN numbers and its own individual bridge number.

SR-TB Bridging: Four Examples

The SR-TB bridge interconnects source routing domains with transparent bridging domains by transparently joining the domains. During operation, stations in both domains are unaware of the existence of each other or of the SR-TB bridge. From the end station's point of view, any station on the combined network appears to be in its own domain.

The following sections provide specific examples of frame forwarding during SR-TB bridging. These examples assume that the SR-TB bridge is designated as a single-route broadcast bridge. Figure 2-12 provides the following information to accompany the situations described in each section:

- Q is the bridge's own bridge number
- X is the LAN number for the LAN on the source routing side
- Y is the LAN number for the LAN on the transparent bridging side
- A, B, C, and D represent end stations

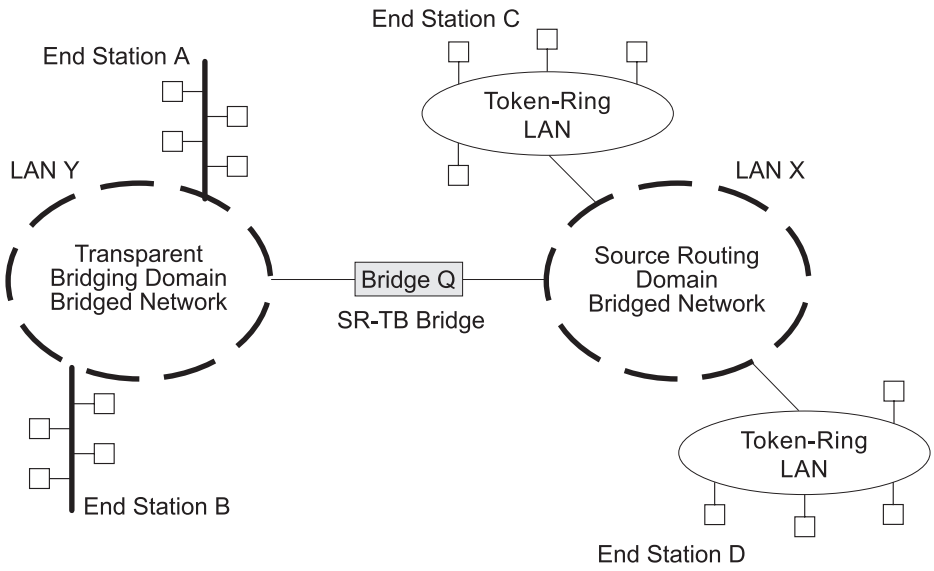

Figure 2-12. SR-TB Bridging Examples

Example 1: Frame Sent from End Station A to End Station B

When the SR-TB bridge receives a frame with a source address of end station A and a destination address of end station B, it enters end station A's address into its transparent bridging side address table. This table contains the addresses of stations known to be on the transparent bridging side of the bridge, which is the normal process for transparent bridging.

If end station B's address is in the transparent bridging side's address table, the SR-TB bridge does not forward the frame. If end station B's address is not in the transparent bridging side's address table and not in the source routing side's address table, its location is not known to the SR-TB bridge. In this case, the frame is forwarded on the source routing side as a single-route broadcast with no request for route explorer return. Any frame sent by end station B (regardless of its destination) causes its address to be added to the transparent bridging address table. This prevents future forwarding of frames addressed to end station B to the source routing side.

Example 2: Frame Sent from End Station A to End Station C

In this example, end station A's address is treated the same as the previous example. Because end station C's address will definitely not be in the transparent bridge address table, the SR-TB bridge will forward the frame on the source routing side.

The bridge then looks for end station C's address in its source routing address table. This table contains all known addresses with related routing information for stations known to be on the source routing side of the bridge. If C's address is in the source routing table, the bridge forwards the frame using the routing information in the address table. If C's address is not in the source routing table (or if it appears but has null routing information), the bridge forwards the frame on the source routing side as a single-route broadcast with no request for route explorer return.

When end station C receives this frame, it enters end station A's address in its source routing table together with the reverse direction of the route built from the SR-TB bridge and marks it as a temporary entry. When end station C later tries to send a frame to end station A, it will use this specific route, and because the route is marked as temporary, the frame will be sent as a non-broadcast route *with* a request for route explorer return.

When the returning frame arrives at the SR-TB bridge, it is forwarded on the transparent bridge side without routing information but will cause the route to end station C to be entered in the source routing table as a temporary route. This further causes the network management entity to send a route-explorer frame with an all-routes broadcast setting back to end station C. This lets end station C select the optimal routing for frames addressed to end station A to be entered as a permanent route in the SR-TB bridge's source routing table.

Example 3: Frame Sent from End Station C to End Station D

If the frame is sent as a non-broadcast and crosses over the segment to which the SR-TB bridge is attached, the bridge scans the RII field for the routing sequence (LAN X to Bridge Q to LAN Y). It cannot find the sequence and so will not forward the frame.

If the frame is sent as a single-route broadcast, the bridge will discard the frame if end station D is already known to be on the source routing side. If end station D is not known to be on the source routing side, the bridge forwards the frame to the transparent bridging side (minus the routing information), and adds “Q to Y” to the routing information. Finally, it saves the routing information for end station C as a temporary route in the source routing table with a non-broadcast indicator and the direction bit complemented.

If the frame is sent as an all-routes broadcast, the SR-TB bridge discards the frame (because end station D’s address is not present in the transparent bridging address table) and makes sure that end station C’s address is in the source routing table.

Example 4: Frame Sent from End Station C to End Station A

If the frame is sent non-broadcast, the bridge scans the RII field for the routing sequence (X to Q to Y). When it finds it, it forwards the frame to the transparent bridging side. It also stores the routing information for end station C.

If the frame is sent as a single-route broadcast, the bridge forwards the frame (minus the routing information) to the transparent bridging side and adds “Q to Y” to the routing information. It also sets the non-broadcast indicator, complements the direction bit, and enters the routing information for C’s address in its source routing table.

If a temporary entry for end station C already exists in the source routing table, the SR-TB bridge updates the routing information. If the frame is sent as an all-routes broadcast, the bridge discards the frame but makes sure that end station C’s address is in the source routing table.

SR-TB and ATM

The ATM interface supports SR-TB bridging by forwarding all bridged frames to the appropriate bridging forwarder as long as bridging has been enabled on the VCC.

Source Routing-Transparent Bridge (SR-TB) Terminology and Concepts

This section describes the terms and concepts used in SR-TB bridging.

All Routes Broadcast

The process of sending a frame through every non-repeating route in the bridged LAN.

All Stations Broadcast

The process of addressing a frame (placing all ones in the destination address) so that every station on the ring the frame appears on copies the frame.

Bridge

A protocol-independent device that connects local area networks (LAN). Bridges operate at the data link layer, storing and forwarding data packets between LANs.

Bridge Number
The unique number identifying a bridge. It distinguishes between multiple bridges connecting the same two rings.

Explorer Frames
The source routing bridge adds routing information to an explorer frame as it forwards the frame through the network to its destination end station. The explorer frame discovers routes. There are two types of explorer frames: all-routes explorer (ARE) frames and spanning-tree explorer (STE) frames. ARE frames are forwarded by all ports while STE frames are forwarded only by ports assigned to forward them by the spanning tree protocol.

Ring Number
The unique number identifying a ring in a bridged network.

Route
A path through a series of LANs and bridges (for example, source routing bridges).

Route Designator
A ring number and a bridge number in the Routing Information Field used to build a route through the network.

Route Discovery
The process of learning a route to a destination end station.

Segment Number
A number that identifies each individual LAN, such as a single token-ring or serial line. A segment connects to the bridge, but can also operate independently.

Single Route Broadcasting
The process of sending a frame through a network such that exactly one copy of the frame appears on each ring in the network.

Source Route Bridging
A bridging mechanism that routes frames through a multi-LAN network by specifying in the frame the route it will travel.

Spanning Tree
A topology of bridges such that there is only one data route between any two end stations.

Transparent Bridging
A type of bridging that involves a mechanism that is *transparent* to end station applications. Transparent bridging interconnects local area network segments by bridges designated to forward data frames in a spanning tree algorithm.

Transparent-Source Routing Compatibility - Issues and Solutions
First, the ASRT bridge provides transparent bridge compatibility with ordinary source routing bridges through source routing bridge conversion (SR-TB). SR-TB was originally proposed as part of the 802.5 specification. This implementation is similar to and can interoperate with IBM's 8209 conversion bridge.

SR-TB converts transparent bridging frames to source routing frames and conversely. In other words, instead of just checking to see whether an RIF is present in a packet and forwarding it to a like destination, the ASRT bridge can translate the packet into either format; it functions as either a transparent bridge or a source routing bridge by inserting or removing an RIF as necessary. With this function, packets can move between Ethernet and SRT token-ring LANs and still be compatible with an installed base of source routing token-ring LANs.

Elimination of Packet Size Problems

SR-TB also eliminates packet sizing problems in token rings being bridged together across an Ethernet domain. In this configuration, end stations use the source routing protocol, which allows them to dynamically determine that there is a network with a 1518-byte maximum frame size between them. The end station automatically honors this limit without a manual reconfiguration. In the reverse situation, bridging Ethernets across a token-ring domain, packet size is not a problem because the token-ring packet size allowance is much larger.

Hardware Address Filtering

Another key feature provided by the ASRT bridge is hardware address filtering. Hardware address filtering solves the conflict in packet acknowledgment methods that exists in the Ethernet and token-ring LAN technologies. It occurs in the MAC layer and is the only technique that accurately sets acknowledgment bits based on the destination MAC address. The ASRT bridge uses content-addressable memories (CAMs) to implement hardware address filtering. This technology effectively gives the bridge a higher level of intelligence by providing instantaneous lookup of MAC addresses without creating any performance penalty.

Bit Ordering in STB and SRB Bridges

Because bridges are continually being built to connect LANs with different MAC address types, bit ordering during data transmission affects the inter-operability of these technologies.

In administering MAC addresses, IEEE assigns addresses known as 48-bit IEEE globally assigned unique MAC addresses. These addresses are supported by 802.3, 802.4, and 802.5 LANs. Due to the lack of standards at the time this addressing scheme was developed, two different situations have arisen:

- 802.3 (Ethernet) and 802.4 LANs transmit source and destination addresses with the group bit first and LLC data fields transmitted least-significant bit (LSB) first.
- 802.5 (token-ring) LANs transmit source and destination addresses with the group bit first and LLC data fields transmitted most-significant bit (MSB) first.

Note: For simplicity, 802.3 and 802.4 bridges and LANs will now be referred to as LSB bridges and LANs. 802.5 bridges and LANs will be referred to as MSB bridges and LANs.

The difference in the bit transmission standard means that a bridge from LSB to MSB LANs has to reverse the bit order of the destination and source MAC addresses at the start of the MAC frame. This is because the different LAN types use the same bit order for the MAC address (that is, group bit first) and yet use a different bit order for the user data (either LSB or MSB first).

The misinterpretation of addresses due to reversed bit ordering is compounded by the fact that some of the higher level communication protocols misinterpret MAC addresses altogether. Protocols such as IP and Novell IPX interpret bridging addresses incorrectly because at the time of their initial development, there was no standard representation of MAC addresses.

The bit order differential is best resolved by combining bridging technology (data link layer technology) with routing technology (network layer technology). Rather than ask the user to “reverse engineer” today’s communications protocols and configure each bridge to “flip” or reverse addresses on a case-by-case basis, the problem is more easily solved by routing these protocols.

Routing eliminates the bit order and protocol addressing problems by accessing the detailed packet addresses running at the higher layer. Routing alone is not a complete solution, because other protocols such as IBM Frames and NetBIOS cannot be routed, and SNA routing is limited. Therefore, it is important to implement SRT in a device where bridging and routing work hand-in-hand.

ASRT Configuration Considerations

The ASRT bridge uses the spanning tree protocol and algorithm described in the IEEE 802.1D bridge standard over all interfaces. It is possible that more than one spanning tree will form in an environment where different types of bridges exist. For example a spanning tree of all bridges practicing IEEE 802.1d protocol (for example, STB and SRT) existing with another tree of IBM 8209 bridges. The loops forming from this configuration require you to correct the situation.

ASRT Configuration Matrix

With an ASRT bridge, the collection of configuration parameters for the bridge and all connected interfaces produces a *bridge personality* for that bridge. The following matrix provides a guide to the configuration settings needed for each interface type to produce the desired bridge personality to handle your network.

Bridge Personality	SR <-> TB Conversion Enabled?	Interface Type & Bridging Method Setting			
		Token Ring	FDDI or Ethernet	Serial Line or Tunnel	ATM
STB	No	TB	TB	TB	TB
SRB	No	SR	--	SR	SR
STB & SRB	No	SR	TB	TB or SR	TB or SR
SR-TB	Yes	SR	TB	TB	TB
SR-TB	Yes	SR	TB	SR	SR
SRT	No	SR & TB	TB	SR & TB	SR & TB
ASRT	Yes	SR & TB	TB	SR & TB	SR & TB
ASRT	Yes	SR	TB	SR & TB	SR & TB
ASRT	Yes	SR or TB	TB	SR & TB	SR & TB

Bridge Personality Key:

STB = Transparent (Spanning Tree) Bridge
SRB = Source Routing Bridge
SR-TB = Source Routing Transparent Conversion Bridge
SRT = Source Routing Transparent Bridge
ASRT = Adaptive Source Routing Transparent Bridge

Bridging Method Key:

SR = Source Routing TB = Transparent Bridging

Chapter 3. Bridging Features

This chapter describes bridging features that are available with the Adaptive Source Routing Transparent (ASRT) bridge. The chapter includes the following sections:

- "Bridging Tunnel"
- "TCP/IP Host Services (Bridge-Only Management)" on page 3-3
- "Bridge-MIB Support" on page 3-3
- "NetBIOS Name Caching" on page 3-3
- "NetBIOS Duplicate Frame Filtering" on page 3-3
- "NetBIOS Name and Byte Filters" on page 3-4
- "Multiple Spanning Tree Protocol Options" on page 3-6
- "Threading (Router Discovery)" on page 3-8
- "Bridging on ATM" on page 3-10

Bridging Tunnel

The bridging tunnel (encapsulation) is another feature of the ASRT bridge software. By encapsulating packets in industry-standard TCP/IP packets, the bridging router can dynamically route these packets through large IP internetworks to the destination end-stations.

End stations see the IP path (the tunnel) as a single hop, regardless of the network complexity. This helps overcome the usual 7-hop distance limit encountered in source routing configurations. It also lets you connect source routing end-stations across non-source routing media, such as Ethernet networks.

The bridging tunnel also overcomes several limitations of regular source routing including:

- Distance limitations of seven hops
- Large amounts of overhead that source routing causes in wide area networks (WANs)
- Source routing's sensitivity to WAN faults and failures (if a path fails, all systems must restart their transmissions)

With the bridge tunnel feature enabled, the software encapsulates packets in TCP/IP packets. To the router, the packet looks like a TCP/IP packet. Once a frame is encapsulated in an IP envelope, the IP forwarder is responsible for selecting the appropriate network interface based on the destination IP address. This packet can be routed dynamically through large internetworks without degradation or network size restrictions. End-stations see this path or tunnel as a single hop, regardless of the complexity of the internetwork. Figure 3-1 on page 3-2 shows an example of an IP internetwork using the tunnel feature in its configuration.

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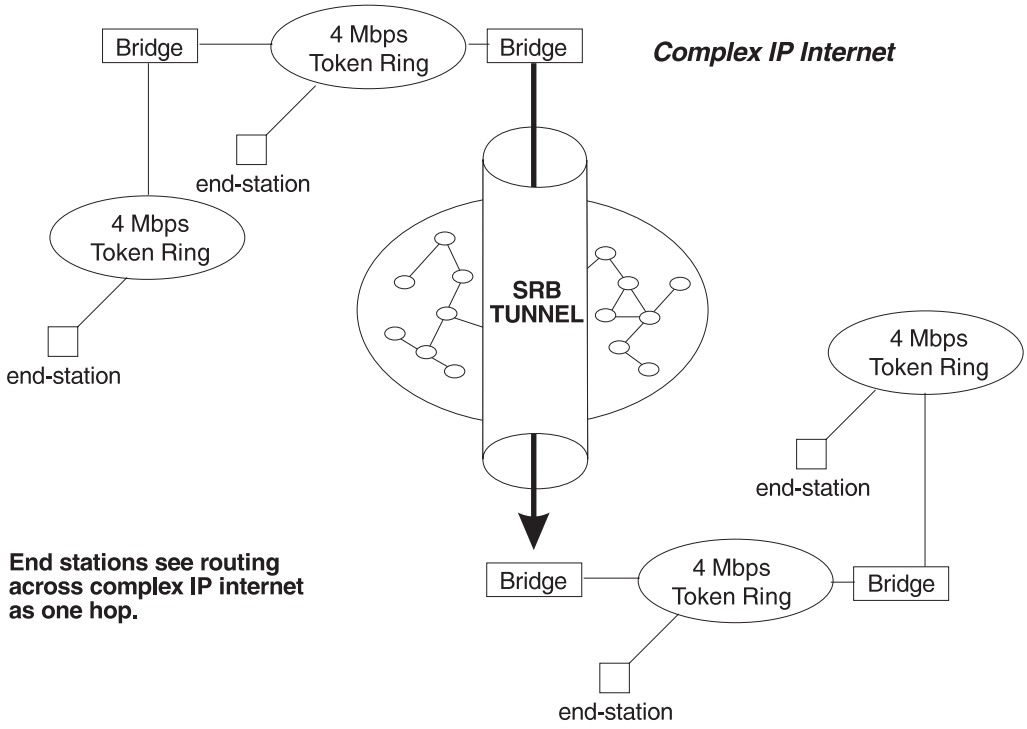

Figure 3-1. Example of the Bridge Tunnel Feature

The tunnel is transparent to the end stations. The bridging routers participating in tunneling treat the IP internet as one of the bridge segments. When the packet reaches the destination interface, the TCP/IP headers are automatically removed and the inner packet proceeds as a standard source routing packet.

Encapsulation and OSPF

A major benefit of the encapsulation feature is the addition of the OSPF dynamic routing protocol to the routing process. OSPF offers the following benefits when used with encapsulation:

- *Least-Cost Routing*. OSPF accesses the fastest path (tunnel) with the fewest delays allowing network administrators to distribute traffic over the least expensive route.
- *Dynamic Routing*. OSPF looks for the least-cost path, and also detects failures and reroutes traffic with low overhead.
- *Multi-Path Routing*. Load sharing makes more efficient use of available bandwidth.

With OSPF, tunnels automatically manage paths inside the internetwork. If a line or bridge fails along the path, the tunnel bridge automatically reroutes traffic along a new path. If a path is restored, the tunnel automatically updates to the best path. This rerouting is completely transparent to the end-stations. For more information on OSPF, see the configuration and monitoring chapters beginning at Chapter 17, “Using OSPF” on page 17-1.

TCP/IP Host Services (Bridge-Only Management)

The bridging router also supports TCP/IP Host services, which let you configure and monitor a bridge when routing functions are disabled. This option gives you the following capabilities:

- Management through SNMP
- Telnet server function
- Downloading and uploading of configurations through the TFTP protocol
- TFTP neighbor boot function
- IP diagnostic tools of ping and trace route
- Control of the device through SNMP sets and the telnet client

When viewed from the bridge's monitoring interface, TCP/IP Host Services is handled as a new protocol having its own configuration and monitoring prompts. These prompts are accessed via the **protocol** command in `talk 6` and `talk 5`.

Bridge-only management function is activated by assigning an IP address to the bridge and enabling TCP/IP Host Services (see Chapter 11, "Configuring and Monitoring TCP/IP Host Services" on page 11-1). This IP address is associated with the bridge as a whole, instead of being associated with a single interface. When booting over the network, the bridge's IP address and a default gateway can be learned automatically through the ROMCOMM interface with the boot PROMs. Default gateway assignments can also be user-configured.

TCP/IP host services are available whenever bridging is an option in the router software load.

Bridge-MIB Support

For Bridge Management via SNMP, the IBM 8210 Multiprotocol Switched Services Server supports the management information bases (MIBs) as specified by RFC 1493 and RFC 1525, ***except*** for the following MIBs:

- dot1dStaticTable
- dot1dTpFdbTable
- dot1dPortPairTable

NetBIOS Name Caching

The NetBIOS name caching feature enables the bridging router to significantly reduce the number of Name-Query frames that leave an originating ring and are forwarded through a bridge. Configuring NetBIOS name caching is part of the NetBIOS configuration. Details are in "NetBIOS Name Caching and Route Caching" on page 8-11.

NetBIOS Duplicate Frame Filtering

Three frame types are typically sent in groups of six:

- Name-Query
- Add-Name
- Add-Group-Name

Duplicate frame filtering uses a timer to allow only one instance of each type of frame to be forwarded through the bridge in the amount of time set by the user.

This process uses a separate database from the one used in Name Caching. Duplicate frame database entries contain the client's MAC address and three time stamps, one for each of the mentioned frame types. Duplicate-frame filtering is processed before name caching. Details are in "Duplicate Frame Filtering" on page 8-5.

NetBIOS Name and Byte Filters

NetBIOS filtering is a feature that allows you to enhance the performance of ASRT Bridging. This feature lets you configure specific filters using the router configuration process. NetBIOS filters are sets of rules applied to NetBIOS packets to determine if the packets should be bridged (forwarded) or filtered (dropped).

Types of NetBIOS Filtering

There are two types of NetBIOS filtering, *host name* and *byte*:

host name You implement host-name filtering using fields in NetBIOS packets that let you select packets with specific NetBIOS host-names to be bridged or filtered. The host-name filters are for bridging only. You can use them based on NetBIOS source or destination names, depending on frame type.

Name filters apply to NetBIOS traffic that is being bridged or data link switched.

Byte You implement byte filtering using bytes (arbitrary fields) in NetBIOS packets that allow you to specify certain NetBIOS packets to be bridged or filtered.

There are no thresholds or timers associated with these filters and they remain active until you either disable or remove them. A NetBIOS filter is made up of three parts, the actual filter, filter-lists, and filter-items (described in more detail at "Building a Filter" on page 3-5).

Configuration and monitoring of NetBIOS is described at Chapter 9, "Configuring and Monitoring NetBIOS" on page 9-1. The remainder of this section describes NetBIOS host-name filtering and NetBIOS byte filtering.

NetBIOS host-name Filtering

NetBIOS filtering using host names lets you select packets with specific NetBIOS host names to be bridged or filtered. When you specify that packets with a particular NetBIOS host name (or set of NetBIOS host names) should be bridged or filtered, the source name or destination name fields of the following NetBIOS packet types are examined:

- ADD_GROUP_NAME_QUERY (source)
- ADD_NAME_QUERY (source)
- DATAGRAM (destination)
- NAME_QUERY (destination)

The host-name filter-lists specify NetBIOS names that should be compared with source or destination name fields in the four different types of NetBIOS packets.

The result of applying a host-name filter-list to a NetBIOS packet that is not one of those four types is *Inclusive*.

When configuring NetBIOS Filtering using host names, you specify which ports the filter is applied to and whether it is applied to input or output packets on those ports. Only NetBIOS Unnumbered Information (UI) packets are considered for filtering. Filtering is applied to NetBIOS packets that arrive at the router for either source route bridging (all RIF types) or transparent bridging.

When specifying a NetBIOS host name in a filter, you can indicate the 16th (last) character of the name, as a separate argument, in its hexadecimal form. If you do this, the first 15 bytes of the name are taken as specified and the 16th byte (if any is specified) is determined by the final argument. If you specify fewer than 16 characters (and no 16th byte), then the name is padded with ASCII blank characters up to the 15th character and the 16th character is treated as a wildcard.

When a specific NetBIOS host name is evaluated, that name is compared with only certain fields of certain NetBIOS packets. NetBIOS host names in filter items may include a wildcard character (?) at any point in the NetBIOS host name, or an asterisk (*) as the final character of a NetBIOS host name. The ? matches against any single character of a host name. The * matches against any one or more characters at the end of a host name.

NetBIOS Byte Filtering

Another filtering mechanism, byte filtering, lets you specify which NetBIOS packets should be bridged or filtered based on fields in the NetBIOS packets that relate to the MAC address. In this case, all NetBIOS packets are examined to determine if they match the configured filtering criteria.

To build a byte filter, you specify the following filter-items:

- An offset from the beginning of the NetBIOS header
- A byte pattern to match on
- An optional mask to apply to the selected fields of the NetBIOS header

The length of the mask, if present, must be of equal length to the byte pattern. The mask specifies bytes that are to be logically ANDed with the bytes in the NetBIOS header before the router compares the header bytes with the hex pattern for equality. If no mask is specified, it is assumed to be all ones. The maximum length for the hex pattern (and hence the mask) is 16 bytes (32 hexadecimal digits).

When configuring NetBIOS filtering using specific bytes, you also specify which ports the filter is applied to and whether it is applied to input or output packets on those ports.

Building a Filter

Each filter is made up of one or more filter-lists. Each filter-list is made up of one or more filter-items. Each filter-item is evaluated against a packet in the order in which the filter-item was specified.

When a match is found between a filter-item and a packet, the router:

- Bridges the packet if the filter-list is specified as *Inclusive*
- Drops the packet if the filter-list is specified as *Exclusive*

If no filter-items in the filter-list produce a match, the router:

- Forwards the packet if the filter as a whole is specified as *Inclusive*
- Drops the packet if the filter as a whole is specified as *Exclusive*

A filter-item is a single rule applied to a particular field of a NetBIOS packet. The result of the application of the rule is either an Inclusive (bridge) or an Exclusive (filter) indication. The following filter-items can be configured with NetBIOS filtering (the first two items are host-name filters, the last two items are byte filters):

- Include NetBIOS host name optional 16th character (hex)
- Exclude NetBIOS host name optional 16th character (hex)
- Include decimal byte offset into NetBIOS hdr hex pattern starting at that offset hex mask
- Exclude decimal byte offset into NetBIOS hdr hex pattern starting at that offset hex mask

Part of the specification of a filter indicates whether packets that do not match any of the filter-items in the filter-list should be bridged (included) or filtered (excluded). This is the default action for the filter-list. The default action for a filter-list is initially set to Include, but this setting can be changed by the user.

Simple and Complex Filters

A simple filter is constructed by combining one filter-list with a router port number and an input/output designation. This indicates that the filter list should be applied to all NetBIOS packets being received or transmitted on the given port. If the filter-list evaluates to Inclusive, then the packet being considered is bridged. Otherwise, the packet is filtered.

A complex filter can be constructed by specifying a port number, an input/output designation, and multiple filter-lists separated by one of the logical operators AND or OR. The filter-lists in a complex filter are evaluated strictly left to right, and each filter-list in the complex filter is evaluated. Each inclusive filter-list result is treated as a true and each exclusive filter-list result is treated as a false. The result of applying all the filter-lists and their operators to a packet is a true or false, indicating that the packet is bridged or filtered. Each combination of input/port or output/port can have at most one filter.

Multiple Spanning Tree Protocol Options

The ASRT bridge lets you extend spanning tree protocol options to cover as many configuration options as possible. The following sections provide information on these features.

Background: Problems with Multiple Spanning Tree Protocols

Bridging technology employs different versions of spanning tree algorithms to support different bridging methods. The common purpose of each algorithm is to produce a loop-free topology.

In the spanning tree algorithm used by transparent bridges (TBs), Hello BPDUs and Topology Change Notification (TCN) BPDUs are sent in a transparent frame to well known group addresses of all participating media (Token-Ring, Ethernet, and so on). Tables are built from this exchanged information and a loop-free topology is calculated.

Source routing bridges (SRBs) transmit spanning tree explorer (STE) frames across other SRBs to determine a loop-free topology. The algorithm sends Hello BPDUs in a transparent frame to well known functional addresses. Since TCN BDPUs are not used by SRBs, the port state setting created as a result of this spanning tree algorithm does not affect all route explorer (ARE) frame and specifically routed frame (SRF) traffic.

In bridging configurations using IBM 8209 Bridges, a different spanning tree method is used to detect parallel 8209 bridges. This algorithm uses Hello BPDUs sent as STE frames to IEEE 802.1d group addresses on the token ring. On the Ethernet, Hello BPDUs sent as transparent frames to the same group address are used. This method allows 8209s to build spanning trees with transparent bridges and other IBM 8209 bridges. It does not participate in the SRB spanning tree protocol, however, and Hello BPDUs sent by SRBs are filtered. Consequently, there is no way to prevent the 8209 from becoming the root bridge. If the 8209 bridge *is* selected as the root, then traffic between two transparent bridge domains may have to pass through token-ring/SRB domains.

As you can see, running multiple spanning tree protocols can cause compatibility problems with the way algorithm creates its own loop-free topology.

STP/8209

The STP/8209 bridging feature is available to allow you to further extend the Spanning Tree protocol. Previously, SRBs allowed only manual configuration of a loop-free tree over the token-ring. This was the only mechanism to prevent loops in the case of parallel SR-TB bridges. With the addition of the STP/8209 feature the following spanning tree algorithm combinations are possible:

- Pure Transparent Bridge (TB) - IEEE 802.1d Spanning Tree protocol is used.
- Pure Source Routing Bridge (SRB) - SRB Spanning Tree protocol is used.
- Transparent and Source Routing Bridges as separate entities - IEEE 802.1d Spanning Tree protocol is used for TB and manual configuration (no Spanning Tree protocol) is used for SRB.
- SR-TB Bridge - IEEE 802.1d Spanning Tree protocol is used for TB ports and IBM 8209 BPDUs on SRB ports are used to form a single tree of TBs and SR-TBs. SRB Hello BPDUs are allowed to pass on the SR domain but are not processed. IBM 8209 bridges filter such frames but this is allowed because it is a two-port bridge with the other port being a TB port.
- Pure SRT Bridge - ***Only*** IEEE 802.1d Spanning Tree protocol is used. SRB Hello BPDUs and IBM 8209 BPDUs are allowed to pass but are not processed.
- ASRT Bridge - IEEE 802.1d Spanning Tree protocol is used to make a tree with TBs and SRT bridges. “8209-like” BPDUs are also generated on all SR interfaces. These BPDUs are processed as soon as they are received. This causes two BPDUs to be generated and received on all SR interfaces. Because both BPDUs carry the same information, there will be no conflict of port information. This lets the ASRT bridge create a spanning tree with IBM 8209 and SR-TB bridges along with other TBs and SRT bridges.

Threading (Router Discovery)

Threading is a process used by a token-ring end station protocol (for example, IP, IPX, or AppleTalk) to discover a route to another end station through a source-routing bridged network.

The details of the threading process vary according to the end station protocol. The following sections describe the threading process for IP, IPX, and AppleTalk.

IP Threading with ARP

IP end-stations use ARP REQUEST and REPLY packets to discover a RIF. Both IP end-stations and the bridges participate in the route discovery and forwarding process. The following steps describe the IP threading process.

1. An IP end-station maintains an ARP table and a RIF table. The MAC address in the ARP table is used as a cross reference for the destination RIF in the RIF table. If a RIF does not exist for that specific MAC address, the end-station transmits an ARP REQUEST packet with an ARE (all routes explorer) or an STE (spanning tree explorer) onto the local segment.
2. All bridges on the local segment capture the ARP REQUEST packet and send it over their connected networks.

   As the ARP REQUEST packet continues its search for the destination end-station, each bridge that forwards it adds its own bridge number and segment number to the RIF in the packet. As the frame continues to pass through the bridged network, the RIF compiles a list of bridge and segment number pairs describing the path to the destination.

   When the ARP REQUEST packet finally reaches its destination, it contains the exact sequence of bridge and segment numbers from source to destination.
3. When the destination end-station receives the frame, it places the MAC address and its RIF into its own ARP and RIF tables. If the destination end-station should receive any other ARP REQUEST packets from the same source, that packet is dropped.
4. The destination end-station then generates an ARP REPLY packet including the RIF and sends it back to the source end-station.
5. The source end-station receives the learned route path. The MAC address and its RIF are then entered into the ARP and RIF tables. The RIF is then attached to the data packet and forwarded onto the destination.
6. Aging of RIF entries is handled by the IP ARP refresh timer.

IPX Threading

IPX end-stations check each packet they receive for a RIF. If the RIF does not exist in the table, they add the RIF to the table and designate that route as *HAVE_ROUTE*. If the RIF indicates that the packet came from an end-station on the local ring, the route is designated as *ON_RING*.

If the end-station needs to send out a packet and there is no entry in the RIF table for the MAC address, the end-station transmits the data as an STE.

When the RIF timer expires, the entry in the table is cleared and will not be reentered until another packet arrives containing a RIF for that entry.

AppleTalk 2 Threading

AppleTalk end-stations use ARP and XID packets to discover a route. Both the AppleTalk end-stations and the bridges participate in the route discovery process and forwarding. The following steps describe the AppleTalk threading process.

1. If a RIF does not exist for a specific MAC address, the end-station transmits an ARP REQUEST packet with an ARE (all routes explorer) onto the local segment.
2. All bridges on the local segment capture the ARP REQUEST packet and send it over their connected networks. As the ARP REQUEST packet continues its search for the destination end-station, each bridge that forwards it adds its own bridge number and segment number to the RIF in the packet. As the frame continues to pass through the bridged network, the RIF compiles a list of bridge and segment number pairs describing the path to the destination.
3. When the destination end-station receives the frame, it places the MAC address and its RIF into its own ARP and RIF tables and the state of the entry is designated as *HAVE_ROUTE*. If the destination end-station should receive any other ARP REQUEST packets from the same source, that packet is dropped.
4. The destination end-station then generates an ARP REPLY packet including the RIF and sends it back to the source end-station with the direction bit in the RIF flipped.
5. The source end-station receives the learned route path. The MAC address and its RIF are then entered into the ARP and RIF tables and the state is designated as *HAVE_ROUTE*. If the RIF indicates that the packet came from an end-station on the local ring, the route is designated as *ON_RING*.
6. If the RIF timer expires, an XID is sent out with an ARE and the state is changed to *DISCOVERING*. If no XID reply is received, the entry is discarded.

SR-TB Duplicate MAC Address Feature

The duplicate MAC address (DMAC) feature allows you to attach an SR-TB bridge to a SR bridged network that has duplicate MAC addresses configured. The duplicate MAC address feature can be enabled with two options:

- **Duplicate MAC Feature without Load-Balance**

  This option allows you to enable duplicate MAC addresses without load-balancing. In this case, only one RIF is learned for the duplicate MAC address and aging is performed on this learned RIF. All stations from the TB domain will use this one RIF to communicate with that MAC address. When the entry for this RIF ages out, the next frame will be sent from the TB domain as a Spanning Tree Explorer (STE) frame.

- **Duplicate MAC Feature with Load-Balance**

  This option allows you to enable duplicate MAC addresses with load-balancing and can be enabled only after enabling DMAC without Load-Balance. In this case, two RIFs are learned and maintained for each duplicate MAC address. Each of the two RIFs will have its own aging timer. Whenever the bridge receives a frame with a particular RIF, the aging value corresponding to that RIF will be refreshed. The first time a station from the TB domain sends a frame to a duplicate MAC address, the bridge software decides which RIF will

be used to send that frame. All subsequent frames from the sending station will be sent using that same RIF. The bridge will maintain primary and secondary RIFs for up to seven duplicate MAC addresses. If you specify separate age values for duplicate MAC addresses, the appropriate value will be used to age out entries corresponding to that duplicate MAC address, allowing you to tune the aging value for duplicate MAC addresses.

Bridging on ATM

The device supports bridging over native ATM (RFC 1483). When bridging over native ATM, multiple (virtual) ports may be configured for a single (physical) interface.

RFC 1483 Support for Bridging

RFC 1483 specifies an LLC value of 0xAA-AA-03 and an OUI value of 0x00-80-C2 for bridged protocols. The 2-octet PID portion of the SNAP header, in the case of bridged protocols, specifies the bridged media, and additionally, whether the original frame check sequence (FCS) is preserved within the original bridged PDU. The PID values for the different media are specified. Refer to RFC 1483 for further details.

The ATM interface will forward bridged MAC frames to and from Token Ring/802.5, Ethernet/802.3. One bridge port is used per VCC. While configuring a bridge port on an ATM interface, you must specify a VCC that is permanently tied to that port. Bridged frames received on a port/VCC are sent out on one or more ports/VCCs as per the bridging protocol being used and the bridging configuration. Once a bridge port is configured on an ATM interface and has a VCC associated with it, it functions as a normal bridging port on a legacy LAN. The association of the port with an ATM interface is transparent to the user and to the bridging function.

When configuring a bridge port on an ATM interface, the user must specify whether PVC or SVC support should be used. For PVC support, you must provide the VPI and VCI for the PVC. For SVC support, you must provide the remote ATM address as well as the selector to be used for the local address.

Note: Unlike PVC support, using SVCs does not require any configuration at the intermediate switches.

Once a port has been added on an ATM interface, the bridging configuration commands that require a port number as a parameter can be used with this port number.

Refer to Chapter 23, “Using ARP” on page 23-1 and Chapter 5, “Configuring and Monitoring Bridging” on page 5-1 for additional information on configuring bridging over ATM.

SuperELANs

Refer to the chapter entitled “Using and Configuring ATM” in the *Software User's Guide* for information about SuperELANs and “Sample SuperELAN Configuration” on page 3-15 for a sample SuperELAN configuration.

Bridging Broadcast Manager

Broadcast frames are especially harmful in bridged environments because every broadcast frame is transmitted on every LAN segment. This causes an interruption at each station on the bridged LAN, consumes precious network bandwidth, and uses processing cycles at each bridge.

Many broadcast frames are destined for all stations only because the source station does not know the destination MAC address. Examples of such frames are IP ARP requests and NetBIOS NAME_QUERY commands. In these examples, the source station is trying to find a specific higher level entity on top of some unknown MAC layer. Because the destination MAC layer is unknown, all stations are interrupted and queried for the entity. Most stations discard the request because it does not pertain to them, and only one station replies to the query.

Bridging Broadcast Manager (BBCM) can transform many IP and NetBIOS query broadcast frames into unicast frames. Because the transformed unicast address is likely in the bridge database, the packet can be forwarded to only the intended destination segment.

Dynamic Protocol Filtering VLANs

Dynamic protocol filtering (DPF) VLANs are based on protocol and subnets, user-defined traffic types, MAC addresses, and entry ports. For each configured vlan, the subset of bridge or SuperELAN ports on which traffic for that vlan is received is the forwarding domain of that vlan. Broadcast and multicast frames and unicast frames on SuperELANs for a particular vlan are not forwarded on ports that are not in the forwarding domain of that vlan. Dynamic protocol filtering (DPF) can partition the bridged network into:

- Sliding window VLANs

  Sliding window VLANs are the most general protocol-specific VLANs. You specify an offset into the frame, a mask, and a value. Any frames matching the specified mask and value at the given offset are included in the sliding window VLAN and are forwarded only on those ports in the forwarding domain of the sliding window VLAN. Sliding window VLANs can also be used as a bridge exclusion filter to drop frames with specific data patterns on specific inbound ports or on all ports.

- IP, IPX, and NetBIOS Protocol VLANs

  DPF monitors traffic on each bridge port and learns the location of traffic matching the configured protocols and subnets. Ports with matching inbound traffic are included in the forwarding domain of the corresponding VLAN.

- MAC address VLANs

  MAC address VLANs allow you to define a collection of MAC addresses that form a VLAN. Ports receiving frames with a source MAC address in the defined VLAN are included in the forwarding domain of the VLAN.

- Port-based VLANs

  Port-based VLANs allow a static grouping of SuperELAN ports as a forwarding domain. These forwarding domains are based only on inbound port and not on the contents of the data frames as in other VLANs. Thus, the *Auto- Detect and Include* setting for ports in Port-based VLANs is not supported. Every port must

be explicitly included or excluded in every Port-based VLAN. Any SuperELAN ports not included in any Port-based VLAN, are in the same forwarding domain which is essentially another Port-based VLAN.

The server allows overlapping sets of ports to provide greater configuration flexibility. When configuring overlapping port VLANs, the definition of a sliding window VLAN to be used as an exclusion filter may be necessary to discard 802.1D spanning tree frames on all ports in order to allow proper convergence of the spanning tree.

To provide a secure Port-based VLAN environment, unicast data and LANE control frames must be filtered as well as broadcast and multicast frames. Since unicast flows are generally temporary over a SuperELAN, Port-based VLANs and unicast filtering are supported in SuperELANs, but not in the ASRT bridge due to performance impacts in some scenarios.

- IP Multicast VLANs

  IP Multicast VLANs restrict IP multicast data to ports in the same IP multicast group and ports attached to multicast routers. IGMP Report frames are used to determine port inclusion in the forwarding domain for a particular IP Multicast VLAN. Also, ports receiving IP multicast router frames are included in the forwarding domain of all IP Multicast VLANs to insure all IP multicast data is sent to the routers.

The purpose of DPF is to limit the proliferation of frames that are normally forwarded over all active spanning tree ports. DPF dynamically activates filters based upon the traffic on each bridge port. The bridged network can thus be dynamically partitioned into protocol-specific subnetworks.

DPF and BBCM each reduce the unnecessary propagation of certain frames. BBCM operates by transforming broadcast frames into unicast frames. DPF operates by forwarding broadcast frames to selected ports based on the forwarding domain of a vlan. In both cases, unnecessary network utilization is decreased because frames are forwarded on fewer bridge ports. Also, stations are interrupted less frequently because broadcast and multicast transmissions now traverse only a portion of the bridged network.

DPF offers further benefits to increase performance, enhance security and facilitate moves and changes in the network.

For subnetted IP networks, DPF has an *IP-cut-through* facility that allows establishment of data-direct VCCs between IP workstations on different IP subnet VLANs. By enabling *IP-cut-through* and shortening the IP subnet mask in end-stations, the end-stations communicate directly with each other without involving an IP router. This significantly increases IP throughput in the network, reduces IP routing requirements, and isolates IP subnet broadcast traffic.

IP-cut-through can be enabled or disabled by an IP subnet or IP end-station. *IP-cut-through* can also be configured to allow cut-through in one direction but force a routed path in the reverse direction. This uni-directional cut-through can be used to force IP clients to go through an IP router for security but allow IP servers to "cut through" to the clients for maximum performance.

DPF also allows the user to explicitly include or exclude a VLAN on specific bridge ports. Explicit inclusion creates one or more default VLANs for a port. Normally, membership in DPF forwarding domains is based on traffic seen on the ports.

Explicit inclusion could be used on ports if the devices attached to that port are silent devices (for example, network printers) that would never be detected. Explicit exclusion enhances security by allowing for the isolation of selected ports.

Since DPF automatically adjusts the forwarding domain of a vlan based on traffic, it lets users move around the network without any changes to their configuration. This is especially useful for IP networks, because it eliminates the need for assigning new IP addresses when users move.

DPF is a bridging and SuperELAN enhancement. All ports on the ASRT bridge and within each SuperELAN environment must be the same type (either Ethernet or Token-Ring). VLANs can be configured for multiple IP subnets, multiple IPX networks, a single NetBIOS network, user-defined traffic types, groups of MAC addresses, groups of ports (SuperELANs only), and IP multicast groups.

Required Static Configurations

You must statically configure VLAN ports in the following situations:

- Ports with devices with low network utilization.

  Devices such as printers, servers or routers on a port could lose connectivity because of low network utilization. To prevent aging-out of a port that defines a VLAN to such a device, configure the port statically; specify **include** when prompted to configure the VLAN on the port. For example:

```
add ip
IP address: [0.0.0.0;]? 9.37.15.24
Subnet Mask: [255.0.0.0;]?
Configure Specific Ports? [No;]: yes
Configure VLAN on port 1 (Include, Exclude, or Auto-detect) [A;]? I
Age (expiration in minutes, 0=infinity) [10000;]
Enable IP-Cut-Through from this VLAN? [Yes;]:
Enable IP-Cut-Through to this VLAN? [Yes;]:
Enable this filter? [Yes;]:
VLAN Name (32 chars max) []? Finance
VLAN 'Finance' (IP subnet 9.0.0.0) successfully added
```

- An 8210 bridge port connected to IPX clients only.

  IPX clients do not know their network numbers. This prevents a VLAN from learning the association between the network number and the port number. Specify **include** when prompted to configure the VLAN for a bridge port connected to IPX clients only.

IP-Cut_Through Considerations

IP Cut-Through allows the establishment of data-direct VCCs between stations on different IP subnets. IP Cut-Through is applicable in subnetted IP networks only. If stations are on different IP nets, then data-direct VCCs cannot be established between them and a router must be used to forward traffic between those stations.

To use IP Cut-Through, the subnet mask in end-stations (typically just servers) should be shortened. That is, a 255.255.255.255 subnet mask is shortened to 255.255.255.0 to imply a 3-byte subnet and a 255.255.0.0 subnet mask implies a 2-byte subnet. Shortening the subnet mask will cause the end-station to ARP for the destination and establish a direct connection (VCC) to the destination (or intermediate LAN switch), maximizing network throughput. However, this configuration can produce the following side effects:

1. A large number of ARP entries can be created in end-stations with a shortened mask which in turn can increase their CPU utilization. If these end-stations are

ATM-attached, the number of ATM connections (data-direct VCCs) will also increase.

Therefore, the need for faster network throughput must be balanced against increased CPU utilization in the end-stations and increased VCC utilization in the ATM switches.

2. An end-station with a shortened mask could ARP for a destination that is not directly connected. For example, this can happen if the destination is on a different type of LAN or behind a router firewall. The only way to reach this destination is through a router but routers normally do not propagate ARPs between networks. To allow this scenario to work, the Proxy ARP function must be enabled in the router. This will cause the router to respond to the ARP and subsequent traffic will be sent to the router.

   To enable proxy ARP in the MSS, the following must be done in IP configuration. See “Enabling ARP Subnet Routing” on page 15-7 for additional information.

```
Config> protocol ip
    Internet protocol user configuration
    IP Config>enable arp-subnet-routing
```

   Proxy ARP is also known as Transparent Subnetting or ARP-Subnet routing. Refer to IETF RFC 1027 for a complete description of Transparent Subnetting.

Answering Yes to the **Enable IP-Cut-Through from this VLAN?** question will allow forwarding of IP traffic from devices on this VLAN to devices on other VLANs that have IP-Cut-Through reception enabled.

Auto-created IP Multicast VLANs

Unlike other VLANs, IP Multicast VLANs can be automatically created and configured without user involvement. If auto-creation of IP Multicast VLANs is enabled, then the receipt of an IGMP Report frame (indicating a station's membership in an IP multicast group) causes an IP Multicast VLAN to be created for the group address indicated in the frame. Thus, IP Multicast groups can be configured on stations in the network without the need for VLAN configuration in the MSS bridge.

Auto-creation is enabled if an IP Multicast VLAN exists for the all IP hosts address of 224.0.0.1 and is enabled. If not already present, this VLAN is created and enabled during box initialization. It contains the initial port configuration, aging time, and MAC Address tracking status that will be applied to each new IP Multicast VLAN that is automatically created. To turn off auto-creation of IP Multicast VLANs, disable the VLAN for the 224.0.0.1 group address.

No IP Multicast VLANs can be auto-created or manually configured for the reserved multicast groups whose address is between 224.0.0.0 and 224.0.0.255, inclusive. This prevents potential problems in filtering frames necessary to several protocols that use these addresses.

Sample Configurations

Sample SuperELAN Configuration

```
The Standalone Configuration Process.  You are here because
No network devices configured.
Config (only)>add dev atm 1    1
Adding CHARM ATM Adapter device in slot 1  port 1 as interface #0
Use "net 0" to configure CHARM ATM Adapter parameters
Config (only)>net 0
ATM user configuration
ATM Config>int    2
ATM interface configuration
ATM Interface Config>add esi    3
ESI in 00.00.00.00.00.00 form []? 333333333333
ATM Interface Config>exit
ATM Config>le-s    4
LAN Emulation Services user configuration
LE Services config>les
    ( 1)  <<< New LES/BUS >>>
Choice of LES/BUS [1]?
New ELAN Name (ELANxx) []? elan1
LES-BUS configuration
LES-BUS config for ELAN 'elan1'>add    5
Turn on Standard Event Logging for LES [yes]
Select ELAN type
        (1) Token Ring
        (2) Ethernet

Enter Selection:  [1]? 2
Select ESI
        (1) Use burned in ESI
        (2) 33.33.33.33.33.33

Enter Selection:  [1]? 2    6


Selector x00 is generally reserved for use by the LECS,
Selector x01 is generally reserved for use by the LECS Interface.

Enter selector (in hex) [2]?
Selection "Add LES-BUS" Complete
LES-BUS config for ELAN 'elan1'>exit
LE Services config>exit
ATM Config>le-s
LAN Emulation Services user configuration
LE Services config>les
    ( 1)  <<< New LES/BUS >>>
    ( 2)  elan1
Choice of LES/BUS [1]? 1
New ELAN Name (ELANxx) []? elan2
LES-BUS configuration
```

```
LES-BUS config for ELAN 'elan2'>add    7
Select ELAN type
        (1) Token Ring
        (2) Ethernet

Enter Selection:  [1]? 2
Select ESI
        (1) Use burned in ESI
        (2) 33.33.33.33.33.33

Enter Selection:  [1]? 2


Selector x00 is generally reserved for use by the LECS,
Selector x01 is generally reserved for use by the LECS Interface.

Enter selector (in hex) [3]?
Selection "Add LES-BUS" Complete
LES-BUS config for ELAN 'elan2'>exit
LE Services config>exit
ATM Config>le-c    8
ATM LAN Emulation Clients configuration
LE Client config>add eth forum    9
Added Emulated LAN as interface 1
LE Client config>add eth forum    10
Added Emulated LAN as interface 2
LE Client config>add eth forum    11
Added Emulated LAN as interface 3
LE Client config>config 1
ATM LAN Emulation Client configuration
Ethernet Forum Compliant LEC Config>set les    12
LES ATM address in 00.00.00.00.00.00:... form []? 39999999999999000099990101
33333333333302
Ethernet Forum Compliant LEC Config>set mac   13
Use adapter address for MAC? [Yes]: n
MAC address [00.00.00.00.00.00]? 100000000001
Ethernet Forum Compliant LEC Config>exit
LE Client config>config 2
ATM LAN Emulation Client configuration
Ethernet Forum Compliant LEC Config>set les    14
LES ATM address in 00.00.00.00.00.00:... form []? 39999999999999000099990101
33333333333303
Ethernet Forum Compliant LEC Config>set mac
Use adapter address for MAC? [Yes]: n
MAC address [00.00.00.00.00.00]? 100000000002
Ethernet Forum Compliant LEC Config>exit
```

```
LE Client config>config 3
ATM LAN Emulation Client configuration
Ethernet Forum Compliant LEC Config>set les    15
LES ATM address in 00.00.00.00.00.00:... form []? 39999999999999000099990101
33333333333302
Ethernet Forum Compliant LEC Config>set mac
Use adapter address for MAC? [Yes]: n
MAC address [00.00.00.00.00.00]? 100000000003
Ethernet Forum Compliant LEC Config>exit
LE Client config>exit
ATM Config>exit
Config (only)>p ip    16
Internet protocol user configuration
IP config>add address    17
Which net is this address for [0]? 3
New address [0.0.0.0]? 1.1.1.1
Address mask [255.0.0.0]? 255.255.255.0
IP config>add address    18
Which net is this address for [0]? 3
New address [0.0.0.0]? 2.2.2.1
Address mask [255.0.0.0]? 255.255.255.0
IP config>list address
IP addresses for each interface:
   intf  0                                    IP disabled on this interface
   intf  3   1.1.1.1          255.255.255.0    Local wire broadcast, fill 1
             2.2.2.1          255.255.255.0    Local wire broadcast, fill 1
IP config>exit
Config (only)>p asrt    19
Adaptive Source Routing Transparent Bridge user configuration
ASRT config>enable bridge    20
ASRT config>del port 3    21
```

```
ASRT config>list bridge

                Source Routing Transparent Bridge Configuration
                ===============================================

Bridge:                 Enabled             Bridge Behavior: STB
                   +----------------------------+
-------------------| SOURCE ROUTING INFORMATION |-------------------------------
                   +----------------------------+
Bridge Number:          N/A                 Segments:           0
Max ARE Hop Cnt:        00                  Max STE Hop cnt:   00
1:N SRB:                Not Active          Internal Segment:  0x000
LF-bit interpret:       Extended
                   +-------------------+
-------------------| SR-TB INFORMATION |----------------------------------------
                   +-------------------+
SR-TB Conversion:       Disabled
TB-Virtual Segment:     0x000               MTU of TB-Domain:  0
                   +-----------------------------------+
-------------------| SPANNING TREE PROTOCOL INFORMATION |----------------------
                   +-----------------------------------+
Bridge Address:         Default             Bridge Priority:   32768/0x8000
STP Participation:      IEEE802.1d
                   +-------------------------+
-------------------| TRANSLATION INFORMATION |---------------------------------
                   +-------------------------+
FA<=>GA Conversion:     Enabled             UB-Encapsulation:  Disabled
                   +------------------+
-------------------| PORT INFORMATION |-----------------------------------------
                   +------------------+
Number of ports added: 2
Port:   1      Interface:       1      Behavior:    STB Only   STP:  Enabled
Port:   2      Interface:       2      Behavior:    STB Only   STP:  Enabled

ASRT config>en super   22
Port Number [1]?
SuperELAN ID [0]? 22
Port priority of SuperELAN enabled ports should be less than 128.
Enter New Port Priority [64]?
Bridge priority with SuperELAN enabled ports should be less than 32768.
Enter New Bridge Priority [16384]?
ASRT config>en super
Port Number [1]? 2
SuperELAN ID [22]?
Port priority of SuperELAN enabled ports should be less than 128.
Enter New Port Priority [64]?
```

```
ASRT config>list port
Port ID (dec)    : 64:01, (hex): 40-01
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 1
Path Cost        : 0
SuperELAN bridging: Enabled       SuperELAN ID: 22
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Port ID (dec)    : 64:02, (hex): 40-02
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 2
Path Cost        : 0
SuperELAN bridging: Enabled       SuperELAN ID: 22
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
ASRT config>broadcast    23
Enter Bridge Broadcast Manager Protocol:  IP or NetBIOS  [IP]?

IP Bridge Broadcast Manager User Configuration

IP B-BCM config>enable    24
IP Bridge Broadcast Manager is   ENABLED
IP B-BCM config>list
IP Bridge Broadcast Manager is   ENABLED
IP B-BCM cache age timeout is    5 minutes
IP B-BCM config>exit

ASRT config>broadcast
Enter Bridge Broadcast Manager Protocol:  IP or NetBIOS  [IP]? net

NetBIOS Support User Configuration

NetBIOS config>enable dup

Duplicate frame filtering is           ON

NetBIOS config>enable route    25

Route caching is                       ON

NetBIOS config>list general

Bridge-only Information:

Bridge duplicate filtering is          ON
Bridge duplicate frame filter t/o     1.5 seconds

DLS-Bridge Common Information:

Route caching is                       ON
Significant characters in name         15
Max local name cache entries          500
Duplicate frame detect timeout         5.0 seconds
Best path aging timeout               60.0 seconds
Reduced search timeout                 1.5 seconds
Unreferenced entry timeout            5000 minutes
NetBIOS config>exit
```

```
ASRT config>vlans    26

VLAN filter configuration
VLAN config>add ip    27
IP Address [0.0.0.0]? 1.1.1.1
Subnet Mask [255.0.0.0]? 255.255.255.0
Configure Specific Ports? [No]:
Age (expiration in minutes,0=infinity) [5000]?
Enable IP-Cut-Through from this VLAN? [Yes]:
Enable IP-Cut-Through to this VLAN? [Yes]:
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) []? Dept A
VLAN 'Dept A' (IP Subnet 1.1.1.0) successfully added
VLAN config>add ip    28
IP Address [0.0.0.0]? 2.2.2.1
Subnet Mask [255.0.0.0]? 255.255.255.0
Configure Specific Ports? [No]:
Age (expiration in minutes,0=infinity) [5000]?
Enable IP-Cut-Through from this VLAN? [Yes]:
Enable IP-Cut-Through to this VLAN? [Yes]:
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) []? Dept B
VLAN 'Dept B' (IP Subnet 2.2.2.0) successfully added
VLAN config>add net    29
Configure Specific Ports? [No]:
Age (expiration in minutes,0=infinity) [5000]?
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) []? Microsoft NT Users
VLAN 'Microsoft NT Users' (NetBIOS) successfully added
```

```
VLAN config>list all

   --------------------- IP VLANS ----------------------

   Subnet Address              = 1.1.1.0
   Subnet Mask                 = 255.255.255.0
   Bridge Port 1 (Interface 1) = Auto-Detect and Include
   Bridge Port 2 (Interface 2) = Auto-Detect and Include
   Age (expiration in minutes) = 5000
   IP-Cut-Through Status:
      Transmit From This VLAN  = Enabled
      Reception By This VLAN   = Enabled
   Tracking of MAC Addresses   = Disabled
   VLAN Filter State           = Enabled
   VLAN Name                   = Dept A
   ++++++++++++++++++++++++++++++++++++++++++++++++++++++
   Subnet Address              = 2.2.2.0
   Subnet Mask                 = 255.255.255.0
   Bridge Port 1 (Interface 1) = Auto-Detect and Include
   Bridge Port 2 (Interface 2) = Auto-Detect and Include
   Age (expiration in minutes) = 5000
   IP-Cut-Through Status:
      Transmit From This VLAN  = Enabled
      Reception By This VLAN   = Enabled
   Tracking of MAC Addresses   = Disabled
   VLAN Filter State           = Enabled
   VLAN Name                   = Dept B

   --------------------- IPX VLANS ---------------------

   ------------------- NetBIOS VLAN --------------------

   Bridge Port 1 (Interface 1) = Auto-Detect and Include
   Bridge Port 2 (Interface 2) = Auto-Detect and Include
   Age (expiration in minutes) = 5000
   Tracking of MAC Addresses   = Disabled
   VLAN Filter State           = Enabled
   VLAN Name                   = Microsoft NT Users
VLAN config>exit
ASRT config>exit
Config (only)>write
```

1 Add the physical ATM device
2 Configure the ATM interface
3 Add a locally administered ESI for the ATM interface
4 Begin configuration of the LAN Emulation Service
5 Add the definition for an Ethernet LAN Emulation Server
6 Select locally administered ESI for 'elan1'
7 Add the definition for a second Ethernet LAN Emulation Server
8 Begin configuration of LAN Emulation Clients (LECs)
9 Add an Ethernet LEC on interface 1 for a bridge port on 'elan1'
10 Add an Ethernet LEC on interface 2 for a bridge port on 'elan2'
11 Add an Ethernet LEC on interface 3 for a router port on 'elan1' (a protocol cannot be both bridged and routed over the same LEC)
12 Assign LEC 1 to the LES for 'elan1'
13 Give each LEC a unique locally administered MAC address
14 Assign LEC 2 to the LES for 'elan2'
15 Assign LEC 3 to the LES for 'elan1'
16 Begin IP protocol configuration
17 Add an IP address for LEC 3 on the VLAN for subnet 1.1.1.0

18 Add an IP address for LEC 3 on the VLAN for subnet 2.2.2.0
19 Begin bridge configuration
20 Enable bridging, which by default add ports for all interfaces
21 Disable bridging on port 3, because it will be routing IP
22 Enable SuperELAN bridging
23 Begin configuration of the Bridging Broadcast Manager
24 Enable Bridging Broadcast Manager for IP
25 Enable route caching (not applicable to Ethernet, but shown here because it is valuable for Token Ring bridging)
26 Begin configuration of VLANs (Dynamic Protocol Filtering)
27 Begin definition of a VLAN for IP subnet 1.1.1.0
28 Begin definition of a VLAN for IP subnet 2.2.2.0
29 Begin definition of a VLAN for NetBIOS

Chapter 4. Using Bridging

This chapter describes how to create basic configurations for the adaptive source routing transparent (ASRT) bridge using the ASRT configuration commands. The chapter includes the “Basic Bridging Configuration Procedures.”

If you need more information about the ASRT bridge configuration commands, refer to the Chapter 5, “Configuring and Monitoring Bridging” on page 5-1.

For an introduction to modification of ASRT bridging, see “NetBIOS Name and Byte Filters” on page 3-4.

For examples of setting up NetBIOS filtering, see “NetBIOS Host Name and Byte Filtering Configuration Procedures” on page 8-15.

For information on how to access the ASRT configuration environment, see “Getting Started” in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide*.

Basic Bridging Configuration Procedures

The ASRT bridge allows you to perform basic bridging configurations using as few commands as possible. For example, using the **enable bridge** command begins this process by letting all correctly configured devices participate in transparent bridging. In addition, all default values for the spanning tree algorithm are enabled.

Bridging function beyond transparent bridging is then enabled on a “per port” basis. When source routing is enabled, user input such as segment number, bridge number, and so on, is still required and must be entered beyond the basic commands that are explained.

Bridging Interfaces

The ASRT bridge supports bridging over combinations of one or more of the following interfaces:

- Ethernet
- Token-Ring
- ATM
- FDDI in the 8210 Model 002

The Ethernet and FDDI interfaces support transparent bridging while token-ring interfaces can support source routing and transparent bridging.

The information immediately following outlines the initial steps required to enable the bridging options offered by the ASRT bridge. Details on making further configuration changes are covered in the command sections of this chapter. After completing these tasks, you must restart the router for the new configuration to take effect.

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Enabling the Transparent Bridge

Use the following commands to enable transparent bridging:

- **Enable bridge** to enable transparent bridging on all local area network (LAN) interfaces.
- **Disable transparent** *port#* to exclude specified token-ring interfaces from participating in transparent bridging. Repeat the command for all interfaces you want excluded from the transparent bridging configuration.

Enabling the Source Routing Bridge

Use the following commands to enable source-route bridging:

- **Enable bridge** to enable bridging on all local area network interfaces.
- **Disable transparent** *port#* to disable transparent bridging on all ports.
- **Enable source-routing** *port# segment# [bridge#]* to enable source routing for given ports. When source routing is enabled on more than two ports, an additional segment number is required to assign an internal virtual segment needed for 1:N SRB configurations.

If source routing is the only feature you require, disable transparent bridging on the interfaces.

Note: You should be careful ***not*** to include interfaces that traditionally do not support source routing. For example, if transparent bridging is disabled and source routing is enabled on an Ethernet port, the bridging facility is disabled for this port.

Enabling the SR-TB Bridge

Use the following commands to enable SR-TB bridging:

- **Enable bridge** to enable bridging on all local area network interfaces.
- **Disable transparent** *port#* to disable transparent bridging on all underlying source routing interfaces.
- **Enable source routing bridge** *port# segment# [bridge#]* to enable source routing for given ports. When source routing is enabled on more than two ports, an additional segment number is required to assign an internal virtual segment needed for 1:N SRB configurations.
- **Enable sr-tb-conversion** *segment#* to enable conversion of source-routed frames to transparent frames and vice versa. You are also required to assign a domain segment number and a domain MTU size to represent the entire transparent bridging domain.

After completing any of the procedures just described, it is advised that you use the **list bridge** command to display the current bridge configuration. This lets you verify and check your configuration.

For more information on all of the commands just mentioned, refer to Chapter 5, “Configuring and Monitoring Bridging” on page 5-1.

Chapter 5. Configuring and Monitoring Bridging

This chapter describes how to configure the adaptive source routing transparent (ASRT) bridge protocol and how to use the ASRT configuration commands. The chapter includes the following sections:

- "Accessing the ASRT Configuration Environment"
- "ASRT Configuration Commands"
- "Tunnel Configuration Commands" on page 5-38
- "Bridging Broadcast Manager Configuration Commands" on page 5-51
- "Dynamic Protocol Filtering (VLANS) Configuration Commands" on page 5-43
- "Sample SuperELAN Configuration" on page 3-15

Accessing the ASRT Configuration Environment

To access the ASRT configuration environment, enter the **protocol asrt** command at the Config> prompt:

```
Config>protocol asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config>
```

ASRT Configuration Commands

The ASRT configuration commands allow you to specify network parameters for the ASRT bridge and its network interfaces. These commands also allow you to enable and configure the SuperELAN, Bridging Broadcast Manager, bridge IP Tunnel, NetBIOS, and ATM interface features.

The router must be restarted for the new configuration to take effect.

Enter the ASRT configuration commands at the ASRT config> prompt. Access the commands as follows:

- Enter the configuration commands for SuperELAN using the ASRT config> **set super-elan-id** command.
- Select the BBCM protocol, either IP or NetBIOS, using the ASRT config> **broadcast-manager** command. The BBCM commands are explained later in this chapter. Enter the configuration commands for IP Bridging Broadcast Manager(BBCM) at the IP B-BCM config> prompt.
- Enter the configuration commands for dynamic protocol filtering (Virtual LANs) at the VLAN config> prompt. The VLAN prompt is accessed by entering the **vlans**command explained later in this chapter.
- Enter configuration commands for IP tunnel at the TNL config> prompt. The TNL config> prompt is a subset of the major ASRT commands and is accessed by entering the ASRT config> **tunnel** command explained later in this chapter.
- Enter configuration commands for NetBIOS at the NetBIOS config> prompt. The NetBIOS config> prompt is a subset of the major ASRT commands and is accessed by entering the ASRT config> **netbios** command explained later in this chapter.
- Enter configuration commands for NetBIOS Filtering at the NetBIOS Filter config> prompt. This prompt is a subset of the NetBIOS commands.

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- Enter bridging configuration commands for ATM at the `ASRT config>` prompt.

Table 5-1 shows the ASRT configuration commands.

Table 5-1 (Page 1 of 2). ASRT Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds station address entries to the permanent database, specific address mapping, LAN/WAN ports, protocol filters, duplicate MAC addresses, and a tunnel between end stations across an IP internetwork.
Ban	Allows access to the boundary access node (BAN) configuration prompt so that BAN configuration commands can be entered.
Broadcast-Manager	Allows you to configure Bridging Broadcast-Manager for either IP or NetBIOS.
Change	Allows the user to change bridge and segment numbers.
Delete	Deletes station address entries, specific address mapping, LAN/WAN ports, protocol filters, duplicate MAC addresses, and a tunnel between end stations across an IP internetwork.
Disable	Disables the following functions: • Bridging • Duplicate frames • Mapping between group and functional addresses • Propagation of Spanning Tree Explorer Frames • Source routing on a given port • Reception of spanning tree explorer frames over a tunnel • SR-TB conversion • SuperELAN bridging • Transparent (spanning tree) bridging function on a given port • Tunnel between bridges • Duplicate MAC address feature • Duplicate MAC load balancing
Enable	Enables the following functions: • Bridging • Duplicate frames • Mapping between group and functional addresses • Propagation of Spanning Tree Explorer Frames • Source routing on a given port • Reception of spanning tree explorer frames over a tunnel • SR-TB conversion • SuperELAN bridging • Transparent (spanning tree) bridging function on a given port • Tunnel between bridges • Duplicate MAC address feature • Duplicate MAC load balancing

Table 5-1 (Page 2 of 2). ASRT Configuration Command Summary

Command	Function
List	Displays information about the complete bridge configuration or about selected configuration parameters.
NetBIOS	Displays the NetBIOS configuration prompt.
Set	Sets the following parameters: • Aging time for dynamic address entries • Bridge address • Maximum frame size for tunneling • Largest Frame (LF) bit encoding • Maximum frame size • Spanning tree protocol bridge and port parameters • Route Descriptor (RD) values • Filtering database size • SuperELAN id • Aging value for duplicate MAC address Routing Information Fields (RIFs)
Tunnel	Allows access to the tunnel configuration prompt so that tunnel configuration commands can be entered.
vlans	Allows the user to configure dynamic protocol filtering
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add the following information to your bridging configuration:

- Station address entries to the permanent database
- Specific address mapping for a given protocol
- LAN/WAN ports
- Protocol filters that selectively filter packets based on their protocol type
- IP tunnel between end-stations and across IP network segments
- Up to 7 duplicate MAC addresses

For the bridge’s IP tunnel feature, the **add** command lets you create an IP tunnel between end-stations across an IP internetwork. This tunnel is counted as only one hop between the end stations no matter how complex the path through the IP internet.

Syntax:

add address . . .
dmac-addr
mapping . . .
port . . .
prot-filter . . .
tunnel . . .

address *addr-value* Adds unique station address entries to the permanent database. These entries are copied into the filtering database as permanent entries when the bridge is restarted. The *addr-value* is the MAC address of the desired entry. It can be an individual address, multicast address, or broadcast address. You are also given the option to specify the outgoing forwarding port map for each incoming port. Permanent database entries are not destroyed by the power off/on process and are immune to the aging settings. Permanent entries cannot be replaced by dynamic entries.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example: `add address`

```
Address (in 12-digit hex) []? 123456789013
    Exclude destination address from all ports?(Yes or [No]):
    Use same output port mapping for all input Ports?(Yes or [No]):
    Output port mapping:
       Input Port Number [1]?
       Bridge to all ports?(Yes or [No]):
       Bridge to  port 1  Yes or [No]:
       Bridge to  port 2  Yes or [No]:
       Bridge to  port 3  Yes or [No]:
       Bridge to  port 4  Yes or [No]:
       Bridge to  port 5  Yes or [No]:
       continue to another input port? (Yes or [No]): y
       Input Port Number [2]? 3
       Bridge to all ports?(Yes or [No]): y
       continue to another input port? (Yes or [No]): y
       Input Port Number [4]?
       Bridge to all ports?(Yes or [No]):
       Bridge to  port 1  Yes or [No]:
       Bridge to  port 2  Yes or [No]:
       Bridge to  port 3  Yes or [No]:
       Bridge to  port 4  Yes or [No]:
       Bridge to  port 5  Yes or [No]:
       continue to another input port? (Yes or [No]): n
    Source Address Filtering Applies? (Yes or No): y
    ASRT config>
```

Note: For any “Yes or No” question in the prompts, “No” is the default value. Press **Return** to accept the default value.

Exclude destination address ...

This prompt lets you set destination address filtering for that entry. Answering “Yes” to the prompt causes filtering of any frames that contain this address as a destination address no matter which port it came from.

Use same output mapping...

Answering “Yes” to this prompt lets you create one outgoing port map for all incoming ports rather than allowing for mapping to only specific ports. Answering “No” to this prompt causes further prompting (`Input Port Number [1]?`) to select each input port. From that specific input port prompt you can then create a unique port map for that input port.

Input Port 1, Port 2

Answering “No” to the previous prompt causes input port-by-input port prompting (`Input Port Number [1]?`) to select each input port and its associated outgoing bridge ports.

Bridge to all ports?

Answering “Yes” to this prompt creates an outgoing port map that includes all ports. Thus, when a frame with this address as the destination address is received, it is forwarded to all outgoing forwarding ports except for the incoming port. The following are examples of how this is done according to the port map:

If a frame is received on *port 1* and the port map indicates 1 (for port 1), the frame is filtered.

If the same frame is received on *port 2* and the port map indicates 1 (for port 1), the frame is forwarded to port 1. If a frame is received on port 1 and the matching address entry's port map indicates 1, 2, or 3, the frame is forwarded to ports 2 and 3.

If the port map indicates no port (NONE/DAF), the frame is filtered. This is known as destination address filtering (DAF).

If no address entry is found to match the received frame, it is forwarded to all the forwarding ports except for the source port.

Bridge to Port 1, Port 2, etc.
This prompt lets you associate an address entry with that specific bridge port. Answering "Yes" maps the address to the specified port so that the port is included in that address entry's port map. Answering "No" skips address mapping for that port.

continue to another bridge port?
This prompt lets you select the next input port to be configured.

Source address filtering
This allows for port-specific source address filtering (SAF). When SAF is applied (answer "yes" at the prompt), frames received with source addresses that match address entries in the filtering database that have source address filtering enabled will be discarded. This mechanism allows a network manager to isolate an end station by prohibiting its traffic to be bridged.

The following sections present specific examples of how the **add address** command is used to manage address entries:

Enabling Destination Address Filtering For Entry

This example shows how to answer the command prompts to select destination address filtering for an entry:

```
ASRT config>add address 000000334455
Exclude destination address from all ports?(Yes or [No]): y
Source Address Filtering Applies? (Yes or [No]): y
ASRT config>
```

After adding the address entry, you can verify its status by using the **list range** command. The following example shows that no port map exists for that entry (in bold) and that destination address filtering (DAF) has been turned on.

```
ASRT config>list range
Start-Index [1]?
Stop-index [3]?
ADDRESS                 ENTRY TYPE      PORT MAP
=======                 ==========      ========
01-80-C2-00-00-00       REGISTERED      Input Port:  ALL PORTS
                                        Output ports:

00-00-00-22-33-44       PERMANENT       Input Port:  3
                                        Output ports: 1, 2
                                        Input Port:  4
                                        Output ports:  1, 2

00 00 00 33 44 55       PERMANENT       NONE/DAF
```

Output Port Map Created For Address Entry Having More Than One Input Port

This example shows how to answer the command prompts to create separate output port maps for an address entry that will have more than one input port.

```
ASRT config> add address 000000123456
Exclude destination address from all ports?(Yes or [No]):
Use same output port mapping for all input Ports?(Yes or [No]):
Input Port Number [1]? 1
Bridge to all ports ?(Yes or [No]):
Bridge to port 1 - Yes or [No]: y
Bridge to port 2 - Yes or [No]: y
Bridge to port 3 - Yes or [No]:
continue to another input port ? (Yes or [No]): y
Input Port Number [2]?
Bridge to all Ports?(Yes or [No]):
Bridge to Port 1 - Yes or [No]:
Bridge to port 2 - Yes or [No]:
Bridge to port 3 - Yes or [No]: y
continue to another input port ? (Yes or [No]):
Source Address Filtering Applies? (Yes or [No]):
ASRT config>
```

After adding the address entry, you can verify its status by using the **list range** command. The following example shows an entry (in bold) that has ports 1 and 2 as input ports and has separate port maps for both input ports. Source address filtering (SAF) has also been enabled.

```
ASRT config> list range
Start-Index [1]?
Stop-index [3]?
ADDRESS                 ENTRY TYPE      PORT MAP
=======                 ==========      ========
01-80-C2-00-00-00       REGISTERED      Input Port:  ALL PORTS
                                        Output ports:

01-80-C2-00-00-01       RESERVED        NONE/DAF

00-00-00-12-34-56       PERM/SAF        Input Port:  1
                                             Output ports: 1, 2
                                             Input Port:  2
                                             Output ports: 3
```

Single Output Port Map Created All Incoming Ports Associated With Address Entry

This example shows how to answer the command prompts to create a single output port map for all incoming ports associated with an address entry.

```
ASRT config> add address 000000556677
Exclude destination address from all ports?(Yes or [No]):
Use same output port mapping for all input Ports?(Yes or [No]): y
   Bridge to all ports?(Yes or [No]): n
   Bridge to  port 1 - Yes or [No]: y
   Bridge to  port 2 - Yes or [No]: y
   Bridge to  port 3 - Yes or [No]:
Source Address Filtering Applies? (Yes or [No]): y
ASRT config>
```

After adding the address entry, you can verify its status by using the **list range** command. The example below shows an entry (in bold) that has a single port map for all incoming ports. Source address filtering (SAF) has also been enabled.

```
ASRT config> list range
Start-Index [1]?
Stop-index [3]?
ADDRESS                ENTRY TYPE      PORT MAP
=======                ==========      ========
01-80-C2-00-00-00      REGISTERED      Input Port:  ALL PORTS
                                       Output ports:

01-80-C2-00-00-01      RESERVED        NONE/DAF

00-00-00-55-66-77      PERM/SAF        Input Port:  ALL PORTS
                                       Output ports:  1, 2
```

dmac-addr *addr-value*

Adds up to 7 duplicate MAC address entries to the database. The *addr-value* is the MAC address of the desired entry. See “SR-TB Duplicate MAC Address Feature” on page 3-9 for additional information about the duplicate MAC address feature.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example:

After adding the address, you can verify DMAC information by using the **list dmac** command.

```
ASRT config>add dmac-addr
Address (in 12-digit hex) []? 10005a777701


ASRT config>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is    ENABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-02
10-00-5A-66-66-05
10-00-5A-77-77-01
```

mapping *dlh-type type-field ga-address fa-address*

Adds specific functional address to group address mapping for a given protocol identifier. The address mapping is converted only on destination addresses crossing Token Ring to Ethernet or conversely.

Note: For every Ether-type mapped value, the corresponding SNAP-type value should be added. This is necessary for bidirectional mapping.

dlh-type (data-link-header type) is a choice for DSAP, Ether-type, or SNAP.

type-field Protocol type field.

Destination Service Access Point (DSAP) protocol type is entered in the range 1–FE (hexadecimal).

DSAP Valid Values: X'1' to X'FE'

Common values are:

Protocol - SAP (hexadecimal value)

- Banyan SAP - BC (used only for 802.5)
- Novell IPX SAP - E0 (used only for 802.5)
- NetBIOS SAP - F0
- ISO Connectionless Internet - FE

DSAP Default Value: 1
Ethernet (Ether) protocol type is entered in the range 5DD–FFFF (hexadecimal).

Ethernet Valid Values: X'5DD' to X'FFFF'

Protocol - Ethernet type (hex value)

- IP - 0800
- ARP - 0806
- CHAOS - 0804
- Maintenance Packet Type - 7030
- DECnet MOP Dump/Load - 6000
- DECnet MOP Remote Console - 6002
- DECnet- 6003
- DEC LAT - 6004
- DEC LAVC - 6007
- XNS - 0600
- Apollo Domain - 8019 (Ethernet)
- Novell NetWare IPX - 8137 (Ethernet)
- AppleTalk Phase 1 - 809B
- Apple ARP Phase 1 - 80F3
- Loopback assistance - 9000

Ethernet Default Value: 1
Subnetwork Access Protocol (SNAP) protocol type is entered in 10-digit hexadecimal format.

SNAP Valid Values: X'00 0000 0000' to X'FF FFFF FFFF'

Common values are:

- AppleTalk Phase 2 08-00-07-80-9B
- Apple ARP Phase 2 00-00-00-80-F3

SNAP Default Value: 00 0000 0800

ga-address

6-byte (12-digit hexadecimal) group/multicast address.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

fa-address

Functional address in noncanonical format. Functional addresses are locally administered group addresses. These are most commonly used in token-ring networks.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example:

```
ASRT config> add mapping dsap
Protocol Type in hex (1 - FE) [1]?
Group-Address (in 12-digit hex) [ ]?
Functional address (in noncanonical format) [ ]?
```

Example:

```
ASRT config> add mapping ether
Protocol Type in hex (5DD - FFFF) [0800]?
Group-Address (in 12-digit hex) []?
Functional address (in noncanonical format) [ ]?
```

Example:

```
ASRT config> add mapping snap
```

```
Address (in 10-digit hex) [0000000800]?
Group-Address (in 12-digit hex) []?
Functional address (in noncanonical format) [ ]?
```

port *interface# port#*

Adds a LAN/WAN port to the bridging configuration. This command associates a port number with the interface number and enables that port's participation in transparent bridging.

Port Number Valid Values: 1 to 254

Port Number Default Value: none

Example: add a port

```
ASRT config> add port
Interface Number [0]?
Port Number [5]?
```

| See "ATM Commands" on page 5-42 for information about adding ATM ports.

prot-filter s**nap** e**ther** d**sap**

Allows the bridge to be configured so that it can selectively filter packets based on their protocol type. Filters can be applied to all ports or only selected ports.

This parameter specifies protocol identifiers for which the received frames of that specific protocol are discarded exclusively without applying bridge logic. ARP packets for this protocol type will also be discarded. The protocol filter is applied only on the received packets. The protocol filters available include:

SNAP Packets Subnetwork Access Protocol with protocol type entered in 10-digit hexadecimal format.

Ether Packets Ethernet Type with the protocol type entered in the range 5DD–FFFF (hexadecimal).

DSAP Packets Destination Service Access Point protocol with the protocol type entered in the range 0–FE (hexadecimal).

Common protocol filters and their respective values are as follows.

DSAP Types

Protocol	SAP (hexadecimal value)
Banyan SAP	BC (used only for 802.5)
Novell IPX SAP	E0 (used only for 802.5)
NetBIOS SAP	F0
ISO Connectionless Internet	FE

SNAP Protocol Identifiers

Protocol	SNAP OUI/IP (10-digit)
AppleTalk Phase 2	08-00-07-80-9B
Apple ARP Phase 2	00-00-00-80-F3

Ethernet Types

Protocol	Ethernet type (hex value)
IP	0800
ARP	0806
CHAOS	0804
Maintenance Packet Type	7030
DECnet MOP Dump/Load	6000
DECnet MOP Remote Console	6002
DECnet	6003
DEC LAT	6004
DEC LAVC	6007
XNS	0600
Apollo Domain	8019 (Ethernet)
Novell NetWare IPX	8137 (Ethernet)
Apple ARP Phase 1	80F3
Loopback assistance	9000

Example: ASRT config> **add prot-filter dsap** (used for DSAP packets)

```
Protocol Type in hex (0 - FE) [1]?
   Filter packets arriving on all ports?(Yes or [No]):
   Filter packets arriving on  port 1 - Yes or [No]:
   Filter packets arriving on  port 2 - Yes or [No]:
   Filter packets arriving on  port 3 - Yes or [No]:
Port assignment Required, filter not added
ASRT config>
```

Example: ASRT config> **add prot-filter ether** (used for Ethernet packets)

```
Protocol Type in hex (5DD - FFFF) [0800]?
   Filter packets arriving on all ports?(Yes or [No]):
   Filter packets arriving on  port 1 - Yes or [No]:
   Filter packets arriving on  port 2 - Yes or [No]:
   Filter packets arriving on  port 3 - Yes or [No]:
Port assignment Required, filter not added
ASRT config>
```

Example: ASRT config>**add prot-filter snap** (used for SNAP packets)

```
Address (in 10-digit hex) [0000000800]?
Protocol Type in hex (5DD - FFFF) [0800]?
   Filter packets arriving on all ports?(Yes or [No]):
   Filter packets arriving on  port 1 - Yes or [No]:
   Filter packets arriving on  port 2 - Yes or [No]:
   Filter packets arriving on  port 3 - Yes or [No]:
Port assignment Required, filter not added
ASRT config>
```

tunnel *port#*

Creates the user-defined IP tunnel to a bridge port. The bridge tunnel allows source route bridge domains or transparent bridge domains to communicate across an IP network.

To allow IBM LAN and terminal traffic to merge with non-IBM traffic (that is, Novell) across a single backbone, the Source Routing Bridge Tunnel and SDLC (Synchronous Data Link Control) Relay features of the bridging router software encapsulate IBM traffic within industry-standard TCP/IP packets. The bridging router then routes these packets using an IP path or *tunnel* through large IP internetworks. The benefit is

increased functionality and network utilization as well as higher network availability and increased ease of use.

End-stations see the IP path (the tunnel) as a single hop, regardless of the network complexity. This helps overcome the usual 7-hop distance limit encountered in source-routing configurations. It also lets you connect source-routing end-stations across non-source-routing media, such as Ethernet networks.

The bridging tunnel also overcomes several limitations of regular source routing including:

- Distance limitation of seven hops
- Large amounts of overhead that source routing causes in wide-area networks (WANs)
- Source-routing's sensitivity to WAN faults and failures (if a path fails, all systems must restart their transmissions)

With the bridge tunnel feature enabled, the software encapsulates packets in TCP/IP packets. To the router, the packet looks like a TCP/IP packet. Once a frame is encapsulated in an IP envelope, the IP forwarder is responsible for selecting the appropriate network interface based on the destination IP address. This packet can be routed dynamically through large internetworks without degradation or network size restrictions. End-stations see this path, or tunnel, as a single hop regardless of the complexity of the internetwork.

The tunnel is transparent to the end stations. The bridging routers participating in tunneling treat the IP internet as one of the bridge segments. When the packet reaches the destination interface, the TCP/IP headers are automatically removed and the inner packet proceeds as a standard source routing packet.

Add Tunnel creates the user-defined IP tunnel to a bridge port. This tunnel is counted as only one hop between the bridges no matter how complex the path through the IP internet. To use the tunnel feature, the IP forwarder must be enabled.

Only one tunnel can be added. You must use a *Port Number* that is not used for any other LAN port. Once a Port Number is assigned to the bridging tunnel, all other bridging commands that need a port number as a parameter can be used to configure the tunnel characteristics. For tunnel-specific configuration, such as the IP addresses of the endpoints, use the **tunnel** command (see "Tunnel" on page 5-38).

Transparent bridging is enabled on this port by default. Source routing can be enabled, however, by using the **Enable Source-Routing** option.

Example: **`add tunnel 3`**

```
Port Number   [1] ? 3
```

Port Number A unique port number that is not being used by the bridge.

Broadcast-Manager Protocol

Use the **broadcast-manager** command to configure Bridging Broadcast-Manager for IP or NetBIOS.

Syntax:

broadcast-manager *protocol*

Example: broadcast-manager ip

```
ASRT config>broad
Enter Bridge Broadcast Manager Protocol: (IP or NetBIOS) [IP]?  IP
IP Bridge Broadcast Manager User Configuration
IP B-BCM config>?
DISABLE ip b-bcm
ENABLE ip b-bcm
LIST configuration
SET cache age timeout
EXIT
```

Example 2: broadcast-manager netbios

```
NetBIOS Support User Configuration
NetBIOS config>
```

Note: The NetBIOS option takes you to the NetBIOS configuration option.

See “Bridging Broadcast Manager Configuration Commands” on page 5-51 for a description of Bridging Broadcast Manager configuration commands.

Change

Use the **change** command to change source routing bridge and segment numbers in the bridging configuration.

Syntax:

change bridge . . .

segment . . .

bridge *new-bridge#*

Changes bridge number in the bridging configuration.

Example: change bridge 3

segment *old-segment# new-segment#*

Changes segment number in the bridging configuration.

Example: change segment 2 3

Delete

Use the **delete** command to delete the following information from your bridging configuration:

- Station address entries to the permanent database
- Specific address mapping for a given protocol
- LAN/WAN ports
- Protocol filters that selectively filter packets based on their protocol type
- Duplicate MAC addresses

For the IP tunnel feature, the **delete port** command with the corresponding port number for the tunnel removes the tunnel between bridges across an IP internetwork.

Syntax:

delete address
dmac-addr
mapping . . .
port . . .
prot-filter . . .

address *addr-value*

Deletes an address entry from the permanent database. The address is the MAC address of the desired entry. Enter the addr-value (in 12-digit hexadecimal format) of the entry to be deleted and press **Return**. Reserved multicast addresses cannot be deleted. If you attempt to delete an address entry that does not exist, you will receive the message

```
Record matching that address not found
```

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example: `delete address`

dmac-addr *addr-value*

Deletes duplicate MAC address entries from the database. The *addr-value* is the MAC address of the desired entry you want to remove.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example:

```
ASRT>list dmac
Duplicate MAC address feature is   DISABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-00
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05

ASRT config>delete dmac-address
Address (in 12-digit hex) []? 10005a666600
Address deleted

ASRT config>list dmac
Duplicate MAC address feature is   DISABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

mapping *dlh-type type-field ga-address*

Deletes specific address mapping for given protocol.

dlh-type (data-link-header type) is a choice for DSAP, Ether-type, or SNAP.

type-field Protocol type field.

Destination service access point (DSAP) protocol type is entered in the range 1–FE (hexadecimal).

Valid Values: X'1' to X'FE'

Common values are:

Protocol - SAP (hexadecimal value)

Default Value: 1

Ethernet (Ether) protocol type is entered in the range 5DD–FFFF (hexadecimal).

Valid Values: X'5DD' to X'FFFF'

Default Value: 1

Subnetwork Access Protocol (SNAP) protocol type is entered in 10-digit hexadecimal format.

Valid Values: X'00 0000 0000' to X'FF FFFF FFFF'

Common values are:

Default Value: 00 0000 0800

ga-address 6-byte (12-digit hexadecimal) group/multicast address.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example: `delete mapping DSAP FE <group address>`

port *port#*

Removes a port from a bridging configuration. Because the **enable bridge** command by default configures all LAN devices to participate in bridging, this command allows you to customize which devices should or should not participate in the bridging. The port number value normally is one greater than the interface number.

This command followed by the IP tunnel port# removes an IP tunnel from a bridging configuration.

Example: `delete port 2`

prot-filter **snap** **ether** **dsap**

Deletes previously specified protocol identifiers used in filtering. You can delete filters for all ports or selected ports. These filters include the following:

SNAP Packets

Subnetwork Access Protocol with protocol type entered in 10-digit hexadecimal format.

Ether Packets

Ethernet Type with the protocol type entered in a range of 5DD – FFFF (hexadecimal).

DSAP Packets

Destination service access point protocol with the protocol type entered in a range of 0–FE (hexadecimal).

Example: ASRT config> **delete prot-filter snap** (used for SNAP packets)

```
Address (in 10-digit hex) [0000000800]?
   Delete filter on all ports?(Yes or [No]):
   Delete filter on  port 1 - Yes or [No]:
   Delete filter on  port 2 - Yes or [No]:
   Delete filter on  port 3 - Yes or [No]:
```

Example: ASRT config> **delete prot-filter ether** (used for Ethernet packets)

```
Protocol Type in hex (5DD - FFFF) [0800]?
   Delete filter on all ports?(Yes or [No]):
   Delete filter on  port 1 - Yes or [No]:
   Delete filter on  port 2 - Yes or [No]:
```

Example: ASRT config> **delete prot-filter dsap** (used for DSAP packets)

```
Protocol Type in hex (0 - FE) [1]?
   Delete filter on all ports?(Yes or [No]):
   Delete filter on  port 1 - Yes or [No]:
   Delete filter on  port 2 - Yes or [No]:
   Delete filter on  port 3 - Yes or [No]:
```

Disable

Use the **disable** command to disable the following bridge functions:

- Bridging
- Duplicate frames
- Mapping between group and functional addresses
- Propagation of Spanning Tree Explorer Frames
- Source routing on a given port
- Reception of spanning tree explorer frames over a tunnel
- SR-TB conversion
- SuperELAN bridging
- Transparent (spanning tree) bridging function on a given port
- Tunnel between bridges
- Duplicate MAC address feature
- Duplicate MAC load balancing
- DLSw

For the tunnel feature, the disable command disables a tunnel between end stations across an IP internetwork.

Syntax:

disable

- bridge
- dls
- duplicate . . .
- dmac-addr
- dmac-load-balance
- ethertype-ibmrt-pc
- fa-ga-mapping
- ibm8209_Spanning_Tree
- spanning-tree-explorer . . .

source-routing . . .

sr-tb-conversion

stp

super-elan-bridging

transparent . . .

tree

ub-encapsulation

bridge Disables bridging function entirely. This command does not remove previously configured bridging values, however.

Example: `disable bridge`

dls Disables the operation of DLSw on the bridge. (The router running DLSw appears as a bridge to the end stations.) See Chapter 6, “Using DLSw” on page 6-1 for more details.

Example: `disable dls`

duplicate *frame-type*

Disables the creation of duplicate frames present in mixed bridging environments. When the SR-TB bridging feature is enabled on an 802.5 interface (with source routing and transparent bridging enabled), there are inconsistencies created when bridging frames to an unknown (or multicast) destination. The bridge does not know whether the destination is behind a source routing (only) or transparent bridge.

To remedy this situation, the bridge sends out duplicates of these frames (by default). One frame has source routing fields present (a spanning tree explorer RIF) and the other is formatted for transparent bridging (no RIF is present). The **disable duplicate** command lets you eliminate this duplication by allowing you to disable the creation of one of these types of frames. The **disable duplicate** command will not allow you to disable simultaneously both types of frames.

Entering **STE** after the command tells the bridge to refrain from sending out spanning tree explorer frames created for the source routing environment. Entering **TSF** after the command tells the bridge to refrain from sending out transparent spanning frames for the transparent bridging environment. In both cases, it is a situation where normally both types of frames would be sent out. Disabling transparent bridging on the interface also disables the creation of transparent frames.

Example: `disable duplicate TSF`

```
Port Number [1]?
```

dmac-addr

Disables the duplicate MAC address feature.

Example: `disable dmac-addr`

```
ASRT>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is    ENABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-00
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05

ASRT config>disable dmac-addr

ASRT>list dmac
Duplicate MAC address feature is   DISABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-00
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

dmac-load-balance

Disables Duplicate MAC load balancing for the duplicate MAC address feature.

Example: `disable dmac-load-balance`

```
ASRT>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is    ENABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-00
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
ASRT config>disable dmac-load-balance
ASRT>list dmac
Duplicate MAC address feature is   ENABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-00
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

ethertype-ibmrt-pc

Disables translation of SNA frames to Ethernet Type 2 format as used by IBM RTs running OS/2 EE.

Example: `disable ethertype-ibmrt-pc`

```
Port Number [1]?
```

fa-ga-mapping

Disables group address-to-functional address (and conversely) mapping. You might under certain circumstances want to disable the mapping between group address and functional address globally.

Example: `disable fa-ga-mapping`

ibm8209_Spanning_Tree
Removes bridges from participating in spanning tree protocols with IBM 8209 bridges.

Example: `disable IBM8209_spanning_tree`

spanning-tree-explorer *port#*
Disables a port from allowing propagation of spanning tree explorer frames if source routing is enabled. This command is used only if transparent bridging is not enabled on the port. In that case, it is automatically known in conformance with the transparent spanning tree.

Example: `disable spanning-tree-explorer 2`

source-routing *port#*
Disables source routing on a given port. This command is used to have an already-participating bridge interface discontinue source routing.

Example: `disable source-routing 2`

sr-tb-conversion
Disables conversion of source routed frame to transparent frame and vice versa.

Example: `disable sr-tb-conversion`

stp Disables the Spanning Tree Protocol on the bridge. The default is enabled.

Example: `disable stp`

super-elan-bridging *port#*
Disables the SuperELAN participation on the bridge port.

Example: `disable super` 1

Note: This option is not available if SuperELAN II is configured.

transparent *port#*
Disables transparent bridging function on the given port. This command is useful for cases where an alternative communication method such as source routing is desirable.

Note: This command might bring about an absurd configuration if not used correctly. For instance, using it on an Ethernet interface will result in disabling bridging function for that interface. This command is used to bring about SRB and SR-TB bridge function.

Example: `disable transparent 2`

tree *port#* Disables STP participation for the bridge on a per-port basis.

Example: `disable tree 1`

Note: Disabling STP on a per-port basis can produce network loops because of the existence of parallel bridges.

ub-encapsulation
Disables Ungermann-Bass OUI encapsulation of XNS frames. XNS frames are forwarded to both Ethernet and Token Ring using SNAP encapsulation with an OUI of all zeros.

Example: `disable ub-encapsulation`

Enable

Use the **enable** command to enable the following bridging functions:

- Bridging
- Duplicate frames
- Mapping between group and functional addresses
- Propagation of Spanning Tree Explorer Frames
- Source routing on a given port
- Reception of Spanning Tree Explorer frames over a tunnel
- SR-TB conversion
- SuperELAN bridging
- Transparent (Spanning Tree) bridging function on a given port
- Tunnel between bridges
- Duplicate MAC address feature
- Duplicate MAC load balancing
- DLSw

For the IP tunnel feature, the **enable** command enables a tunnel between end stations across an IP internetwork.

Syntax:

e**nable**	bridge . . .
	dls
	duplicate
	dmac-addr
	dmac-load-balance
	ethertype-ibmrt-pc
	fa-ga-mapping
	ibm8209_Spanning_Tree
	spanning-tree-explorer . . .
	source-routing . . .
	sr-tb-conversion
	stp
	super-elan-bridging
	transparent . . .
	tree
	ub-encapsulation

bridge Enables transparent bridging function on all the LAN devices (interfaces) configured in the bridging router. The port numbers are assigned to each interface as the previous interface number plus 1. For example, if interface 0 is a LAN device its port number will be 1.

Example: `enable bridge`

dls Enables the operation of DLSw on the bridge. The device running DLSw appears as a bridge to the end stations. See from more information.

duplicate *frame-type*

Enables the generation of duplicate STE (spanning tree explorer) frames or TSFs (transparent spanning frames). This command is available to offset the **disable duplicate** command. Duplicate frame generation is enabled by default. The **enable duplicate** command can be followed by a frame type of **TSF** or **STE** to specifically enable one of the frame types, or by the frame type **BOTH**, which yields the same behavior as not specifying a frame type for this parameter.

Example: `enable duplicate STE`

```
Port Number [1]?
```

dmac-addr

Enables the duplicate MAC address feature. See “SR-TB Duplicate MAC Address Feature” on page 3-9 for additional information about the duplicate MAC address feature.

Example with load-balancing:

```
ASRT config>enable dmac-addr

ASRT config>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05

ASRT config>enable dmac-load-balance

ASRT config>li dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is    ENABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

Example (without load-balancing):

```
ASRT config>enable dmac-addr

ASRT config>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

dmac-load-balance

Enables Duplicate MAC load balancing for the duplicate MAC address feature. See the discussion “SR-TB Duplicate MAC Address Feature” on page 3-9 for a description of Duplicate MAC load balancing.

Example :

```
ASRT config>enable dmac-addr

ASRT config>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05

ASRT config>enable dmac-load-balance

ASRT config>li dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is    ENABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

ethertype-ibmrt-pc

Enables translation of SNA frames to Ethernet Type 2 as used by IBM PC RTs running OS/2 EE. This will result in SNA frames being duplicated into both 802.3/802.2 and IBM-RT formats to unknown hosts on an Ethernet.

Example: `enable ethertype-ibmrt-pc`

```
Port Number  [4]?
```

fa-ga-mapping

Enables group address to functional address (and conversely) mapping. This mapping is conducted when frames are forwarded between token ring and other media (except serial line). In the token-ring arena, functional addresses are more popular even though they are locally assigned group addresses due to restrictions in hardware. On other media, group addresses are widely used. Under normal circumstances group address to functional address mapping is inevitable.

Mapping is enabled by default if mapping addresses have been added. The enable/disable mapping lets users have a choice when it comes to deleting added map records.

Example: `enable fa-ga-mapping`

IBM8209_Spanning_Tree

Allows bridges to participate in spanning tree protocols with IBM 8209 bridges.

Example: `enable IBM8209_spanning_tree`

spanning-tree-explorer *port#*

Enables the port to allow propagation of spanning tree explorer frames if source routing is enabled. This command is valid on token-ring and WAN ports only. This feature is enabled by default when source routing is configured on the port.

Example: `enable spanning-tree-explorer 2`

source-routing *port# segment# [bridge#]*

Enables source routing for a given port. This command is typically used when source routing on part of the bridge is required. If source routing is the only feature desired, transparent bridging on the interface should be disabled. For the first instance of the command, entering the bridge number is required. For subsequent times, this input is not required.

Important: If you enable source-route bridging on the MSS Family Client, you cannot enable source-route bridging on the LAN Switch.

port# Valid port participating in the bridge configuration.

Valid Values: X'0' to X'FFF'

Default Value: 1

segment#

12-bit number that represents the LAN/WAN to which media are attached. All the media on other bridges attached to this LAN/WAN must be configured with the same value. For correct operation of the source routing function, it is very important that all the bridges attached to this LAN/WAN have the same perspective of the LAN/WAN identification value.

bridge# 4-bit value unique among all the bridges attached to the same LAN/WAN. This value is required when source routing is enabled on the first interface. For later interfaces, this input is optional. It is recommended that the bridge# be unique on the segment.

Valid Values: X'0' to X'F'

Default Value: 1

Note: If the configuration is a situation where two segments have already been configured (that is a 1:N SRB configuration), you will be prompted for an additional *virtual-segment#* parameter.

Example: `enable source-routing 2 1 1`

sr-tb-conversion

This option enables conversion of source routing to transparent bridging frame format and vice versa. It allows for compatibility between source routing and transparent bridging domains. When this feature is enabled, the bridge lets source-routed frames be accepted into a transparent domain by stripping off the RIF field and converting them into transparent frames.

The bridge also gathers routing information concerning source routing stations from the passing source routing frames. This is obtained from the RIF. This RIF information is then used to convert a transparent frame to a source-routed frame. If an RIF is not available for a station, then the frame is sent out as a spanning tree explorer frame in the source routing domain.

In order for the conversion function to operate correctly, you must give the transparent bridging domain a segment number. All SR-TB bridges that are connected to this domain should also be configured with the same segment number.

TB-Domain Segment Number Valid Values: X'1' - X'FFF'

TB-Domain Segment Number Default Value: 1

The maximum transmission unit (MTU) is the number of octets per frame of data that can be transferred across a given physical network. When an IP datagram travels from one host to another, it can cross different physical networks. Some physical networks may have this set MTU, which will not allow long IP datagrams to be placed in on a physical frame. Fragmentation will occur when you attempt to transmit frames larger than that which the physical network can handle.

TB-Domain MTU Valid Values: 576 to 18000 bytes

TB-Domain MTU Default Value: 2048

Example: `enable sr-tb-conversion`

```
TB-Domain Segment Number in hex(1 - FFF) [1]? 2
Bridge Virtual Segment Number in hex[1 - FFF]? aa
TB-Domain's MTU [1470]? 1455
TB-Domain's MTU is adjusted to 1350
```

stp Enables the spanning tree protocol on the bridge. This is the default.

Example: `enable stp`

super-elan-bridging *port# super-elan-id*

Migration of SuperELANs to SuperELAN II: For compatibility with older configurations, SuperELANs can still be configured from the `ASRT config>` prompt. However, all new SuperELAN configurations should be configured using the `SE Services config>` menu from the `ATM config>` prompt. See the chapter entitled “Using and Configuring ATM” in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide for more information.

Existing `ASRT config>` SuperELAN configurations can be migrated using the `SE Services config>` **migrate** command.

This option enables the bridge port for SuperELAN support. SuperELAN support allows LAN Emulation clients on different ELANs to communicate directly with each other. Clients can establish data direct VCCs with any other client in the SuperELAN, even if the clients are defined on different ELANs. Once the data-direct VCC is established, bridge support is not required to forward data frames.
The SuperELAN function can be enabled only for Transparent bridge ports that have an ATM physical interface and are identified with Ethernet or Token-Ring LAN Emulation Clients.

Example: `enable super` 1 1

Note: This option is not available if SuperELAN II is configured.

transparent *port#*

Enables transparent bridging function on the given port. Under normal circumstances, this command is not necessary.

Example: `enable transparent`

```
Port Number [1]?
```

tree *port#* Enables STP participation for the bridge on a per-port basis.

Example: `enable tree 1`

ub-encapsulation

Causes XNS Ethernet Type 2 frames to be translated into Token-Ring frames using the Ungermann-Bass OUI in the SNAP header. Token-Ring frames containing the UB OUI header will be forwarded to Ethernets as type 0x0600 Ethernet Type 2 frames rather than as 802.3/802.2 frames.

Example: `enable ub-encapsulation`

List

Use the **list** command to display information about the complete bridge configuration or to display information about selected configuration parameters.

Syntax:

list address

bridge

dmac

filtering . . .

mapping . . .

permanent . . .

port . . .

prot-filter . . .

protocol

range . . .

address *addr value* Reads an address entry from the permanent database. The addr value is the MAC address of the required entry. It can be an individual address, multicast address, or broadcast address. Permanent databases are not destroyed by the power off/on process and are immune to the aging settings. Permanent entries cannot be replaced by dynamic entries.

Valid Values: X'0000 0000 0000' to X'FFFF FFFF FFFF'

Default Value: none

Example: `list address 000000123456`

```
0000-00-12-34-56    PERMANENT  Input Port:  1
                               Output ports:  1, 2
                               Input port:  2
                               Output ports:  3
ASRT config>
```

Address Address entry in 12-digit hexadecimal format.

Entry Type

Permanent

Indicates that the entry is permanent in nature and will survive power on/offs or system resets.

Reserved

Indicates that the entry is reserved by the IEEE 802.1d committee for future use. Frames destined to reserved addresses are discarded.

Registered

Indicates that the entry is meant for the bridge itself.

SAF Appears after the entry type if source address filtering has been configured.

Input Port

Displays the numbers of the input port or ports associated with that address entry.

Output Port

Displays the numbers of the output port or ports associated with that address entry. Displays “NONE/DAF” to indicate that destination address filtering applies because no ports have been selected to be associated with that address entry.

bridge Lists all general information regarding the bridge.

Example: `list bridge`

```
Source Routing Transparent Bridge Configuration
===============================================

Bridge:  ENABLED                        Bridge Behavior: ADAPTIVE SRT
                  +----------------------------+
-----------------| SOURCE ROUTING INFORMATION |----------------------------
                  +----------------------------+
Bridge Number:          0A               Segments:          2
Max ARE Hop Cnt:        14               Max STE Hop cnt:  14
1:N SRB:                Active          Internal Segment:  0xFF6
LF-bit interpret:       Extended
                  +-------------------+
-----------------| SR-TB INFORMATION |-----------------------------------
                  +-------------------+
SR-TB Conversion:       Enabled
TB-Virtual Segment:     0x107               MTU of TB-Domain:   1470
                  +-----------------------------------+
-----------------| SPANNING TREE PROTOCOL INFORMATION |------------------
                  +-----------------------------------+
Bridge Address:         00-00-00-00-00-06    Bridge Priority:   32768/0x8000

STP Participation:      IEEE802.1d and IBM-8209
                  +-------------------------+
-----------------| TRANSLATION INFORMATION |----------------------------
                  +-------------------------+
FA<=>GA Conversion:     Enabled                UB-Encapsulation:  Disabled

                  +------------------+
-----------------| PORT INFORMATION |-----------------------------------
                  +------------------+
Number of ports added:  3
Port:   1      Interface:     0      Behavior:   STB only    STB:  Enabled
VPI:   0      VCI:          48
Port:   2      Interface:     1      Behavior:   STB & SRB   STB:  Enabled
Port:   3      Interface:     2      Behavior:   STB & SRB   STB:  Enabled
Port:   4      Interface:     0      Behavior:   STB only    STP: Enabled
Dest ATM Address: 39.11.22.33.44.55.66.77.88.99.00.11.22.33.44.55.66.77.88.99
```

Bridge Indicates current state of bridge. Values are ENABLED or DISABLED.

Bridge Behavior

Indicates method of bridging being used by that bridge. The values include STB for transparent, SRB for source routing, and ADAPTIVE SRT for source-routing transparent conversion bridging.

Bridge address
Bridge address specified by the user (if set).

Bridge priority
A high-order 2-octet bridge address found in the Bridge Identifier, either the MAC address obtained from the lowest-number port or the address set by the Set Bridge command.

Source Routing Bridge Number
The unique number identifying a bridge. It is used to distinguish between multiple bridges connecting the same two rings.

Number of Source Routing Segments
Indicates the number of source-routing bridge segments configured for the source-routing domain.

SRB: Max ARE/STE Hop cnt
The maximum hop count for frames transmitting from the bridge for a given interface associated with source routing bridging.

SR-TB Conversion
Indicates whether the source routing/transparent bridge frame conversion function is enabled or disabled.

TB-Virtual Segment
Indicates the segment number of the transparent bridging domain.

MTU for TB-Domain
Specifies the maximum frame size (maximum transmission units) the transparent bridge can transmit and receive.

1:N Source Routing
Indicates the current state of 1:N Source Routing as ACTIVE or NOT ACTIVE.

Internal Virtual Segment
Displays the virtual segment number configured for 1:N SRB bridging.

SRB LF-bit interpretation
Indicates the largest Frame (LF) bit encoding interpretation mode if source routing is enabled in this bridge. This is listed as either BASIC or EXTENDED.

FA-GA conversion
Indicates whether FA-GA conversion is enabled or disabled.

Spanning Tree Protocol Participation
Displays the types of spanning tree protocols that the bridge participates in.

Number of ports added
Number of bridge ports added to the bridging configuration.

Port Number
A user-defined number assigned to an interface by the Add Port command.

Interface Number
Identifies devices connected to a network segment through the bridge. You must add at least two interfaces to participate in bridging. An interface number of 255 is used for bridging.

Port Behavior
Indicates method of bridging being used by that port, STB for transparent bridging and SRB for source route bridging.

VPI Specifies the VPI associated with the ATM port.

VCI Specifies the VCI associated with the ATM port.

dmac Displays the configured options for the duplicate MAC address feature.

Example:

```
ASRT config>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

filtering *datagroup-option* The following general data groups can be displayed under the **list filtering** command:

All Displays all filtering database entries.

Ethertype Displays Ethernet protocol type filter database entries.

SAP Displays SAP protocol filter database entries.

SNAP Displays SNAP protocol identifier filter database entries.

The following examples illustrate each of the **list filtering** display options.

Example 1: `list filtering all`

```
Ethernet type 0800 is routed on ports 1
IEEE 802.2 destination SAP 42 is routed on ports 1
IEEE 802 SNAP PID 00-00-00-08-00 is routed on ports 2-3
```

Descriptors used in explaining how packets are communicated include:

Routed Describes packets passed to routing forwarder to be forwarded.

Filtered Describes packets that are administratively filtered setting protocol filters that you set.

Bridged and routed
This describes a protocol identifier for which there is a protocol entity within the system that is not a forwarder. For example a link level echo protocol. Unicast packets from this protocol are bridged or locally processed if being sent to a registered address. Multicast packets are forwarded and locally processed for a registered multicast address.

All of these descriptors also apply to ARP packets with this Ethertype.

Example 2: `list filtering ethertype`

```
Ethernet type (in hexadecimal), 0 for all [0]? 0800
Ethernet type 0800 is routed on ports 1
```

Example 3: `list filtering sap`

```
SAP (in hexadecimal), 100 for all [100]? 42
IEEE 802.2 destination SAP 42 is routed on ports 1
```

Example 4: `list filtering snap`

```
SNAP Protocol ID, return for all [00-00-00-00-00]?
IEEE 802 SNAP PID 00-00-00-08-00 is routed on ports 2-3
```

mapping *add-type type-field* Lists specific address mapping for a given protocol.

Example: `list mapping SNAP`

```
PROTOCOL TYPE          GROUP ADDRESS          FUNCTIONAL ADDRESS
=============          =============          ==================
123456-7890            12-34-56-78-90-12      12:34:56:78:90:12
```

add-type Choice of either DSAP, Ether (Ethernet), or SNAP.

type-field Protocol type field:

- Destination Service Access Point (DSAP) protocol type is entered in the range 1–FE (hexadecimal).
- Ethernet (Ether) protocol type is entered in the range of 5DD–FFFF (hexadecimal).
- Subnetwork Access Protocol (SNAP) protocol type is entered in 10-digit hexadecimal format.

permanent Displays the number of entries in the bridge's permanent database.

Example: `list permanent`

```
Number of Entries in Permanent Database:  17
```

port *port#* Displays port information related to ports that are already configured. Port# selects the port you want to list. Specifying no number selects all ports.

Example: `list port`

```
Port Id (dec)    : 128: 5, (hex): 80-05
Port State       : Enabled
STP Participation: Enabled
Port Supports    : NO Bridging
Assoc Interface  : 1
Path Cost        : 0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Port ID (dec)    : 128: 2, (hex): 80-02
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 0  VPI  0  VCI:    78
Path Cost        : 0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Port ID (dec)    : 128: 3, (hex): 80-03
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 2
SuperELAN bridging: Enabled       SuperELAN ID:
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Port ID (dec)    : 128: 1, (hex): 80-01
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 0  VPI:   0  VCI:   795
Path Cost        : 0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Port ID (dec)    : 128: 4, (hex): 80-04
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 0  Dest ATM Addr: 391122334455667788990011223344
                                                              5566778899
Path Cost        : 0
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

Port ID The ID consists of two parts: the port priority and the port number. In the example, 128 is the priority, and 1, 2, and 3 are the port numbers. In hexadecimal format, the low-order byte denotes the port number and the high-order byte denotes the priority.

Port state

Displays current state of the specified port or ports. This can be either ENABLED or DISABLED.

Port supports

Displays bridging method supported by that port (for example, transparent bridging, source route bridging).

SRB Displayed only when SRB is enabled and lists source routing bridging information. This includes the SRB segment number (in hex), the Maximum Transmission Unit size, and whether the transmission of spanning tree explorer frames is enabled or disabled.

Duplicate Frames Allowed

Displays a breakdown and count of the types of duplicate frames allowed.

Assoc interface

Displays interface number associated with the displayed port. Also displays the VPI/VCI or the destination ATM address if the port exists on an ATM interface.

Path Cost

Cost associated with the port which is used for possible root path cost. The range is 1 to 65535.

SuperELAN Bridging
Displays SuperELAN status for the bridge port and Super ELAN ID to which the port is assigned. The range of values for SuperELAN ID is 1 to 65535.

prot-filter *port#* Reads a current list of the filter protocol types. Filters can be listed selectively by port or all ports can be displayed at once. Port# selects the bridge port that you want to list.

Example: `list prot-filter 1`

```
PORT 1
Protocol Class   :  DSAP
Protocol Type    :  01
Protocol State:  :  Filtered
Port Map         :  1, 2, 3
```

Port Number
Port number is displayed for each port if all ports are selected to be displayed.

Protocol Class
Displays protocol class (SNAP, Ether, or DSAP).

Protocol Type
Displays protocol ID in hexadecimal format.

Protocol State
Denotes that protocol is being filtered for selected port.

Port Map Displays the numbers of the ports where this type of protocol filter is present.

protocol Displays bridge information related to the spanning tree protocol.

Example: `list protocol`

```
Bridge Identifiers: 32768/00000000003
Bridge-Max-Age (in seconds): 20
Bridge-Hello-Time (in seconds): 2
Bridge-Forward-Delay (in seconds): 15
```

Note: Each of these bridge-related parameters is also described in detail in the previous chapter.

Bridge Identifier
8-byte value in ASCII format. If you did not set the bridge address prior to displaying this information, the low order 6 bytes will be displayed as zero, denoting that the default MAC address of a port is being used. When a bridge has been selected as the root bridge, the bridge max age and bridge hello time are transmitted by it to all the bridges in the network via the HELLO BPDUs.

Bridge-Max-Age
Maximum age (period of time) that should be used to time out spanning tree protocol-related information.

Bridge-Hello-Timer
Time interval between HELLO BPDUs.

Bridge-Forward-Delay
Time interval used before changing to another state (should this bridge become the root).

range *start-index stop-index* Reads a range of address entries from the permanent database. To specify this, first determine the size of the database by using the **list permanent** command. From this value you can then determine a “start index” value for your entry range. The start index is in the range from 1 to the size of the database. You can then choose a “stop index” for displaying a limited number of entries. This input is optional. If you do not specify the stop index, the default value is the size of the database.

Address entries contain the following information:

Example: `list range`

```
Start-Index [1]? 1
Stop-index [17]? 6
ADDRESS                 ENTRY TYPE      PORT MAP

=======                 ==========      ========
01-80-C2-00-00-00       REGISTERED      Input Port:  ALL PORTS
                                        Output ports:

01-80-C2-00-00-01       RESERVED        NONE/DAF
01-80-C2-00-00-02       RESERVED        NONE/DAF
01-80-C2-00-00-03       RESERVED        NONE/DAF
01-80-C2-00-00-04       RESERVED        NONE/DAF
01-80-C2-00-00-05       RESERVED        NONE/DAF
```

Address 6-byte MAC address of the entry.

Type of Entry

Specifies one of the following types:

- Reserved - entries reserved by the IEEE 802.1d committee
- Registered - entries consist of unicast addresses belonging to proprietary communications hardware attached to the box or multicast addresses enabled by protocol forwarders
- Permanent - entries entered by the user in the configuration process which survive power on/offs or system resets
- Static - entries entered by the user in the monitoring process that do not survive power on/offs or system resets and are ageless
- Dynamic - entries “learned” by the bridge “dynamically” that do not survive power on/offs or system resets and that have an “age” associated with the entry
- Free - locations in database that are free to be filled by address entries

Port Map Displays outgoing port map for all incoming ports.

NetBIOS

Displays the NetBIOS configuration prompt. Enter **netbios** at the `ASRT config>` prompt to display the NetBIOS configuration prompt. See “NetBIOS Commands” on page 9-3 for an explanation of each of the NetBIOS configuration commands.

Syntax:

netbios

Example: **`netbios`**

```
NetBIOS Support User Configuration
NetBIOS config>
```

Set

Use the **set** command to set certain values, functions, and parameters associated with the bridge configuration. These include:

- Aging time for dynamic address entries in the filtering database
- Bridge address
- Largest Frame (LF) bit encoding interpretation for source routing
- MAC service data unit (MSDU) size
- Spanning tree protocol bridge and port parameters
- Route Descriptor (RD) limit
- Size of the bridge filtering database
- Aging time for RIFs associated with duplicate MAC addresses
- SuperELAN identifier

Syntax:

set age

bridge

dmac-age

filtering

lf-bit-interpretation . . .

maximum-packet-size . . .

port

protocol bridge

protocol port . . .

route-descriptor-limit . . .

super-elan-id

age *seconds resolution*

Sets the time for aging out dynamic entries in the filtering database when the port with the entry is in the forwarding state. This age is also used for aging RIF entries in the RIF table in the case of an SR-TB bridge personality.

Enter the required value after each prompt and press **Return**.

Aging Time Valid Values: 10 to 1000000

Aging Time Default Value: 30

The resolution value specifies how often dynamic entries in the filtering database should be scanned to determine if they have exceeded their age limit as set by the aging timer.

Resolution Valid Values: 1 to 60 seconds

Resolution Default Value: 5 seconds

Example: `set age`

```
seconds [300]  ?  400
resolution [5] ?  6
```

bridge *bridge-address*

Sets the bridge address. This is the low-order 6-octet bridge address found in the bridge identifier. By default, the bridge-addr-value is set to the medium access control (MAC) address of the lowest-numbered port at initialization time. You can use this command to override default address and enter your own unique address.

Note: Each bridge in the network must have a unique address for the spanning tree protocol to operate correctly.

Attention: In cases where a serial line interface (or tunnel) is the lowest numbered port, it is mandatory to use this command so that the bridge will have a unique address when restarted. This process is necessary because serial lines do not have their own MAC address.

At the prompt, enter the bridge address in 12-digit hexadecimal format and press **Return**.

If you enter the address in the wrong format you will receive the message `Illegal Address`. If you enter no address at the prompt you will receive the message `Zero length address supplied` and the bridge will maintain its previous value. To return the bridge address to the default value, enter an address of all zeros.

Valid Values: 12 hexadecimal digits

Do not use dashes or colons to separate each octet. Each bridge in the network must have a unique address for the spanning tree protocol to operate correctly.

Default Value: 000000000000

Example: `set bridge`

```
Bridge Address (in 12-digit hex)[]?
```

dmac-age *seconds*

Sets the time for aging out RIF entries in the RIF table for duplicate MAC addresses. This value will be used for only the learned duplicate MAC addresses. For all other addresses, the value from the **set age** command will be used for aging.

Enter the desired value after each prompt and press **Return**.

DMAC Aging Time Valid Values: 10 to 1000000

DMAC Aging Time Default Value: 300

Example: `set dmac-age`

```
ASRT config>set dmac-age
seconds [300]? 200
ASRT config>list dmac
Duplicate MAC address feature is   DISABLED
Load balance feature is   DISABLED
Age value for Duplicate MAC address :000000C8
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

filtering *database-size*

Sets the number of entries that can be held in the bridge filtering database.

Default Value: 1024 times the number of bridge ports.

For more information, see the **list filtering** command on page 5-27.

Example: `set filtering`

```
database-size [2048]?
```

lf-bit-interpretation *encode-mode*

Sets the Largest Frame (LF) bit encoding interpretation if source routing is enabled in this bridge.

Example: `set lf-bit-interpretation basic`

Encode-mode

Entered as either **basic** or **extended**. In the basic mode only 3 bits of the routing control field are used. This is the common practice in source routing bridges that exist today. In extended mode, 6 bits of the routing control field are used to represent the maximum data unit that the bridge supports. The default value is **extended**. Extended and Basic nodes are compatible.

maximum-packet-size *port# msdu-size*

Sets the largest MAC service data unit (MSDU) size for the port, if source routing is enabled on this port. The MSDU value setting has no implication on traditionally transparent media. An MSDU value greater than the packet size configured in the router will be treated as an error.

If this parameter is not set, the default value used is the size configured as the packet size for that interface.

Valid Values: Specify an integer in the range 16 to 65535

Default Value: packet size set for the port

Example: `set maximum-packet-size 1 4399`

port *block* **or** *disable*

Begins the port's participation in the spanning tree protocol. This is done by entering a status value of "block." This places the port in the "blocked" status as a starting point. The actual state of the port will later be determined by the spanning tree protocol as it determines its topology. Entering a status value of "disable" removes the port from participating in the spanning tree.

Example: `set port block`

```
Port Number [1]?
```

protocol *bridge* **or** *port*

Modifies the spanning tree protocol bridge or port parameters for a new configuration, or tunes the configuration parameters to suit a specific topology.

Enter "bridge" as the option to modify bridge parameters. The bridge-related parameters that can be modified with this command are described below.

Enter **srb** or **tb** to specify whether the source routing bridge (srb) or transparent bridge (tb) spanning tree protocol parameters are to be affected.

When setting these values, make sure that the following relationships exist between the parameters or the input will be rejected:

2 X (Bridge Forward Delay - 1 second) ≥ *Bridge Maximum Age*
Bridge Maximum Age ≥ *2 X (Bridge Hello Time + 1 second)*

Example: `set protocol bridge tb`

```
Bridge Max-Age [20]  25
Bridge Hello Time [2]   3
Bridge Forward Delay [15] 20
Bridge Priority [32768]    1
```

Bridge Maximum Age

Maximum age (period of time) that should be used to time out spanning tree protocol-related information.

When this bridging router is selected as the root bridge in a spanning tree, the value of this parameter specifies how long other active bridges are to store the configuration bridge protocol data units (BPDUs) they receive. When a BPDU reaches its maximum age limit without being replaced, the active bridges in the network discard it and assume that the root bridge has failed. A new root bridge is then selected.

Dependencies

The setting of this parameter may be affected by the setting of the Bridge Hello Time parameter. In addition, the setting of this parameter may affect the setting of the Bridge Forward Delay parameter.

Valid Values: 6 to 40 seconds

Default Value: 20 seconds

Bridge Hello Timer

Time interval between HELLO BPDUs.

When this bridging router is selected as the root bridge in a spanning tree, this parameter specifies how often this bridge transmits configuration bridge protocol data units (BPDUs). BPDUs contain information about the topology of the spanning tree and reflect changes to the topology.

Dependencies

The setting of this parameter may affect the setting of the Max age parameter.

Valid Values: 1 to 10 seconds

Default Value: 2 seconds

Bridge Forward Delay

Time interval used before changing to another state (should this bridge become the root).

When this bridging router is selected as the root bridge in a spanning tree, the value of this parameter specifies how long active ports in all bridges remain in a *listening state*. When

the forward delay time expires, ports in the listening state go into the *forwarding state*. State changes occur as a result of changes in the topology of the spanning tree, such as when an active bridge fails or is shut down.

The root bridge conveys this value to all bridges. This process ensures that all bridges are consistent between changes.

Dependencies

The setting of this parameter may be affected by the setting of the SRB Bridge Max Age parameter.

Valid Values: 4 to 30 seconds

Default Value: 15

Bridge Priority

A high-order 2-octet bridge address found in the Bridge Identifier - either the MAC address obtained from the lowest-numbered port or the address set by the **Set Bridge** command.

The bridge priority indicates the chances that this bridge will become the root bridge of the spanning tree. The lower the numerical value of the bridge priority parameter, the higher the priority of the bridge and the more likely it is to be chosen. The spanning tree algorithm chooses the bridge with the lowest numerical value of this parameter to be the root bridge.

Valid Values: 0 to 65535

Default Value: 32768

Enter **port** as the option to modify the spanning tree protocol port parameters. Enter the desired value at each prompt and press **Return**.

Example: `set protocol port`

```
Port Number [1] ?
Port Path-Cost (0 for default) [0] ?   1
Port Priority [128] ?   1
```

Port Number

Bridge port number; selects the port for which the path cost and port priority will be changed.

Path Cost

Cost associated with the port, which is used for possible root path cost.

Each port interface has an associated path cost, which is the relative value of using the port to reach the root bridge in a bridged network. The spanning tree algorithm uses the path cost to compute a path that minimizes the cost from the root bridge to all other bridges in the network topology.

This parameter specifies the cost associated with passing frames through this port interface, should

this bridging router become the root bridge. Factor this value in when determining spanning tree routes between any two stations. A value of 0 instructs the bridging router to automatically calculate a path cost for this port using its own formula.

Valid Values: 1 to 65535

Default Value: 0 (means the cost will be calculated automatically)

Port Priority

Identifies port priority for the specified port. This is used by the spanning tree algorithm in making comparisons for port selection (which port offers the lowest cost path to the root bridge) and blocking decisions.

Valid Values: 0 to 255

Default Value: 128

route-descriptor-limit *limit-type*

Allows the user to associate a maximum Route Descriptor (RD) length for all route explorer (ARE) or spanning tree explorer (STE) frames forwarded by the bridge if source routing is enabled.

Example: `set route-descriptor-limit ARE`

Limit-type

Entered either as ARE or STE, depending on whether the RD-limit-value is applied to all route explorer (ARE) or spanning tree explorer (STE) frames. You will then be prompted for an RD-limit-value.

RD-limit-value

Specifies the maximum number of RDs that might be contained in the routing information field (RIF) of the frame type specified by the RD limit type.

The hop count for each frame is the number of bridges through which the frame has traveled so far. One RD is added to the Routing Information Field each time the frame passes through a bridge. Therefore, the number of RDs equals the number of hops. When the number of RDs (hops) exceeds the number of hops allowed by this parameter, the frame is discarded.

Valid Values: 0 to 14

Default Value: 14

super-elan-id *super-elan-identifier*

The identifier designates the SuperELAN to which the bridge port is attached. Bridge ports with the same SuperELAN ID comprise a single SuperELAN. Super ELAN IDs have only local significance. Thus, two bridge ports in different physical

systems can belong to the same SuperELAN but have difference local SuperELAN identifiers. Data frames are not bridged between bridge ports with different SuperELAN identifiers.

Valid Values: 1 - 65535

Example: set super-elan-id *1*

Note: This option is not available if SuperELAN II is configured.

Tunnel

Use the **tunnel** command to access the Tunnel configuration prompt. Tunnel configuration commands are entered at this prompt. See “Tunnel Configuration Commands” for an explanation of each of these commands.

Syntax:

tunnel

VLANS

Use the **vlans** command to access the VLAN configuration prompt. VLAN configuration commands are entered at this prompt. See “Dynamic Protocol Filtering (VLANS) Configuration Commands” on page 5-43 for an explanation of each of these commands.

Syntax:

vlans

Tunnel Configuration Commands

This section describes the Tunnel configuration commands. The Tunnel configuration commands allow you to specify network parameters for a tunnel that transmits bridging frames over IP.

Configuration commands for the tunnel are entered at the `TNL config>` prompt. This prompt is accessed by entering the **tunnel** command at the `ASRT config>` prompt. Table 5-2 on page 5-39 shows the tunnel configuration commands.

Table 5-2. Tunnel Configuration Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds the IP address of destination bridges participating in an IP unicast or multicast addressing configuration for bridging over IP.
Delete	Deletes the IP address of a destination bridge participating in an IP unicast or multicast addressing configuration for bridging over IP.
Join	Configures the router as a member of one or more multicast groups.
Leave	Removes the router as a member of multicast groups.
List	Displays the IP addresses of end-stations participating in an IP unicast or multicast addressing configuration for bridging over IP. Also displays the size (in number of bytes) of bridging packets being routed through an IP tunnel and whether or not multicast addressing is enabled or disabled.
Set	Sets a base multicast IP address for multicast tunneling on the router.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Tunneling and Multicast Packets

The bridging tunnel can be defined as either a unicast tunnel or a multicast tunnel. To define a unicast tunnel, use the **add** command to configure the IP address of the tunnel’s endpoint. To define a multicast tunnel, use the **set** and **join** commands. For tunnel configurations where multicast packets are involved, the source address of the multicast packets must lie on a network segment that is capable of the Internet Group Management Protocol (IGMP).

IGMP is not defined on some interfaces such as ATM. This means that when you define a multicast tunnel on the router (for example, the MOSPF tunnel), you must ensure that one of the following conditions exists:

- The source is one of the LAN segment addresses
- The source is the internal IP address

The first condition can be ensured by using the IP **set router-id** configuration command. The second condition can be ensured by using the IP **set internal-ip-address** configuration command.

In all cases, the second option is preferred and the first should be used only if some of the routers in the network do not like host addresses (this would happen in mixed vendor networks).

Add

Use the **add** command to add the IP address of end stations participating in a unicast IP addressing configuration.

For IP unicast addressing, the tunneling configuration requires that you supply IP addresses of destination bridges. This record will be used by the router software to convert the segment number in the routing information field (RIF) in a source-routed frame to the corresponding IP address of the destination bridge. For transparent bridging frames, it identifies the other endpoint of the tunnel.

Syntax: add

add**dress** *IP-address*

Valid Values: a valid IP address

Default Value: none

Example: `add address 128.185.144.37`

Delete

Use the **delete** command to delete the IP address of bridges participating in a unicast or multicast IP addressing configuration.

Syntax:

del**ete** address *IP-address*

Valid Values: a valid IP address

Default Value: none

Example: `delete address 128.185.144.37`

Join

Use the **join** command to establish the router as a member of one or more multicast groups. A tunnel group may be one of three types: peer, client, or server. The tunnel group is defined by an integer tag. A bridge can belong to only one group type for each tag. A bridge cannot belong to both *peer group 1* and *server group 1*, for example.

Syntax:

join client-group *group-number*

peer-group *group-number*

server-group *group-number*

client-group *group-number*

Joins the client group with the given group number.

Valid Values: 0 to 64

Default Value: 0

Example: `join client-group 3`

peer-group *group-number*

Joins the peer group with the given group number.

Valid Values: 0 to 64

Default Value: 0

Example: `join peer-group 5`

server-group *group-number*

Joins the server group with the given group number.

Valid Values: 0 to 64

Default Value: 0

Example: `join server-group 7`

Leave

Use the **leave** command to remove the router as a member of multicast groups.

Syntax:

le**ave** server-group *group-number*

client-group *group-number*

peer-group *group-number*

server-group *group-number*
Leaves the server group with the given group number.

Valid Values: 0 to 64

Default Value: 0

Example: `leave server-group 7`

client-group *group-number*
Leaves the client group with the given group number.

Valid Values: 0 to 64

Default Value: 0

Example: `leave client-group 3`

peer-group *group-number*
Leaves the peer group with the given group number.

Valid Values: 0 to 64

Default Value: 0

Example: `leave peer-group 5`

List

Use the **list** tunnel command to display the IP addresses of bridges participating in an IP unicast or multicast addressing configuration for tunneling over IP. This command can also be used to display the current size of IP packets being sent through the tunnels and displays, whether or not IP is enabled or disabled.

Syntax:

l**ist** address

all

address Lists the IP addresses of bridges participating in an IP unicast or multicast addressing configuration for tunneling over IP.

Example: `list address`

```
IP Tunnel Addresses
128.185.179.51      128.185.170.51      128.185.142.39
128.185.143.39       224.0.0.5
```

all Lists all unicast IP addresses, configured multicast addresses, and the tunnel packet size.

Example: `list all`

```
IP Tunnel Addresses
128.185.179.51      128.185.170.51      128.185.142.39
128.185.143.39       224.0.0.5
Frame size for the tunnel 2120
```

Set

Use the **set** command to set the base multicast address of the router.

For IP multicast addressing, the tunneling configuration requires only the IP multicast address reserved for tunneling. Encapsulation uses three groups of IP multicast addresses. The first group is for sending all-routes explorer (ARE) frames, the second group for sending spanning tree explorer (STE) frames, and the third group for specifically routed frames (SRF).

Syntax:

set base-multicast-address

base-multicast-address

Sets the base multicast IP address for multicast tunneling.

Valid Values: any valid class D IP address with the last two bytes set to 0.

Default Value: 224.186.0.0

Example: `set base-multicast-address 224.10.0.0`

ATM Commands

To enable bridging over the ATM interface, you must associate a VCC with a bridge port.

Once a bridge port is configured, all the function associated with the bridge ports, including protocol filtering and address filtering are available.

You need to specify PVC or SVC support. For PVC support, you must specify the VPI and VCI of the PVC. For SVC support, you must provide the remote ATM address and the local selector byte.

At the `ASRT config>` prompt, use the following command to enable bridging on the ATM interface:

add port *interface# port# VPI VCI destaddr selector*

interface#
The interface number of the ATM interface.

port# The unique bridge-specific number associated with the VCC.

Port Number Valid Values: 1 to 254

Port Number Default Value: none

Once the port has been added on the ATM interface, the port number will identify the port to the ATM ARP client and to the VCC associated with this port.

Refer to Chapter 23, “Using ARP” on page 23-1for ATM ARP client configuration information.

Use PVC?

If no, an SVC will be added.

Valid Values: Yes or No

Default Value: No

VPI The VPI of the PVC on which bridging is enabled.

VPI Valid Values: 0 to 255

VPI Default Value: 0

VCI The VCI of the PVC on which bridging is enabled.

VCI Valid Values: 0 to 65535

VCI Default Value: 0

Destaddr The destination ATM address of the SVC.

Destination ATM address Valid Values: any valid 20-byte ATM address

Destination ATM address Default Value: none

Selector The selector of the destination ATM address of the SVC.

Selector Valid Values: X'00' – X'FF'

Selector Default Value: X'00'

Example: add a port on an ATM interface (PVC)

```
ASRT config> add port
Interface number [0]?
Port number [1]?
Use PVC? [Yes]:
VPI, Range 0..255 [0]? 0
VCI, Range 0..65535 [0]? 795
```

Example: add a port on an ATM interface (SVC)

```
ASRT config> add port
Interface number [0]?
Port number [2]?
Use PVC? [Yes]:No
Destination ATM Address []? 391122334455667788990011223345566778899
Selector, Range 00..FF [00]? 0A
ASRT config>
```

List

Use the **list** command to display information about ATM ports configured for bridging.

Dynamic Protocol Filtering (VLANS) Configuration Commands

This section explains all of the VLAN configuration commands. These commands let you configure port-based, sliding window, and MAC address VLANs, as well as VLAN filtering for IP, IP multicast, IPX, and NetBIOS on the ASRT bridge or on a particular SuperELAN II.

See “Dynamic Protocol Filtering VLANs” on page 3-11 for additional information about VLANs.

Configuration commands for the ASRT bridge are entered at the `ASRT VLAN config>` prompt. This prompt is accessed by entering the **vlans** command at the `ASRT config>` prompt.

Note: These same commands can also be used to configure VLANs on a SuperELAN II. Refer to the chapter entitled “Using and Configuring ATM” in the *Software User's Guide* for information about SuperELAN II.

The following table shows the VLAN filtering configuration commands.

Table 5-3. VLAN Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds the definition of a new VLAN filter
Change	Changes VLAN filtering parameters for an indicated VLAN
Delete	Deletes the selected VLAN filters
Disable	Disables VLAN filtering on the selected VLANs
Enable	Enables VLAN filtering on the selected VLANs
List	Displays all information associated with the selected VLAN filters
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **Add** command to define a new VLAN filter. See “Required Static Configurations” on page 3-13 for additional information.

Syntax:

add address to MAC vlan
ip
ip-multicast
ipx
mac-address vlan
netbios
port-based
sliding-window

Example 1: add ip

```
IP Address [0.0.0.0]? 9.2.3.4
Subnet Mask [255.0.0.0]?
Configure this VLAN on Specific Ports? [No]:
Age (expiration in minutes,0=infinity) [10000]? 0
Enable IP-Cut-Through from this VLAN? [Yes]:
Enable IP-Cut-Through to this VLAN? [Yes]:
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) []? IP 9.x.x.x
VLAN 'IP 9.x.x.x' (IP subnet 9.0.0.0) successfully added
```

If some ports should not be configured as Auto-Detect and Include, then the port can be manually configured.

Example 2: add ip-multicast

```
IP Multicast Address [0.0.0.0]? 230.1.1.1
Configure Specific Ports? [No]:
Age (expiration in minutes,0=infinity) [10]? 0
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) []? IPmcast01
VLAN 'IPmcast01' (IP Multicast 230.1.1.1) successfully added
```

Example 3: add ipx

```
Network Number (in 8-digit hex) (1 - FFFFFFFE) [1]? 2FF
Configure this VLAN on Specific Ports? [No] y
Configure VLAN on port 1 (Include, Exclude, or Auto-Detect) [A]?
Configure VLAN on port 2 (Include, Exclude, or Auto-Detect) [A]? e
Age (expiration in minutes,0=infinity) [5000]?
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) []? IPX 2FF
VLAN 'IPX 2FF' (IPX network 0x2FF) successfully added
```

A description of each parameter follows:

MAC Address

The MAC address of a device to be added as a member of an existing MAC Address VLAN.

IP Address

This prompt allows you to enter the IP address of the IP subnet whose traffic will be dynamically filtered to create this VLAN. This value, after the subnet mask is applied, is what will be saved and referenced in other VLAN commands.

Subnet Mask

This is the subnet mask that will be applied to the input IP Address to create the IP subnet value used to detect traffic for this VLAN.

IP Multicast address

This is the IP group address whose multicast traffic will be filtered to create this VLAN.

Note: A VLAN for 224.0.0.1 (the all IP hosts address) is created during initialization and is used to configure IP multicast VLANs that are auto-created when an IGMP report frame is detected and the 224.0.0.1 VLAN is enabled. See “Auto-created IP Multicast VLANs” on page 3-14 for additional information about auto-created IP multicast VLANs.

Valid Values: 224.0.1.0 - 239.255.255.255

Default Value: none

Network Number

This prompt allows you to enter the IPX network ID number whose traffic will be dynamically filtered to create this VLAN.

Sliding Window Filter Base

Determines whether the base for the offset is the first byte of the destination MAC address or the first byte of the frame's information field.

Valid Values: mac or info

Default Value: mac

Sliding Window Filter Offset

Sets the byte offset into the frame where the comparison with the mask and value begins.

Valid Values: 0 - 255

Default Value: 0

Sliding Window Filter Value

The value used for comparing the sliding window filter.

A frame "matches" a sliding window filter if the octet pattern (whose start is determined by the *Sliding Window Filter Base* and *Sliding Window Filter Offset*) ANDED with the *Sliding Window Filter Mask* equals this *Sliding Window Filter Value* ANDED with the *Sliding Window Filter Mask*.

Valid Values: Any octet string of length 1 - 10

Default Value: None

Sliding Window Filter Mask

The mask used for comparing the sliding window filter.

Valid Values: Any octet string of length 1 - 10

Default Value: None

Configure

Answering "No" to this prompt causes all bridge ports to be set to the default value of Auto-Detect and Include. Answering "Yes" to this prompt causes further prompting to select the desired port inclusion mode for each bridge port.

The modes are:

- Auto-Detect and Include (the default mode that requires that traffic from this vlan be received on the port before being included in the VLAN forwarding domain).

  Note: Auto-Detect and Include is not valid on port-based VLANs because no data comparison is performed.

- Include Always (to always include this port in the forwarding domain regardless of received traffic)
- Exclude Always (to always exclude this port from the forwarding domain regardless of received traffic).

Age The amount of time, in minutes, that an Auto-Detect port will remain in the forwarding state in the absence of traffic received from that port for this VLAN. Entering a value of zero means that ports auto-detected will never expire and be removed from the forwarding domain.

If MAC address tracking is enabled for a VLAN, the aging time also determines when a MAC address is no longer considered a member of the VLAN in the absence of traffic received from that MAC address.

Valid Values: 0 to 4 294 967 295

Default Value

IP subnet 10 000 minutes

IP multicast 10 minutes

IPX Network 10 minutes

NetBIOS 5 000 minutes

MAC Address 5000 minutes

Sliding Window 5000 minutes

Port-based 1440 minutes

Enable IP-Cut-Through Transmission Status
Answering *yes* will allow forwarding of IP traffic from devices on this VLAN to devices on other VLANs that have IP-Cut-Through reception enabled. See “IP-Cut_Through Considerations” on page 3-13 for additional information.

Enable IP-Cut-Through Reception Status
Answering *yes* will allow IP traffic to be forwarded to devices on this VLAN from devices on other VLANs that have IP-Cut-Through transmission enabled. See “IP-Cut_Through Considerations” on page 3-13 for additional information.

Track Active MAC Addresses
Answering *yes* causes source MAC addresses from transmissions on this VLAN to be saved. These learned addresses can be displayed with the **show-members** command. Learned addresses will be aged out with the aging timer for this VLAN.

VLAN Filter Status
Answering *yes* will enable dynamic filtering for this VLAN. Answering “No” means that no filtering will be done on traffic from members of this VLAN.

VLAN Name
This prompt lets you define a name for this VLAN that can be used with all VLAN commands. A VLAN name is required for MAC address, port-based, and sliding window VLANs.

This name must be unique among all VLANs of all types within the ASRT bridge and each SuperELAN II instance. This name consists of up to 32 characters and can include spaces.

Change

Use the change command to change the configuration parameters associated with a particular VLAN. The VLAN to change can be chosen by explicitly specifying the subnet or by selecting the VLAN from a list with the *by-name* option. This command invokes the same prompts used with the add command. The current parameter values will be displayed as the default and can be maintained by simply pressing **Return**.

Syntax:

change by-name
ip subnet address
ip-multicast
ipx network number
mac-address
netbios
port-based
sliding-window

Example: change ip

```
IP Address [9.0.0.0]?
Configure Specific Ports? [No]:
Age (expiration in minutes,0=infinity) [0]? 300
Enable IP-Cut-Through from this VLAN? [Yes]:
Enable IP-Cut-Through to this VLAN? [Yes]:
Track Active MAC Addresses on this VLAN? [No]:
Enable This Filter? [Yes]:
VLAN Name (32 chars max) [IP 9.x.x.x]?
VLAN 'IP 9.x.x.x' (IP subnet 9.0.0.0) successfully changed
```

Delete

Use the **delete** command to delete a particular VLAN filter, all VLAN filters of a particular type, or all defined VLAN filters. If you are deleting a single filter, you can choose the VLAN to be deleted by selecting the VLAN from a list using the *by-name* option.

Syntax:

delete address from MAC vlan
by-name
ip all
ip subnet *subnet address*
ip-multicast all
ip-multicast by-name
ipx all
ipx network *network-number*
mac-address all
mac-address by-name

netbios
port-based all
port-based by-name
sliding-window all
sliding-window by-name
all

Example 1: del ip subnet 9.0.0.0

```
VLAN 'IP 9.x.x.x' (IP subnet 9.0.0.0) deleted
```

Example 2: del ipx all

```
Are you sure you want to delete ALL IPX VLANS? [No]: y
All IPX VLANS deleted
```

Disable

Use the **disable** command to disable a particular VLAN filter, all VLAN filters of a particular type, or all defined VLAN filters. If disabling a single filter, the VLAN to be disabled can be chosen by selecting the VLAN from a list using the *by-name* option.

Syntax:

disable
by-name
ip all
ip subnet *subnet-address*
ip-multicast all
ip-multicast by-name
ipx all
ipx network *network-number*
mac-address all
mac-address by-name
netbios
port-based all
port-based by-name
sliding-window all
sliding-window by-name
all

Example: disable ip subnet 220.5.3.0

```
VLAN 'Building #4' (IP subnet 220.5.3.0) now disabled
```

Enable

Use the **enable** command to enable a particular VLAN filter, all VLAN filters of a particular type, or all defined VLAN filters. If you are enabling a single filter, you can choose the VLAN to be enabled by selecting the VLAN from a list using the *by-name* option.

Syntax:

enable by-name
ip all
ip subnet *subnet-address*
| ip-multicast all
| ip-multicast by-name
ipx all
ipx network *network-number*
mac-address all
mac-address by-name
netbios
| port-based all
| port-based by-name
sliding-window all
sliding-window by-name
all

Example: enable by-name

```
 Choice of VLAN:
       VLAN type    Identifier         VLAN Name
       =========    ==========         =========
    (1) IP           9.0.0.0            IP 9.x.x.x
    (2) IP           220.5.3.0          Building #4
    (3) IPX          0x2FF              Token Ring A
    (4) IPX          0x3FF              Token Ring B
Enter Selection [1]? 3
VLAN 'Token Ring A' (IPX Network 0x2FF) now enabled
```

List

Use the **list** command to list the configuration information about a particular VLAN filter, all VLAN filters of a particular type, or all defined VLAN filters. If you are listing a single filter, you can choose the VLAN to be listed can be chosen by selecting the VLAN from a list using the *by-name* option.

Syntax:

list by-name
ip all
ip subnet *subnet-address*
| ip-multicast all

| ip-multicast by-name
ipx all
ipx network *network-number*
mac-address all
mac-address by-name
netbios
| port-based all
| port-based by-name
sliding-window all
sliding-window by-name
all

Example 1: list ip subnet 9.0.0.0

```
Subnet Address              = 9.0.0.0
Subnet Mask                 = 255.0.0.0
Bridge Port 1 (Interface 0) = Auto-Detect and Include
Bridge Port 2 (Interface 1) = Always Exclude
Age (expiration in minutes) = 300
IP-Cut-Through Status:
   Transmit From This VLAN  = Enabled
   Reception By This VLAN   = Enabled
Tracking of MAC Addresses   = Disabled
VLAN Filter State           = Enabled
VLAN Name                   = IP 9.x.x.x
```

Example 2: list ipx all

```
----------- IPX VLANS -------------------------------
IPX Network Number          = 0x2FF
Bridge Port 1 (Interface 0) = Auto-Detect and Include
Bridge Port 2 (Interface 1) = Always Exclude
Age (expiration in minutes) = Never Expires
IP-Cut-Through Status:
   Transmit From This VLAN  = Enabled
   Reception By This VLAN   = Disabled
Tracking of MAC Addresses   = Disabled
VLAN Filter State           = Enabled
VLAN Name                   = Token Ring A
+++++++++++++++++++++++++++++++++++++++++++++++++++++++
IPX Network Number          = 0x3FF
Bridge Port 1 (Interface 0) = Auto-Detect and Include
Bridge Port 2 (Interface 1) = Auto-Detect and Include
Age (expiration in minutes) = 5000
IP-Cut-Through Status:
   Transmit From This VLAN  = Enabled
   Reception By This VLAN   = Enabled
Tracking of MAC Addresses   = Disabled
VLAN Filter State           = Disabled
VLAN Name                   = Token Ring B
```

Bridging Broadcast Manager Configuration Commands

Bridging Broadcast Manager (BBCM) can transform many broadcast frames into unicast frames, thus lessening their effects on network performance. BBCM snoops on packets to learn bindings between layer 3 and layer 2 network addresses. Future broadcast packets to any learned layer 3 address can be transformed into unicast packets and forwarded by the bridge as any other unicast packet. If the transformed unicast address is in the bridge database, then the packet can be

forwarded to its destination segment. The packet will not cause an interruption at every station, nor will it utilize bandwidth on every network segment. See “Bridging Broadcast Manager” on page 3-11 for additional information.

BBCM operates over:

- Ethernet
- Token Ring
- RFC 1483 bridge ports
- SuperELAN bridge ports

This section explains all of the BBCM configuration commands. These commands let you configure BBCM for IP. See Chapter 9, “Configuring and Monitoring NetBIOS” on page 9-1 for configuring NetBIOS Filtering and Name Caching.

Configuration commands are entered at the `IP B-BCM config>` prompt. This prompt is accessed by entering the **broadcast-manager** command at the `ASRT config>` prompt. Table 5-4 shows the BBCM configuration commands.

Table 5-4. BBCM Configuration Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Enable	Enables bridging broadcast-manager.
Disable	Disable bridging broadcast-manager.
List	Displays general information concerning BBCM configuration.
Set *cache age timeout*	Sets the bridging broadcast-manager cache age timeout. Cache entries that are not refreshed in this amount of time are aged out.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Enable

Use the **enable** command to enable BBCM.

Syntax:

enable

Example: `enable`

```
IP B-BCM config>enable
IP Bridge Broadcast Manager is   ENABLED
```

Disable

Use the **disable** command to disable BBCM.

Syntax:

disable

Example: `disable`

```
IP B-BCM config>disable
IP Bridge Broadcast Manager is   DISABLED
```

List

Use the **list** command to list general information about BBCM.

Syntax:

list

Example: `list`

```
IP B-BCM config>list
IP Bridge Broadcast Manager is   ENABLED
IP B-BCM cache age timeout is    9 minutes
```

Set

Use the **Set** command to set the cache age timeout for the BBCM cache.

Syntax:

set

Example: `set`

```
IP B-BCM config>set
IP B-BCM cache age timeout in minutes (system default=5) [9]? 10
IP B-BCM cache age timeout set to 10 minutes
```

Accessing the ASRT Monitoring Environment

To access the ASRT monitoring environment, enter the **protocol asrt** command at the + (GWCON) prompt:

```
+protocol asrt
ASRT>
```

ASRT Monitoring Commands

This section describes the ASRT monitoring commands. These commands allow you to view and modify parameters from the active monitoring. Information you modify with the monitoring commands is reset to the SRAM configuration when you restart the bridging router.

You can use these commands to temporarily modify the configuration without losing configuration information in the bridge memory. The `ASRT>` prompt is displayed for all ASRT monitoring commands.

Monitoring commands for NetBIOS are entered at the `NetBIOS>` monitoring prompt. The NetBIOS prompt is a subset of the major ASRT commands and is accessed by entering the ASRT **netbios** command explained later in this chapter.

Monitoring commands for NetBIOS are entered at the `NetBIOS>` monitoring prompt. The NetBIOS-filtering prompt is a subset of the major ASRT commands.

Monitoring and dynamic reconfiguration VLANS commands are entered at the `VLAN>` monitoring prompt. The `VLAN>` command is accessed by entering the **VLANS** command explained later in this chapter.

Note: For commands requiring you to enter MAC Addresses, the addresses can be entered in the following formats:

IEEE 802 canonical bit order 00-00-00-12-34-56
IEEE 802 canonical bit order (shorthand format) 000000123456
IBM Token-Ring native bit order (noncanonical) 00:00:00:12:34:56

Table 5-5 shows the ASRT monitoring commands.

Table 5-5. ASRT Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds permanent (static) address entries to the bridging router's permanent database.
Broadcast	Allows you to access the Bridging Broadcast Manager monitoring prompt for entering specific BBCM monitoring commands.
Cache	Displays cache entries for a specified port.
Delete	Deletes MAC addresses entries from the bridging router database.
Disable	Disables bridging features.
Enable	Enables bridging features.
Flip	Flips MAC address from canonical to 802.5 (noncanonical or IBM) bit order.
List	Displays information about the complete bridge configuration or about selected configuration options.
NetBIOS	Displays the NetBIOS monitoring prompt.
VLANS	Displays the VLAN monitoring prompt.
Set	Dynamically changes bridge parameters.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add static address entries and destination address filters to the bridging router’s database. These additions to the database are lost when you restart the router.

Syntax:

add destination-address-filter

static-entry

destination-address-filter *mac_address*

Adds a destination address filter to the bridging router’s permanent database. Enter the command followed by the MAC address of the entry.

Example: **`add destination-address-filter`**

```
Destination MAC address [00-00-00-00-00-00]?
```

static-entry *mac_address input_port [output_ports]*

Adds static address entries to the bridging router's permanent database. Enter the command followed by the MAC address of the static entry and the input port number (an optional output port number may also be entered). To create a static entry with multiple port maps (1 per input port), use this command several times.

Example: add static-entry

```
MAC address [00-00-00-00-00-00]?  400000012345
Input port, 0 for all [0]? 2
Output port, 0 for none [0]? 3
Output port, 0 to end [0]?
```

Broadcast

Use the **broadcast** manager command to display the BBCM configuration and to allow you access to the monitoring functions of BBCM.

Syntax:

broadcast

Example 1:

```
*t 5

CGW Operator Console

+p asrt
ASRT>broadcast
Enter Bridge Broadcast Manager Protocol:  IP or NetBIOS  [IP]? ip

IP Bridge Broadcast Manager User Console
IP B-BCM>
```

Example 2:

```
ASRT>broadcast
Enter Bridge Broadcast Manager Protocol:  IP or NetBIOS  [IP]? netbios

NetBIOS Support User Console

NetBIOS>
NetBIOS>exit
ASRT>exit
+
```

Table 5-6 shows the Broadcast monitoring commands.

Table 5-6 (Page 1 of 2). Broadcast Monitoring Commands Summary

Command	Function	
?		Displays information about BBCM configuration options
Clear	**cache**	Clears the BBCM cache
	statistics	Clears the BBCM statistics
Disable		Disables BBCM
Enable		Enables BBCM
List	**cache**	Lists the contents of BBCM's cache
	general	Lists general information about BBCM
	statistics	Lists BBCM statistics

Table 5-6 (Page 2 of 2). Broadcast Monitoring Commands Summary

Command	Function
Set	Sets the cache aging timeout value for BBCM
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Clear

Use the **clear** command to clear the BBCM cache or clear BBCM statistics.

Syntax:

clear cache
statistics

Example:

```
IP B-BCM>clear ?
CACHE entries
STATISTICS
IP B-BCM>clear cache
Clearing IP B-BCM cache.
IP B-BCM>clear statistics
```

Disable

Use the **disable** command to disable BBCM.

Syntax:

disable

Example:

```
IP B-BCM>disable
IP Bridge Broadcast Manager is   INACTIVE
```

Enable

Use the **enable** command to enable BBCM.

Syntax:

enable

Example:

```
IP B-BCM>enable
IP Bridge Broadcast Manager is   ACTIVE
```

List

Use the **list** command to list general information about BBCM.

Syntax:

list cache
general
statistics

Example:

```
IP B-BCM>list cache
No entries found
IP B-BCM>list general
IP Bridge Broadcast Manager is   ENABLED
IP B-BCM cache age timeout is    9 minutes

Current Status:
IP Bridge Broadcast Manager is   ACTIVE
# of IP Addresses in cache is    0

IP B-BCM>list ?
CACHE entries
GENERAL information
STATISTICS
```

Set

Use the **set** command to set the cache age timeout for the BBCM cache.

Syntax:

set

Example:

```
IP B-BCM>set
IP B-BCM cache age timeout in minutes (system default=5) [9]? 10
IP B-BCM cache age timeout set to 10 minutes
```

Cache

Use the **cache** command to display the contents of a selected bridging-port routing cache. If the port does not possess a cache you will see the message `Port X does not have a cache`.

Syntax:

cache *port#*

Example: **`cache`**

```
Port number [1]? 3

MAC Address    MC*   Entry Type       Age  Port(s)

00-00-93-00-C0-D0   PERMANENT          0  3 (TKR/1)
00-00-00-11-22-33   STATIC             0  3 (TKR/1)
```

MAC Address

6-byte MAC address of the entry.

Entry Type

Specifies one of the following address entry types:

Reserved - entries reserved by the IEEE802.1D Standard.

Registered - entries consist of unicast addresses belonging to proprietary communications hardware attached to the box or multicast addresses enabled by protocol forwarders.

Permanent - entries entered by the user in the configuration process which survive power on/offs or system resets.

Static - entries entered by the user in the monitoring process which do not survive power on/offs or system resets and are not effected by the aging timer.

Dynamic - entries “learned” by the bridge “dynamically” which do not survive power on/offs or system resets and which have an “age” associated with the entry.

Free - locations in database that are free to be filled by address entries.

Unknown - entry types unknown to the bridge. May be possible bugs and/or illegal addresses.

Age Age in seconds of each dynamic entry. Age is decremented at each resolution intervals.

Port(s) Specifies the port number associated with that entry and displays the interface name (this will always be that of the interface having the cache).

Delete

Use the **delete** command to delete station (including MAC) address entries from the router’s permanent database.

Syntax:

del**ete** *MAC-address*

Example: **`delete 00-00-93-10-04-15`**

Disable

Use the **disable** command to disable bridging features.

Syntax:

di**sable** *super-elan-bridging*

Example:

```
ASRT config> disable super
port number [1]? 2
SuperELAN ID [0]? 3
```

Note: This option is not available if SuperELAN II is configured.

Enable

Use the **enable** command to enable bridging features.

Syntax:

e**nable** *super-elan-bridging*

Example:

```
ASRT config> enable super
port number [1]? 2
SuperELAN ID [0]? 3
```

Note: This option is not available if SuperELAN II is configured.

Flip

Use the **flip** command to view specific MAC addresses in the canonical and noncanonical format by “flipping” the address bit order. This command is useful for translating IEEE 802.5 addresses in their typical noncanonical format to the canonical format universally used by the bridge monitoring and ELS (and vice versa).

Syntax:

flip *MAC-address*

Example: **`flip`**

```
MAC address [00-00-00-00-00-00]? 00-00-00-33-44-55
IEEE 802 canonical bit order:    00-00-00-33-44-55
IBM Token-Ring native bit order: 00:00:00:CC:22:AA
```

List

Use the **list** command to display information about the bridging router configuration or to display information about selected configuration or bridging options.

Syntax:

list
- adaptive-bridge . . .
- adaptive-database-duplicate
- bridge . . .
- conversion . . .
- database . . .
- dmac
- filtering . . .
- port
- source-routing . . .
- spanning-tree-protocol . . .
- super-elan-bridge cache
- transparent . . .
- tunnel . . .

adaptive-bridge *datagroup-option [sub-option]*

Lists all general information regarding the SR-TB bridge which converts between types of bridging. There are a number of general datagroup options which may be displayed under **list adaptive-bridge**. These include the following:

- Config - Displays general information regarding the SR-TB bridge.
- Counters - Displays all SR-TB bridge counters.
- Database - Displays contents of the SR-TB bridge RIF database.

The following examples illustrate each of the **adaptive-bridge** display options.

Example: **`list adaptive-bridge config`**

```
Adaptive bridge:           Enabled
Translation database size: 0
Aging time:                320 seconds
Aging granularity          5 seconds

Port  Segment  Interface   State     MTU
   1  001      TKR/1       Enabled   2052
   -  001      Adaptive    Enabled   1470
```

Conversion bridge
Shows the current state of the SR-TB conversion bridge. This value is displayed as either Enabled or Disabled.

Translation database size
Displays the current size of the SR-TB database, which contains MAC addresses and associated RIFs for the source-routing domain.

Aging time
Displays the aging timer setting in seconds. All SR-TB RIF database entries which exceed this time limit are discarded.

Aging granularity
Displays how often entries are scanned to look for expiration according to the aging timer.

Port Displays the number of a port associated with conversion bridging.

Segment Displays the source routing segment number assigned to the port associated with conversion bridging.

Interface Identifies the device connected to a conversion bridge network segment and the VPI/VCI if an ATM port.

State Indicates the current state of the conversion bridge port.

MTU Specifies the maximum frame size (from the end of the RIF to the beginning of the FCS) that the conversion bridge can transmit and receive.

Example: `list adaptive-bridge counters`

```
Hash collision count: 28
Adaptive database entry count: 0
Adaptive database overflow  count: 0
```

Hash Collision Count
Displays number of addresses that were stored (hashed) to the same location in the hash table. This number is accumulative and reflects the total number of hash collision incidents that occurred. Increases in this number may indicate a potential table size problem.

Adaptive Database Entry
Displays the number of entries currently stored in the adaptive bridge database.

Adaptive Database Overflow
Displays the number of times that an address was overwritten as the conversion database table ran out of table space.

The *database* option of the **list adaptive-bridge** command lets you select certain portions of the adaptive bridge RIF database to display. This is due to the potential size of the database. The display options include the following:

- Address - Displays the conversion bridge database related to that specific MAC address
- All - Displays the entire database.

- Port - Displays all conversion bridge entries a specific port.
- Segment - Displays all conversion bridge entries associated with the port having the specified segment number.

The following examples illustrate each of the **list adaptive-bridge database** command options.

Note: These are only displayed if adaptive bridging is enabled.

Example: `list adaptive-bridge database address` ***mac-address***

Example: `list adaptive-bridge database all`

Example: `list adaptive-bridge database port` ***segment#***

Example: `list adaptive-bridge database segment` ***segment#***

Each entry is displayed on two lines followed by a blank line. The following information is displayed for each entry:

Canonical address
Lists the MAC address of the node corresponding to this entry. This is displayed in IEEE 802 canonical (hexadecimal) format.

Interface Displays the name of the network interface that learned this entry.

Port Displays the port number of the port that learned this address entry.

Seg Displays the number of the segment that learned this address.

Age Displays the entry age in seconds.

RIF Type Displays the RIF type as SRF, STE, or ARE.

RIF Direction
Displays the RIF direction as Forward or Reverse.

RIF Length
Displays the RIF length in bytes.

RIF LF Displays the largest frame value encoded in the RIF.

IBM MAC Address
Shows the MAC address of the node corresponding to this entry. This is displayed in the “IBM” noncanonical bit order as typically labeled on 802.5 interfaces and used by the IP/ARP, IPX, and NetBIOS protocols.

RIF Displays the Routing Information Field learned from this node.

adaptive-database-duplicate
Lists database entry of all duplicate MAC addresses. It displays primary and secondary RIFs for each duplicate MAC address.

Example: `list adaptive-database-duplicate`

```
Canonical Address  Interface  Port  Seg    Age  RIF: Type Direct   Length  LF IBM MAC Address    RIF

08-00-5a-ee-ee-ee  TKR/0         3  001    180       SRF  Forward  14  1470 90:00:5a:77:77:77  0e10fef0dcab001b960395029001  PRI. RIF(3)

                   TKR/2         5  003    185       SRF  Reverse  14  1470                    0c9070087109003bdcabfef00000  SEC. RIF(3)
```

bridge Lists all general information regarding the bridge router configuration.

Example: `list bridge`

```
Bridge ID (prio/add):  32768/10-00-5A-63-01-00
Bridge state:          Enabled
UB-Encapsulation:      Disabled
Bridge type:           STB
Bridge capability:     ASRT
Number of ports:       2
STP Participation:     IEEE802.1d

                                                        Maximum
Port  Interface      State  MAC Address         Modes   MSDU   Segment

   1  Eth/1            Up   10-00-5A-63-01-00       T    1514
   2  FR/0:16        Down   00-00-00-00-00-00               0
   2  AT/0:0:48      Down   00-00-00-00-00-00 SR    0     121   RD


SR bridge number:      7
SR virtual segment:    001
Adaptive segment:      000
```

Bridge ID
Unique ID used by the spanning tree algorithm in determining the spanning tree. Each bridge in the network is assigned a unique bridge identifier. The bridge priority is displayed in decimal followed by the hex address.

Bridge State
Indicates whether bridging is enabled or disabled.

Bridge Type
Displays the configured bridge type. This is displayed as NONE, SRB, TB, SRT, ADAPT, A/SRB, A/TB, or ASRT.

Number of Ports
Displays the number of ports configured for that bridge.

Port Specifies a user defined number assigned to an interface by the Add Port command.

Interface Identifies devices connected to a network segment through the bridge.

State Indicates the current state of the port. This is displayed as UP or DOWN.

MAC address
Displays the MAC address associated with that port in canonical bit order.

Modes Displays the bridging mode for that port. T indicates transparent bridging. SR indicates source routing. A indicates adaptive bridging.

MSDU Specifies the maximum frame (data unit) size (including the MAC header but not the FCS field) the bridge can transmit and receive on this interface.

Segment Displays the source routing bridge segment number assigned to that port (if any).

SR bridge number
Displays the user assigned source routing bridge number.

SR virtual segment
Displays the source routing bridge virtual segment number (if any).

Adaptive segment
Displays the number of the segment which is used in the source routing domain to route to the transparent domain (via conversion).

conversion *datagroup-option*

- Displays general information about the bridge's rules for converting frame formats based on the frame type. There are a number of general datagroups which may be displayed under the **list conversion** command. These include the following:
  - All - Displays all rules.
  - Ethertype - Displays rules for all Ethernet types or for a specific Ethernet type.
  - SAP - Displays rules for all SAP protocol identifiers or a specific 802.2 SAP type.
  - SNAP - Displays rules for all SNAP protocol identifiers or a specific 802.2 SNAP type.

  The following examples break down each of the list conversion display options.

  Example: `list conversion all`

  Example: `list conversion ethertype`

  ```
  Ethernet type (in hexadecimal), 0 for all [0]?
  ```

  Example: `list conversion SAP`

  ```
  SAP (in hexadecimal), 100 for all [100]?
  ```

  Example: `list conversion SNAP`

  ```
  SNAP Protocol ID, return for all [00-00-00-00-00]?
  ```

database *datagroup-option*
Lists the contents of transparent filtering databases. There are a number of datagroups which can be chosen to be displayed under the list database command. These include the following:

- All - Displays the entire transparent bridging database.
- Dynamic - Displays all dynamic (learned) address database entries.
- Local - Displays all local (reserved) address database entries.
- Permanent - Displays all permanent address database entries.
- Port - Displays address entries for a specific port.
- Range - Displays a range of database entries from the total transparent bridging filtering address database. A starting and

ending MAC address is given to define the range. All entries falling within this range will be displayed.

- Static - Displays static entries from the address database.

The following examples break down the list database command options. The first example also shows the related output.

Example: `list database all`

```
MAC Address    MC*  Entry Type       Age  Port(s)
00-00-00-00-AA-AA   Dynamic          295  4 (Eth/2)
00-00-00-12-34-56   Perm/Source filter    2 (TKR/1)  ->  3-4
                                          1-2
00-00-00-22-33-44   Permanent             1-2
                                          1-2
00-00-00-33-44-55   Perm Dest filter      All
00-00-00-55-66-77   Perm/Source filter    1-2,4

00-00-93-10-04-15   Registered            1 (Eth/1)
00-00-93-10-E4-F9   Dynamic          300  1 (Eth/1)
00-00-93-90-04-A6   Dynamic          300  1 (Eth/1)
00-00-A7-10-68-28   Dynamic          270  1 (Eth/1)
01-80-C2-00-00-00*  Registered            1,3
01-80-C2-00-00-01*  Reserved              All
01-80-C2-00-00-02*  Reserved              All
01-80-C2-00-00-03*  Reserved              All
01-80-C2-00-00-0D*  Reserved              All
01-80-C2-00-00-0E*  Reserved              All
01-80-C2-00-00-0F*  Reserved              All
03-00-00-00-80-00*  Reserved              All
08-00-17-00-35-F9   Dynamic          300  1 (Eth/1)
08-00-17-00-4D-DA   Dynamic          300  1 (Eth/1)
```

Note: The following fields are displayed for all of the **list database** command options.

MAC Address Specifies the address entry in 12-digit hex format (canonical bit order).

MC* An asterisk following an address entry indicates that the entry has been flagged as a multicast address.

Entry Type Specifies one of the following types:

Reserved
Entries reserved by the IEEE802.1D standard.

Registered
Entries consist of unicast addresses belonging to interfaces participating in the bridge or multicast addresses enabled by protocol forwarders

Permanent
Entries entered by the user in the configuration process which survive power on/offs or system resets

Static Entries entered by the user in the monitoring process which do not survive power on/offs or system resets and are ageless.

Dynamic Entries “learned” by the bridge “dynamically” which do not survive power on/offs or system resets and which have an “age” associated with the entry

Free This type is not used and should not be normally be seen except in occasional “race” conditions between the monitoring and the bridge.

Unknown Unknown entry type. May indicate a software bug. Report the hex entry type to Customer Service.

Age Refers to the age (in seconds) of each dynamic entry. Age is decremented at each resolution interval.

Port(s) Specifies the outgoing port number(s) for that entry. Device type is also listed for single port entries. If dynamic entry on IP tunnel, the port will be “5” for IP tunnel.

Example: `list database dynamic`

Example: `list database local`

```
MAC Address    MC*  Entry Type       Age  Port(s)

00-00-93-B8-00-48   Registered            1 (TKR/1)
01-80-C2-00-00-00*  Registered            1
03-00-02-00-00-00*  Registered            1
ASRT>
```

Example: `list database permanent`

Example: `list database port` *`port#`*

Example: `list database static`

Example: `list database range`

```
First MAC address [00-00-00-00-00-00]? 00-00-93-00-C0-D0
Last MAC address [FF-FF-FF-FF-FF-FF]? 01-80-C2-00-00-00

MAC Address    MC*  Entry Type       Age  Port(s)
00-00-93-10-04-15   Registered            1 (Eth/2)
01-80-C2-00-00-00   Registered            1,3
```

dmac Displays information about configured options for the duplicate MAC address feature.

Example: `list dmac`

```
ASRT>list dmac
Duplicate MAC address feature is    ENABLED
Load balance feature is    ENABLED
Age value for Duplicate MAC address :00000096
Duplicate MAC ADDRESSES CONFIGURED
==================================
10-00-5A-66-66-00
10-00-5A-66-66-01
10-00-5A-66-66-02
10-00-5A-66-66-03
10-00-5A-66-66-04
10-00-5A-66-66-05
```

filtering *datagroup-option*

displays general information about the bridge’s protocol filtering databases. There are a number of general datagroups which may be displayed under the **list filtering** command. These include the following:

- All - Displays all filtering database entries.
- Ethertype - Displays Ethernet protocol type filter database entries.
- SAP - Displays SAP protocol filter database entries.
- SNAP - Displays SNAP protocol identifier filter database entries.

The following examples break down each of the list filtering display options.

Example: `list filtering all`

```
Ethernet type 0800 is routed on ports 1
IEEE 802.2 destination SAP 42 is routed on ports 1
IEEE 802 SNAP PID 00-00-00-08-00 is routed on ports 2-3
```

Descriptors used in explaining how packets are communicated include the following:

- Routed - Describes packets which are passed to routing forwarder to be forwarded
- Filtered- Describes packets which are administratively filtered by the user setting protocol filters
- Bridged and routed - This describes a protocol identifier for which there is a protocol entity within the system which is not a forwarder. An example of this would be a link level echo protocol. Unicast packets from this protocol are bridged or locally processed if being sent to a registered address. Multicast packets are forwarded and locally processed for a registered multicast address.

All of the descriptors just explained also apply to ARP packets with this Ethertype.

Example: `list filtering ethertype`

```
Ethernet type (in hexadecimal), 0 for all [0]? 0800
Ethernet type 0800 is routed on ports 1
```

Example: `list filtering SAP`

```
SAP (in hexadecimal), 100 for all [100]? 42
IEEE 802.2 destination SAP 42 is routed on ports 1
```

Example: `list filtering SNAP`

```
SNAP Protocol ID, return for all [00-00-00-00-00]?
IEEE 802 SNAP PID 00-00-00-08-00 is routed on ports 2-3
```

source-routing

Displays source-routing bridge configuration information. There are a number of general datagroup options which may be displayed under the list source-routing command. These include the following:

- Configuration - Displays general information regarding the SRB bridge.
- Counters - Displays all SRB bridge counters.
- State - Displays contents of all related SR-TB bridge databases.

The following examples illustrate each of the list source-routing display options.

Example: `list source-routing configuration`

```
Bridge number:              1
Bridge state:               Enabled
Maximum STE hop count       14
Maximum ARE hop count       14
Virtual segment:            003
Port  Segment  Interface   State     MTU    STE Forwarding  LNM
2     001      TKR/1       Enabled   4399   Yes             ENA
3     002      TKR/2       Enabled   4399   Yes
```

Bridge number

The bridge number (in hexadecimal) assigned to this bridge.

Bridge State

Indicates whether bridging is enabled or disabled.

Maximum STE hop count
The maximum hop count for spanning tree explorer frames transmitting from the bridge for a given interface associated with source routing bridging.

Maximum ARE hop count
The maximum hop count for all route explorer frames transmitting from the bridge for a given interface associated with source routing bridging.

Virtual segment
The virtual segment number assigned for 1:N bridging.

Port The numbers of ports associated with source routing bridging.

Segment The assigned segment numbers for networks associated with source routing bridging.

Interface The associated interface names. “Adaptive” is listed for interfaces participating in the SR-TB feature and VPI/VCI for ATM.

State The current port state (Enabled or Disabled).

MTU The MTU size set for that port.

STE Forwarding
Indicates whether Spanning Tree Explorers received on this port are forwarded (Yes) and whether STEs from other ports go out this port.

LNM Indicates whether LAN Network Manager (LNM) agents are enabled (ENA) or disabled (DIS) on that specific port.

The counters option has further subgroups of information which may be displayed using the list source-routing command. These include the following:

- All-ports - Displays counters for all ports.
- Port - Displays counters for a specific port.
- Segment - Displays counters for the port corresponding to a specific segment.

The following examples illustrate each of the list source-routing display options.

Example: `list source-routing counters all-ports`

```
ASRT>list source counters all-ports
Counters for port 2, segment 001, interface TKR/1
SRF frames received:          0    sent:          0
STE frames received:          0    sent:          0
ARE frames received:        648    sent:          0
SR frames sent as TB:                               0
TB frames sent as SR:                            2057
Dropped, input queue overflow:                      0
Dropped, source address filtering:                  0
Dropped, dest address filtering:
Dropped, invalid RIF length:                        0
Dropped, duplicate segment:                      2594
Dropped, segment mismatch:                          0
Dropped, Duplicate LAN ID or tree error:            0
Dropped, STE hop count exceeded:                    0
Dropped, ARE hop count exceeded:                    0
Dropped, no buffer available to copy:               0
Dropped, MTU exceeded:                              0


Counters for port 3, segment 002, interface TKR/2:
SRF frames received:          0    sent:          0
STE frames received:          0    sent:          0
ARE frames received:        825    sent:          0
SR frames sent as TB:                               0
TB frames sent as SR:                            2041
Dropped, input queue overflow:                      0
Dropped, source address filtering:                  0
Dropped, dest address filtering:                    0
Dropped, invalid RIF length:                        0
Dropped, duplicate segment:                      3300
Dropped, segment mismatch:                          0
Dropped, Duplicate LAN ID or tree error:            0
Dropped, STE hop count exceeded:                    0
Dropped, ARE hop count exceeded:                    0
Dropped, no buffer available to copy:               0
Dropped, MTU exceeded:                              0
```

Port Lists the numbers of ports associated with source routing bridging

Segment Lists the source-routing segment numbers in hex.

Interface Lists the name of the network interface. VPI/VCI for ATM.

SRF Frames Received/Sent
Lists the number of Specifically Routed Frames received or sent on this bridge.

STE Frames Received/Sent
Lists the number of Spanning Tree Explorer Frames received or sent on this bridge.

ARE Frames Received/Sent
Lists the number of All Routes Explorer Frames received or sent on this bridge.

SR Frames Sent as TB
Lists the number of source routing frames received on this interface that were sent as Transparent Bridge Frames.

TB Frames Sent as SR
Lists the number of transparent bridge frames received on this interface that were sent as source routing frames.

Dropped, input queue
Lists the number of frames arriving on this interface that were not bridged for flow control reasons. The input queue to the forwarder overflowed.

Dropped, source address filtering
Lists the number of frames arriving on this interface that were not bridged because this source address matched a source address filter in the filtering database.

Dropped, destination address filtering
Lists the number of frames arriving on this interface that were not bridged because this destination address matched a destination address filter in the filtering database.

Dropped, protocol filtering
Lists the number of frames arriving on this interface that were not bridged because their protocol identifier was one that is being administratively filtered.

Dropped, invalid RIF length
Lists the number of frames arriving on this interface that were dropped because the RIF length as less than 2 or over 30.

Dropped, duplicate segment
Lists the number of frames arriving on this interface that were dropped because of a duplicate segment in the RIF. This is normal for ARE frames.

Dropped, segment mismatch
Lists the number of frames arriving on this interface that were dropped because the outgoing segment number does not match any in this bridge.

Dropped, Duplicate LAN ID or tree error:
The number of duplicate LAN IDs or Tree errors. This helps in the detection of problems in networks containing older IBM Source Routing Bridges.

Dropped, STE hop count exceeded:
The number of explorer frames that have been discarded by this port because the Routing Information Field has exceeded the maximum route descriptor length.

Dropped, ARE hop count exceeded:
The number of explorer frames that have been discarded by this port because the Routing Information Field has exceeded the maximum route descriptor length.

Dropped, no buffer available to copy:
Number of times a frame was not forwarded out of an interface, because there were no buffer resources available to copy the frame. (Frame to multicast destinations and to unknown destinations, need to be copied for transmission out on all active ports.)

Dropped, MTU exceeded:
The number of frames that were discarded by this port due to an excessive size.

Example: `list source-routing counters port 3`

```
Counters for port 3, segment 002, interface TKR/1:
SRF frames received:          0    sent:           0
STE frames received:          0    sent:           0
ARE frames received:       1140    sent:           0
SR frames sent as TB:                                0
TB frames sent as SR:                             2931
Dropped, input queue overflow:                       0
Dropped, source address filtering:                   0
Dropped, dest address filtering:                     0

Dropped, invalid RIF length:                         0
Dropped, duplicate segment:                       4560
Dropped, segment mismatch:                           0
Dropped, Duplicate LAN ID or tree error:             0
Dropped, STE hop count exceeded:                     0
Dropped, ARE hop count exceeded:                     0
Dropped, no buffer available to copy:                0
Dropped, MTU exceeded:                               0
Dropped, dest address filtering:                     0
Dropped, protocol filtering:                         0
```

Example: `list source-routing counters segment 2`

```
Counters for port 3, segment 002, interface TKR/2:
SRF frames received:          0    sent:          0
STE frames received:          0    sent:          0
ARE frames received:       1249    sent:          0
SR frames sent as TB:                               0
TB frames sent as SR:                            3200
Dropped, input queue overflow:                      0
Dropped, source address filtering:                  0
Dropped, dest address filtering:                    0
Dropped, protocol filtering:                        0
Dropped, invalid RI length:                         0
Dropped, duplicate segment:                      4996
Dropped, segment mismatch:                          0
Dropped, Duplicate LAN ID or tree error:            0
Dropped, STE hop count exceeded:                    0
Dropped, ARE hop count exceeded:                    0
Dropped, no buffer available to copy:               0
Dropped, MTU exceeded:                              0
```

spanning-tree protocol

- Displays spanning tree protocol information. The spanning tree protocol is used by the transparent bridge to form a loop-free topology. There are a number of general datagroup options which may be displayed under the **list spanning-tree-protocol** command. These include the following:
  - Configuration - Displays information concerning the spanning tree protocol.
  - Counters - Displays the spanning tree protocol counters.
  - State - Displays the current spanning tree protocol state information.
  - Tree - Displays the current spanning tree information including port, interface, and cost information.

  The following examples illustrate each of the list spanning-tree-protocol display options.

Example: `list spanning-tree-protocol configuration`

```
Bridge ID (prio/add):  32768/0000-93-00-84-EA
Bridge state:          Enabled
Maximum age:           20 seconds
Hello time:            2 seconds
Forward delay:         15 seconds
Hold time:             1 seconds
Filtering age:         320 seconds
Filtering resolution:  5 seconds

Port  Interface  Priority  Cost   State
  4   Eth/1      128    100     Enabled
128   Tunnel     128    65535   Enabled
```

Example: `list spanning-tree-protocol counters`

```
            Time since topology change (seconds)         0
            Topology changes:                            1
            BPDUs received:                              0
            BPDUs sent:                              14170

Port  Interface  BPDUs received  BDPU input overflow  Forward transitions

   1  TKR/1             0              0               1
   2  AT/0:0:48         0              0               0
```

Example: `list spanning-tree-protocol state`

```
       Designated root (prio/add):    32768/00-00-93-00-84-EA
       Root cost:                     0
       Root port:                     Self
       Current (root) maximum age:    20 seconds
       Current (root) hello time:     2 seconds
       Current (root) Forward delay:  15 seconds
       Topology change detected:      FALSE
       Topology change:               FALSE

       Port  Interface   State
         4  Eth/1       Forwarding
       128  Tunnel      Forwarding
```

Example: `list spanning-tree-protocol tree`

```
       Port                 Designated   Desig.         Designated   Des.
       No.  Interface            Root     Cost             Bridge   Port

       1  TKR/1  32768/12-34-56-78-90-12    0 32768/12-34-56-78-90-12 90-01
       2  AT/0:0:48  0/00-00-00-00-00-00    0     0/00-00-23-45-00-00 80-00
```

super-elan-bridge-cache

- Lists the ATM LAN Emulation control frame cache.

Note: This option is not available if SuperELAN II is configured.

transparent

Displays transparent bridge configuration information. There are a number of general datagroup options which may be displayed under the list transparent command. These include the following:

- Configuration - Displays information concerning the transparent bridge.
- Counters - Displays the transparent bridge counters. You may use all-ports after the command to display the counters for all ports or enter the specific port number after the command to display counters for one port.
- State - Displays the transparent state information.

  The following examples illustrate each of the list transparent display options.

Example: `list transparent configuration`

```
Filtering database size:    5141
Aging time:                 300 seconds
Aging granularity           5 seconds
Port  Interface   State     MTU
  4   Eth/1       Enabled   0
128   Tunnel      Enabled   0
```

Example: `list transparent counters all-ports`

```
Counters for port 4, interface Eth/1:
Total frames received by interface:          25885
Frames submitted to bridging:                13732
Frames submitted to routing:                  6101
Dropped, source address filtering:               0
Dropped, dest address filtering:             12677
Dropped, protocol filtering:                     0
Counters for port 128, interface Tunnel:
Total frames received by interface:              0
Frames submitted to bridging:                    0
Frames submitted to routing:                     0
Dropped, source address filtering:               0
Dropped, dest address filtering:                 0
Dropped, protocol filtering:                     0
Dropped, no buffer available to copy:            0
Dropped, input queue overflow:                   0
Dropped, source port blocked:                    0
Frames sent by bridging:                      5327
Dropped, dest port blocked:                      0
Dropped, transmit error:                         0
Dropped, too big to send on port:                0
```

Example: `list transparent counters port 4`

```
Counters for port 4, interface Eth/1:
Total frames received by interface:          25885
Frames submitted to bridging:                13732
Frames submitted to routing:                  6101
Dropped, source address filtering:               0
Dropped, dest address filtering:             12677
Dropped, protocol filtering:                     0
Dropped, no buffer available to copy:         6073
Dropped, input queue overflow:                 122
Dropped, source port blocked:                   31
Frames sent by bridging:                       388
Dropped, dest port blocked:                      0
Dropped, transmit error:                         0
Dropped, too big to send on port:                0
```

Example: `list transparent state`

```
Filtering database size:                      5141
Number of static entries:                        0
Number of dynamic entries:                      10
Hash collision count:                            1
Filtering database overflow count:               0
```

tunnel *bridges* **or** *config*

Displays tunnel configuration information. There are general datagroup options which may be displayed under the list tunnel command. These include:

- Bridges - Displays tunnel bridge information.
- Config - Displays information concerning the tunnel configuration.

The following examples illustrate each of the list tunnel display options.

Example: `list tunnel bridges`

Example: `list tunnel config`

NetBIOS

Use the **netbios** command to access the `NetBIOS>` prompt. NetBIOS monitoring commands may be entered at the `NetBIOS>` prompt.

See “NetBIOS Commands” on page 9-3 for the NetBIOS monitoring commands.

Syntax:

netbios

Set

Use the **set** command to change the SuperELAN ID for a specific bridge port.

Syntax:

set *super-elan-id*

Example:

```
ASRT config> set super
port number [1]? 2
SuperELAN ID [0]? 3
```

Note: This option is not available if SuperELAN II is configured.

Dynamic Protocol Filtering (VLANS)

The VLAN monitoring commands are a superset of the VLAN configuration commands. However, instead of updating the SRAM configuration records immediately, they change the behavior of VLANs in real-time. Changes made through the monitoring can be optionally saved to SRAM. Also, the configuration in SRAM can be loaded and used without requiring a reboot.

Monitoring commands for the ASRT bridge are entered at the `ASRT VLAN>` prompt. This prompt is accessed by entering the **vlans** command at the `ASRT>` prompt.

Note: These same commands can be used to monitor VLANs on SuperELAN II. Refer to the chapter entitled “Using and Configuring ATM” in the *Software User's Guide* for information about SuperELAN II.

The following table shows the VLAN monitoring commands.

Table 5-7. VLAN Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds the definition of a new VLAN filter
Change	Changes VLAN filtering parameters for an indicated VLAN
Delete	Deletes the selected VLAN filters
Disable	Disables VLAN filtering on the selected VLANs
Enable	Enables VLAN filtering on the selected VLANs
List	Displays all information associated with the selected VLAN filters
Load	Loads and uses the VLAN configuration currently in SRAM
Reset-Counters	Resets all counters associated with the selected VLAN filters
Save	Saves the current runtime configuration to SRAM
Show-members	Displays learned MAC addresses for a selected VLAN
Show-vlans	Lists the enabled VLANs of which a particular MAC address is a member
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

For a description of the **Add**, **Change**, **Delete**, **Disable**, and **Enable** commands, see “Dynamic Protocol Filtering (VLANS) Configuration Commands” on page 5-43.

List Use the list command to list the current real-time configuration for a particular VLAN filter, all VLAN filters of a particular type, or all defined VLAN filters. If listing a single filter, the VLAN to list can be chosen by selecting the VLAN from a list with the *by-name* option. The resulting output includes both configuration parameters and VLAN counters.

Syntax:

list by-name
ip all
ip subnet *subnet address*
ip-multicast all
ip-multicast by-name
ipx all
ipx network *network number*
mac-address all
mac-address by-name
netbios
port-based all
port-based by-name
sliding-window all
sliding-window by-name
all

Example:

```
vlans config>list ip subnet 9.0.0.0

   Subnet Address              = 9.0.0.0
   Subnet Mask                 = 255.0.0.0
   Port 1 (Interface 0) = Auto-Detect and Include, Forwarding
   Port 2 (Interface 1) = Always Exclude,          Not Forwarding
   Age (expiration in minutes) = 300
   IP-Cut-Through Status:
      Tx From This VLAN    = Enabled  Reception By This VLAN = Disabled
      Packets Transmitted  = 25       Packets Received       = 0
      Tx Packets Discarded = 0        Rx Packets Discarded   = 14
   Tracking of MAC Addresses  = Disabled
   VLAN Status                = Enabled
   Packets Processed          = 43
   Discards Due To Exclusion  = 13
   VLAN Name                   = IP 9.x.x.x
```

A description of the VLAN counters follows:

Packets Transmitted
Total number of IP packets successfully cut through from this VLAN.

Packets Received
Total number of IP packets successfully cut through to this VLAN.

Tx Packets Discarded

Number of IP packets that were intended to be cut through from this VLAN, but were discarded due to IP-Cut-Through transmission being disabled. Packets from ports configured as Always Exclude are not included in this count.

Rx Packets Discarded

Number of IP packets that were intended to be cut-through to this VLAN, but were discarded due to IP-Cut-Through reception being disabled.

Packets Processed

Total number of packets processed by this VLAN's forwarding logic. This includes all packets forwarded and discarded. For IP Multicast VLANs, this number includes IGMP Reports and matching IP Multicast frames.For the IP Multicast auto-creation VLAN (group 224.0.0.1), this counter indicates the number of received IP multicast router "Hello" packets.

Discards Due To Exclusion

Number of packets received matching this VLAN on ports configured as Always Exclude for this VLAN.

Load Use the load command to load and immediately use the VLAN configuration stored in SRAM. This will overwrite any configuration changes that may have been made via monitoring since the last save. All timers and counters associated with VLANs will be reset.

Syntax: load

Example: load

```
Warning: This process will overwrite your current configuration.
Are you sure you want to load the VLAN configuration from SRAM? [No] y
VLAN configuration loaded
```

Reset-Counters

Use the reset-counters command to set all counters to zero for a particular VLAN filter, all VLAN filters for a particular protocol, or all defined VLAN filters. If you are resetting the counters in a single filter, you can choose the VLAN by specifying the subnet or by selecting the VLAN from a list with the by-name option.

Syntax:

reset-counters by-name
ip all
ip subnet *subnet address*
ip-multicast all
ip-multicast by-name
ipx all
ipx network *network number*
mac-address all
mac-address by-name
netbios
port-based all
port-based by-name
sliding-window all
sliding-window by-name

all

Example: reset ipx network 3ff

```
VLAN 'Token Ring B' (IPX Network 0x3FF) counters reset
```

Save Use the **save** command to store the current runtime VLAN configuration into SRAM. This will overwrite the current SRAM configuration. This command does not affect the runtime behavior of VLANs or reset the timers or counters associated with VLANs.

Syntax: save

Example: save

```
Are you sure you want to save the VLAN configuration to SRAM? [No] y
VLAN configuration saved
```

Show-members

Use the **show-members** command to display all the learned MAC addresses for a particular VLAN that has MAC Address Tracking enabled. Addresses in this list have all transmitted broadcast frames within the configured aging time. The MAC addresses will be displayed along with the associated bridge port and interface and can be sorted by bridge port or increasing MAC address.

Syntax:

show-members by-name
ip *subnet-address*
ip-multicast
ipx *network-number*
mac-address
netbios
port-based
sliding-window

Example: show-members ip

```
Subnet Address [9.0.0.0]?

        Sort VLAN Members by Port (P) or Mac Address (M) [P]?
        Port Number to Show Membership (0=All) [0]?

        Current Members of Runtime VLAN 'IP 9.x.x.x' (IP Subnet 9.0.0.0):

           Port  1 (Interface  0),  Mac Address: 10.00.5A.00.64.00
           Port  2 (Interface  1),  Mac Address: 10.00.5A.00.65.00
```

Show-vlans

Use the **show-vlans** command to display all the enabled VLANs in which traffic from a particular MAC address has been observed since the last aging timer expiration.

Syntax:

Example: show-vlans

```
Enter Mac Address in Hex: []? 10005A006400

        List of VLANS with Mac Address 10.00.5A.00.64.00:

             VLAN Type    Identifier            VLAN Name
             =========    ==========            =========
          (1) IP           9.0.0.0               IP 9.x.x.x
```

Chapter 6. Using DLSw

This chapter describes the Data Link Switching (DLSw) , and the implementation of the Data Link Switching (DLSw) protocol. Changes made at the `Config>` prompt do not take effect immediately, but become part of the SRAM configuration used for subsequent restarts of the router. For a description of temporary, but immediate, configuration changes, see page 7-19.

The IBM 8210 offers a wide range of function that enables you to integrate Systems Network Architecture (SNA) and Network Basic Input/Output System (NetBIOS) traffic into heterogeneous, wide area networks.

The following sections explain how to configure your router for DLSw:

- "About DLSw"
- "Using DLSw Features" on page 6-4
- "Setting up DLSw" on page 6-10
- "Sample DLSw Configuration" on page 6-13

About DLSw

DLSw is a forwarding mechanism for the LLC2 protocol. It relies on the bridging function of the router, the Switch-to-Switch protocol (SSP), and TCP/IP to provide a reliable transport of SNA traffic over an internet. DLSw does not provide full routing capabilities, but it provides switching at the data link layer. Rather than bridging LLC2 frames, DLSw encapsulates their data in TCP frames and forwards the resulting messages over the WAN link to a peer DLSw router for delivery to their intended end-station addresses.

How DLSw Works

LLC2 is a connection-oriented protocol. DLSw provides the dynamic characteristics of routable protocols ***and*** preserves both end-to-end reliability and control features for effective communication.

Problems in the Bridging Solution

Figure 6-1 on page 6-2 illustrates the traditional approach to bridging LLC2 frames across WAN links. Figure 6-2 on page 6-2 illustrates the traditional approach to bridging LLC2 frames between ELANs. With the traditional approach, network delays occur much more frequently in the WAN than on a LAN. These delays can result from simple network congestion, slower line speeds, or other factors. Whatever the cause, these delays increase the possibilities of session timeouts and of data not reaching intended destinations.

Also, LAN protocols, like LLC2, use significantly shorter retransmit/response times than the WAN's. Thus, end-to-end connections across a WAN link are extremely difficult to maintain, and session timeouts are much more probable.

In addition to session timeouts, there is a significant problem when data is delayed while crossing the WAN. A sending station can resend data that is delayed (but not lost); this can result in LLC2 end stations receiving duplicate data. Duplicate data can cause confusion for LLC2 procedures on the receiving side which can, in turn, result in inefficient use of the WAN link.

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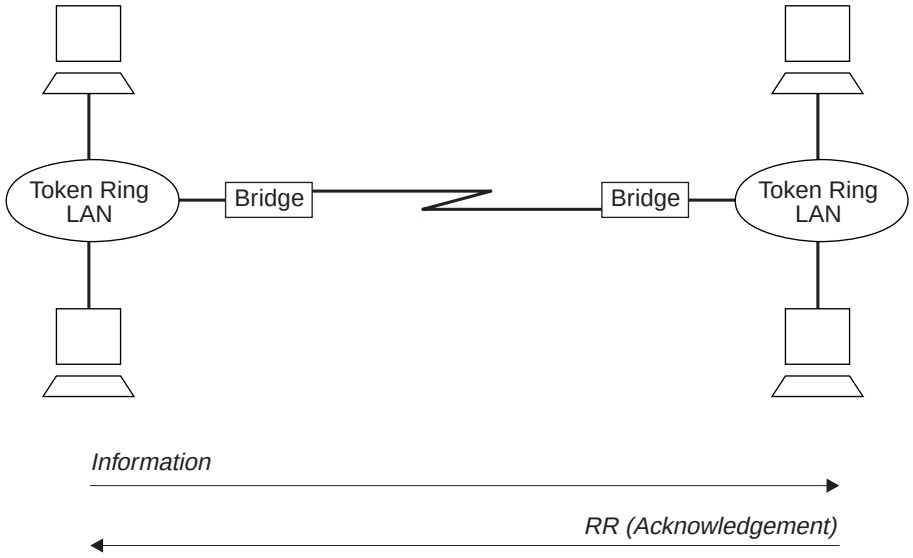

Figure 6-1. Traditional Approach to Bridging Across WAN Links

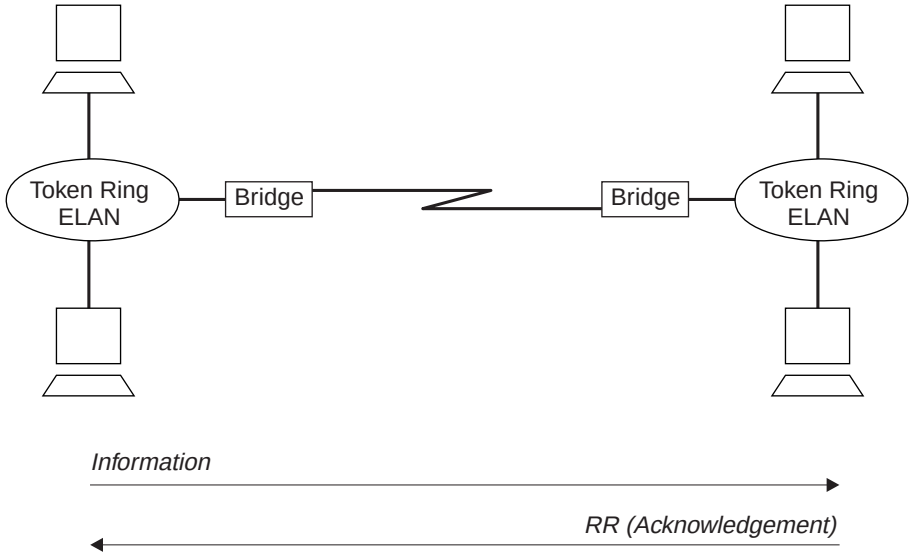

Figure 6-2. Bridging Between ELANs

The preceding example shows traditional bridging, involving end-to-end data-link control. As a connectionless protocol, bridging does nothing to ensure the integrity of LLC traffic on the ELAN.

Protocol Spoofing

To reduce the chance of session timeouts, and to maintain the appearance of end-to-end connectivity for sending stations, DLSw works by terminating or "spoofing" LLC2 connections at the local router. Upon receiving an LLC2 frame, the router sends an acknowledgement to the sending station. This acknowledgment tells the sender that data that was previously transmitted has been received.

The acknowledgment prevents the station from retransmitting. From this point forward, assuring that data gets through is the responsibility of the DLSw software. The software accomplishes this by encapsulating the data in routable IP frames,

then transports them (via TCP) to a DLSw peer. The peer DLSw router strips away the TCP headers, determines the address of the data's intended recipient, and establishes a new LLC2 connection with that end station.

Figure 6-3 illustrates this relationship between two DLSw peer routers, each attached to a Token-Ring ELAN.

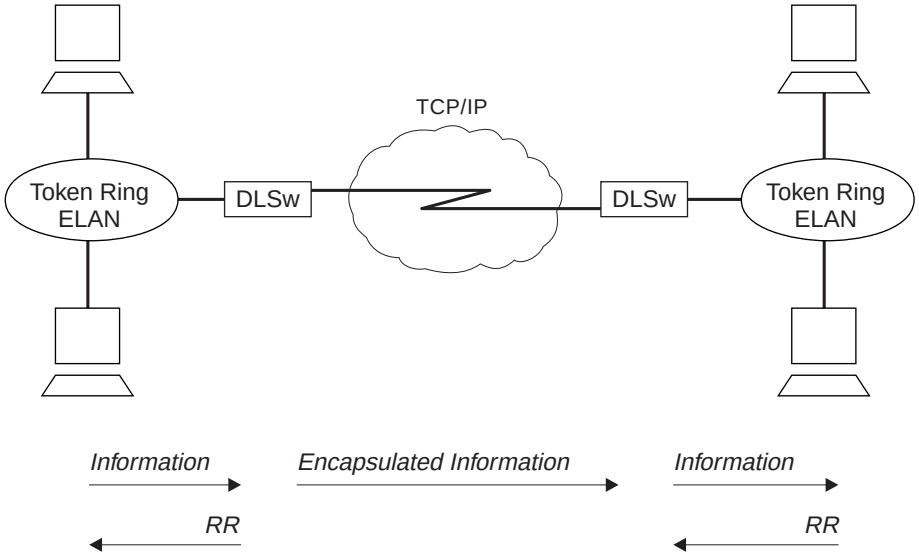

Figure 6-3. Data Link Switching over the ELAN

DLSw terminates the LLC2 connection at the router. This means that LLC2 connections do not cross the wide area network. This reduces session timeouts and the acknowledgments (RRs) that would otherwise traverse the wide area's area links.

Benefits of DLSw

Because DLSw terminates the DLC connection at the local device (see Figure 6-3), it is especially effective at eliminating SNA session timeouts and reducing WAN overhead on shared circuits. The protocol has these main benefits:

- Reduces the possibility of session timeouts by terminating LLC2 control traffic at the local device.
- Reduces WAN network overhead by eliminating the need to transmit acknowledgments (RRs) over the wide area. The RRs are confined to the LANs local to each DLSw router.
- Provides flow and congestion control, and broadcast control of search packets, between DLSw routers and their attached end stations.
- Increases Source Route Bridging hop-count limits.
- Supports NetBIOS traffic.

Using DLSw Features

The following sections address the use of various DLSw features:

- "TCP Connections, Neighbor Discovery, and Multicast Exploration"
- "LLC Device Support" on page 6-6
- "APPN Interface Support" on page 6-7
- "Using the Neighbor Priority Feature" on page 6-7
- "Balancing SNA and NetBIOS Traffic" on page 6-9

TCP Connections, Neighbor Discovery, and Multicast Exploration

DLSw uses TCP to provide reliable, sequenced delivery of end-user information across an IP network. DLSw message formats allow multiple end-station sessions, or circuits, to be carried across a single TCP transport connection. There are two ways to configure which DLSw-capable routers should have TCP transport connections between them to allow the desired end-station connectivity:

- Configure the IP addresses of the neighbor router at one or both of each pair of routers. This is the most basic method and is supported by all DLSw router vendors.
- Configure multicast group membership at each router, allowing the routers to discover each others' IP addresses dynamically. This is a special feature of this product's DLSw, to ease the burden of configuring neighbor IP addresses.

Configuring TCP Neighbors

To configure a neighbor IP address at a router, use the **add tcp** command once for each of that router's neighbors. It is not required for each of the two routers in a neighbor relationship to configure the other's IP address. Only one router needs to have the other's address, and the other router can be configured to accept dynamic TCP connections from non-configured neighbors. Use the **enable dynamic-neighbors** command to configure this behavior, and use the **set dynamic-tcp** command to configure the parameters used for these dynamic connections. Enabling dynamic TCP connections can be particularly useful for "hub" routers that you do not want to reconfigure when you set up new remote branch office routers that connect to the hub.

In addition to the IP address, the **add tcp** command allows you to configure a number of parameters for the neighbor and the TCP connection itself. The *Keepalive* parameter controls whether the TCP layer occasionally polls its peer TCP layer in the absence of any user data traffic. Enabling Keepalive messages results in more timely notification of TCP connection failure, but can increase WAN overhead and cause the reporting of failures that could have been successfully re-routed.

The NetBIOS SessionAlive Spoofing parameter controls whether or not the NetBIOS SessionAlive frames are forwarded to the DLSw peer. If this parameter is enabled and the Keepalive parameter is disabled, then no DLSw traffic will pass between the DLSw partners if idle NetBIOS sessions are established between the DLSw peers. This would allow an underlying connection to terminate while maintaining an idle NetBIOS session over DLSw.

The *connectivity setup type* parameter controls when DLSw brings up and takes down the TCP connection. When one or both neighbors have the CST set to *active*, DLSw attempts to bring up the connection at system startup and at regular intervals

until it is up. Once the TCP connection is established, DLSw attempts to keep it up at all times by trying to bring it back when it fails. If both neighbors have set the CST to *passive*, DLSw brings up the TCP connection only when it is actually needed to establish a DLSw end-station session. When the last DLSw session ends and no new session is started in a configurable period of time (the *neighbor inactivity timer*), DLSw disconnects the TCP connection and frees the associated internal resources.

Configuring Groups for Neighbor Discovery

To avoid configuring neighbor IP addresses in one or both of every pair of neighbor routers, set up DLSw to use multicast IP to discover the IP address of the neighbors to which it should connect. Use the **join-group** command at each router to make it a member of one or more DLSw groups and to assign a role within the group. The role may be “client,” “server,” or “peer.” DLSw uses multicast IP to discover the IP addresses of all DLSw routers that are members of the same groups and that have the complementary role (that is, clients discover servers within a group and vice versa, and peers discover other peers).

When DLSw learns the IP addresses of its neighbors in each group, it uses the “connectivity setup type” of its membership in the group and that of each group neighbor to determine when a TCP connection to that neighbor should be brought up. As with configured individual neighbors, when either CST is *active*, DLSw brings up the TCP connection to the discovered neighbor as soon as possible and attempts to keep the connection up at all times. When both CSTs are *passive*, DLSw brings up the TCP connection only when it is required to carry DLSw sessions, and uses the *neighbor inactivity timer* to disconnect the TCP connection when it is not being used.

Multicast Exploration and Frame Forwarding

DLSw uses multicast IP services for more than discovering the IP addresses of neighbor routers. It uses these same services to forward DLSw messages searching for end-station resources (for example, MAC addresses or NetBIOS names), and to forward NetBIOS datagram traffic. This feature can dramatically increase the scalability of DLSw networks because there is no need for static TCP connections to all neighbors to carry search and datagram messages. Also, DLSw does not need to send a different copy of each broadcast message on every TCP connection, but can send a single copy that is replicated within the multicast IP infrastructure.

To use multicast IP for exploration and frame forwarding, issue the **join-group** command and set the *connectivity setup type* to *passive*. DLSw automatically determines which other group members are multicast-capable, and which are using their group membership simply to discover neighbor IP addresses and bring up static TCP connections. DLSw simultaneously works with both types of neighbors when searching for end-station resources, forwarding NetBIOS datagrams, and establishing DLSw sessions.

When you issue the **join-group** command, you select one of two addressing methods to describe the group you are joining. When you provide a group ID and the client/server/peer role as previously described, the router constructs the corresponding multicast IP addresses and can communicate with other IBM routers that use this method. You may also choose to directly specify the multicast IP addresses to be used and whether each address should be read from, written to, or

both. This method was introduced to support RFC 2166, and allow multicast interoperability with other DLSw Version 2 compliant products.

A given router may be a member of traditional groups and concurrently read from and write to DLSw Version 2 multicast addresses. The new multicast addresses may also be used for neighbor discovery, but you must ensure that for every pair of routers intended to form a TCP connection, one router has a *connectivity setup type* of *active* on a write-capable address on which the other router is reading. Whether you are doing neighbor discovery or not, specifying multicast addresses requires more careful configuration planning to ensure reachability than using group IDs and the client/server/peer model.

Reducing Explorer Traffic: If the amount of explorer traffic being forward between DLSw neighbors is too high, there are some capabilities to reduce this explorer traffic.

DLSw open SAPs
: Each DLSw sends a lists of all SAPs open on any interface to its DLSw neighbors via DLSw capabilities exchange. The DLSw neighbors can use this SAP list to limit the explorer traffic sent to this DLSw.

DLSw MAC address lists
: Each DLSw can configure a local MAC address list. This list is defined as exclusive (respresents all MAC addresses accessible via this DLSw) or non-exclusive (represents a set of MAC addresses accessible via this DLSw). Each entry in the list contains a MAC address mask and a MAC address value. The entire MAC address list and exclusivity type is sent to all DLSw neighbors via DLSw capabilities exchange. The DLSw neighbors can use this MAC address list to limit the explorer traffic sent to this DLSw.

  The MAC address lists operate in a similar manner as the NetBIOS name lists. For information about NetBIOS Name Lists, see “NetBIOS Name Lists” on page 8-9.

DLSw MAC cache entries
: A DLSw can configure individual MAC cache entries that map a particular MAC address with a particular DLSw neighbor. Multiple MAC cache entries can be used to map a particular MAC address with multiple DLSw neighbors. The DLSw uses this list locally to limit where DLSw explorers destined for a configured MAC address are sent.

MAC address filters
: MAC address filters configured for the bridge net interface apply to DLSw traffic. These inbound MAC address filters on the bridge net can be used to limit the traffic given to DLSw, thus limiting the explorer traffic sent to DLSw partners. For more information about MAC filters, refer to “Using and Configuring Mac Filtering”and“Monitoring MAC Filtering”in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide*.

LLC Device Support

DLSw supports SNA and NetBIOS end stations attached to the router via LAN and remote-bridging WAN interfaces. These end stations and the router are both running ISO 8802-2 (IEEE 802.2) standard Logical Link Control (LLC) to provide data sequencing and reliable delivery. The router currently supports bridged LLC traffic over the following interface types, and all can be used for traffic flowing between DLSw and LLC end stations:

- FDDI
- ATM (as a LAN Emulation client)

Because DLSw uses the MAC and SAP addresses available in bridged frames, there is no need to configure in DLSw any information about individual LLC end stations. DLSw receives broadcast traffic sent by these end stations, and uses normal LAN/bridge broadcast methods to make initial contact with them. You must, however, configure the bridging support for any interface that DLSw is to use, and configure within DLSw the SAPs that it is to use on each interface.

APPN Interface Support

DLSw has an internal interface with APPN that connects APPN to end stations attached to remote DLSw routers. The remote routers need not support APPN, which may reduce the amount of memory they require. As shown in Figure 6-4, this internal interface is the equivalent of collapsing a DLC connection (for example, LLC over a LAN) into a single software interface.

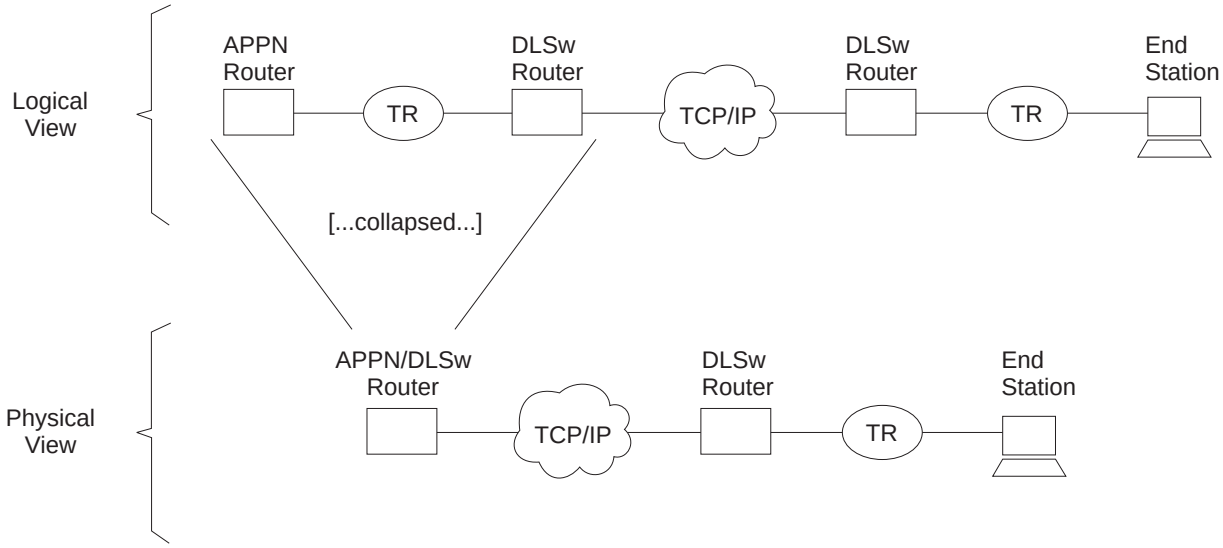

Figure 6-4. APPN-to-DLSw Software Interface

APPN cannot use the DLSw software interface to reach end stations that are locally attached to the APPN/DLSw router. It must use its native DLC support to communicate with these devices.

No additional DLSw configuration is required to support the APPN interface. You should enable TCP Keepalive messages to the DLSw remote router, to allow detection of the loss of the link stations on the DLSw port. You must configure APPN to use a DLSw virtual interface to reach a given end station. For information on implementing APPN using DLSw, refer to the chapter on configuring APPN in *Multiprotocol Switched Services (MSS) Configuring Protocols and Features*

Using the Neighbor Priority Feature

Many DLSw network configurations provide multiple paths from an origin DLSw router to destination end-stations by making the end-stations local to more than one destination DLSw router. To provide additional control over which remote DLSw router are used for new circuits, you can assign a priority (high, medium, or low) to each defined neighbor. Although the allowable values are similar, neighbor priority

is ***not*** the same as priorities for balancing SNA and NetBIOS traffic that is discussed in “Balancing SNA and NetBIOS Traffic” on page 6-9.

For neighbor priority, you assign a priority when you define a neighbor using the **add tcp** or **join group** commands. A group’s priority is inherited by all transport connections brought up within that group.

When DLSw is originating a circuit and finds that the destination MAC address or NetBIOS name is reachable through multiple remote DLSw routers, it establishes the circuit through the one of those neighbors that has the highest priority. If there are multiple remote routers that share this highest priority, DLSw uses a “round-robin” method of allocating new circuits among those routers.

Using neighbor priority, you can establish a primary/backup relationship among remote routers. A lower priority router is not used unless the higher priority router becomes unavailable. In addition, the round-robin method provides for load balancing among routers of equal priority.

Notes:

1. When an SNA frame is received that is destined for a MAC address that does not have cached information for which neighbors can reach the MAC address, an SNA explorer message is sent to all DLSw neighbors. Responses for the SNA explorer message are collected for the period of time specified by the “neighbor priority wait timer.” After this period of time, the MAC address cache entry is updated with information from the responses from the neighbors with the highest priority. One of these neighbors is chosen to handle this SNA circuit, and a response is sent to the original SNA frame that was received. Subsequent SNA circuit requests for this MAC address will use one of the cached highest priority neighbors to bring up the circuit.
2. When a NetBIOS frame is received that is destined for a NetBIOS name that does not have a current cache information entry for that NetBIOS name, a NetBIOS explorer message is sent to all DLSw neighbors supporting NetBIOS. Unlike the SNA case, responses are collected for a specified period of time before the response to the original NetBIOS frame is sent. The end station timers do not usually allow a wait delay at the router.

   Thus, the first response to the NetBIOS explorer message is saved. This neighbor is used to bring up this NetBIOS circuit, and a response is sent to the original NetBIOS frame that was received. In the meantime, subsequent responses to the NetBIOS explorer message are used to update the NetBIOS name cache.

   - If a response from a neighbor of equal priority to the currently cached information is received, it is added to the cache.
   - If a response from a neighbor of higher priority to the currently cached information is received, the currently cached information is removed and the information for the new higher priority neighbor is added.
   - If a response from a neighbor of lower priority to the currently cached information is received, it is ignored. Subsequent NetBIOS circuit requests for the NetBIOS name will use one of the currently cached highest priority neighbors to bring up the circuit.

Balancing SNA and NetBIOS Traffic

With the introduction of DLSw support for NetBIOS traffic, you need to control the mix of SNA and NetBIOS traffic within DLSw transport connections. Without this control, NetBIOS file transfers have a tendency to shut out interactive SNA traffic for undesirably long periods of time, especially if the TCP connections are running over relatively slow WAN links. You can control this traffic mix using configuration parameters of the **set priority** command. Using these parameters, you can:

- Establish a ratio of the number of frames from each protocol transmitted onto a TCP connection during periods of congestion
- Establish a maximum frame size for NetBIOS frames so that one large frame will not consume a slow WAN link.

To set up a ratio of SNA and NetBIOS frames, you globally select one of four priority values (critical, high, medium, or low) for each protocol. At circuit setup time, the router uses the DLSw Version 1 (RFC 1795) circuit priority mechanism to try to negotiate each new circuit's priority to the value for the protocol the circuit will be using. The DLSw router that initiates the circuit will choose the circuit priority to use. If the local DLSw router initiates the circuit, the circuit priority it chooses is based on the configured circuit priority defaults and circuit priority overrides. If the remote DLSw router initiates the circuit, the local DLSw router will notify the remote DLSw router of its need to use a circuit priority based on the configured defaults and overrides, but the remote DLSw router may choose a different value. In any event, each established circuit is assigned one of the four priorities by the router that initiated that circuit's establishment.

During periods of TCP congestion, the router queues frames (from circuits that have data to transmit) into one of four queues - one queue for each possible circuit priority. The frames are queued FIFO within each priority. To feed the TCP transmit process, the router selects frames from each priority queue as dictated by the “message allocation by priority” parameter. This defaults to 4/3/2/1, meaning that at most, four messages are taken from the critical priority queue, followed by at most three from the medium priority queue, and so on. If a queue is empty, it misses its turn in the cycle.

To prevent a single large NetBIOS frame from dominating a slow link for a long time, you can use the “NetBIOS maximum frame size” parameter to provide an upper limit to the size of a single NetBIOS frame. This value is passed to both NetBIOS end-stations during circuit establishment using the Largest Frame (LF) bits in the source-routing MAC header. Source-routing NetBIOS end-stations should observe the LF values and not generate frames larger than the specified value.

There are four default circuit priorities that can be configured:

- Default SNA explorer traffic circuit priority
- Default SNA session traffic circuit priority
- Default NetBIOS explorer traffic circuit priority
- Default NetBIOS session traffic circuit priority

These different values allow different ratios of SNA and NetBIOS and explorer and session traffic to be assigned.

There may be cases where you want to assign a certain circuit priority to specific traffic. For example, you might want to make traffic destined for a certain SNA MAC

address higher priority than all other traffic. This can be accomplished using circuit priority overrides (**add priority**) command. This allows an explorer and session circuit priority to be assigned to a specific range of source MAC addresses and SAPs and destination MAC addresses and SAPs. These circuit priority overrides are evaluated in the order in which they are configured. The circuit priority is set to the value in the first circuit priority override match found. If no circuit priority override match is found, the default circuit priority is used.

Setting up DLSw

The following sections explain the setup procedures for DLSw:

- "DLSw Configuration Requirements"
- "Configuring Adaptive Source Route Bridging (ASRT) for DLSw"
- "Configuring the Internet Protocol (IP) for DLSw" on page 6-11
- "Configuring OSPF for DLSw" on page 6-12
- "Configuring DLSw" on page 6-12

DLSw Configuration Requirements

To use DLSw, configure the following protocols: ASRT, IP, and DLSw. In addition, you may need to configure the protocols listed in Table 6-1.

Table 6-1. DLSw Optional Protocols

Optional Protocol	When Used
LLC2	When non-default LLC2 parameters need to be used
OSPF	For dynamic routing or to use DLSw multicast groups

The sections that follow explain how to configure these required and optional protocols in a step-by-step fashion.

Configuring Adaptive Source Route Bridging (ASRT) for DLSw

Since the DLSw router appears as a bridge to attached end-stations, you need to configure source route bridging. Do this by following these steps:

1. Enter the ASRT (Adaptive Source Route Bridging) configuration process. Use the **protocol asrt** command from the `Config>` prompt.
2. Enable bridging to occur on the router using the **enable bridge** command. Each bridge must have an unique bridge address in each DLSw.
3. Add a bridge port with the **add port** command. The display prompts you for an interface number and a port number.
   - ***For LANE interfaces:***

     Running DLSw over LANE requires that only source route bridging be present on the designated bridge port. Thus, you must disable transparent bridging. Do this with the **disable transparent** command. Then, issue the **enable source routing** command to turn on source routing for the bridge port.
4. If you are configuring the router for ***concurrent bridging and DLSw:***

Create a protocol filter against the SAPs (service access points) you intend DLSw to use. If the router is performing bridging operations, plus forwarding packets via DLSw, it is essential to do this. If you do not, DLSw packets that are received by the bridge will be forwarded by DLSw and bridged by the router. The idea is to prevent DLSw packets from being forwarded (bridged) in parallel with DLSw routing.

To create a SAP filter, issue this command at the `Config ASRT>` prompt:

```
add protocol-filter dsap 4
```

In addition to this command, you must specify the bridge port to which it applies. This command tells the router to filter all traffic that has a DSAP of 4 except on the port designated for DLSw. (Note that this assumes you have chosen a SAP of 4 for DLSw traffic. This is something you do during the DLSw configuration.)

5. Enable DLSw using the **enable dls** command. This enables the DLSw protocol on the bridge port you have designated.
6. Verify the ASRT configuration. You do not have to do this, but it is a good idea to check the bridge configuration before proceeding. Use the **list bridge** command to verify the configuration of the ASRT protocol. The following example shows the results of the list bridge command after configuring ASRT.

```
                Source Routing Transparent Bridge Configuration
                ===============================================

 Bridge:                 Enabled                 Bridge Behavior: Unknown
                        +---------------------------+
 ------------------- | SOURCE ROUTING INFORMATION |------------------------------
                        +---------------------------+
 Bridge Number:          01                       Segments: 1
 Max ARE Hop Cnt:        14                      Max STE Hop cnt:  14
 1:N SRB:                 Not Active              Internal Segment:  0x000
 LF-bit interpret:        Extended

                        +-------------------+
 ------------------- | SR-TB INFORMATION |--------------------------------------
                        +-------------------+
SR-TB Conversion:        Disabled
TB-Virtual Segment:      0x000                   MTU of TB-Domain:  0

                       +-----------------------------------+
------------------- | SPANNING TREE PROTOCOL INFORMATION |----------------------
                       +-----------------------------------+
Bridge Address:          Default                 Bridge Priority:   32768/0x8000
STP Participation:       IEEE802.1d

                       +-------------------------+
------------------- | TRANSLATION INFORMATION |---------------------------------
                       +-------------------------+
 FA<=>GA Conversion:      Enabled                 UB-Encapsulation :  Disabled
 DLS for the bridge:      Enabled

                        +------------------+
 ------------------- | PORT INFORMATION |--------------------------------------
                        +------------------+
 Number of ports added: 1
 Port:   1      Interface:       0      Behavior:    SRB Only STP:  Enabled
```

Configuring the Internet Protocol (IP) for DLSw

You need to configure IP so that the local DLSw router can form TCP connections to other DLSw peers. To do this:

1. Enter the IP configuration process by issuing the **protocol ip** command from the `Config>` prompt.

2. Assign the IP address to the hardware interface. Use the **add address** command to assign the IP address to the hardware interface you are using to connect to the other DLSw peer.
3. ***Enable Dynamic Routing***. You must choose either OSPF or RIP as your routing protocol. Using OSPF is recommended because it requires less network overhead than RIP.
   - To enable OSPF: see "Configuring OSPF for DLSw."
   - To enable RIP: enter **enable RIP** at the `IP Config>` prompt.
4. Set the Internal IP Address. Use the **set internal-ip-address** command to set the address that belongs to the router as a whole, and not to any particular interface. The internal ip address is used by the router when making the TCP connection to the other DLSw peer.
   - If you are using RIP, choose one of the interface addresses as your internal-ip-address.
   - If you are using OSPF, choose an address that has a different subnet from any subnets that are being used in your network.

Configuring OSPF for DLSw

If you want to use OSPF as your routing protocol, you need to configure it as follows:

1. *Enter the OSPF Configuration process*. Use the **protocol ospf** command from the `Config>` prompt.
2. *Assign the OSPF address to the hardware interface*. Use the **set interface** command to assign the OSPF address to the hardware interface you are using to connect to the other DLSw peer.
3. *Enable Dynamic Routing*. Use the **enable ospf** command to enable routing. If you are using DLSw group function, you must enable the OSPF routing protocol and OSPF multicast routing from the OSPF `Config>` prompt. All defaults for OSPF work fine. You only need to enable OSPF and multicast OSPF after using the **join-group** command rather than using add TCP neighbor to explicitly define the TCP connection.

Configuring DLSw

Before configuring DLSw, enter the **list device** command at the `Config>` prompt to list the interface numbers of different devices.

To configure the DLSw protocol:

1. At the `Config>` prompt, enter the **protocol dls** command. This brings up the `DLSw config>` prompt.
2. At the `DLSw config>` prompt, enter the **enable dls** command to enable DLSw in the router.
3. Enter the **set srb** command to designate the SRB (source route bridging) segment number for the DLS router.

   This SRB segment number must be the same for all DLSw routers attached to the same LAN, and should be unique in the source route bridge domain. The bridge uses this number in the Routing Information Field (RIF) when the frames are sent on the LAN. The segment number is the key for preventing loops.

4. Enter the **open-sap** command for each SAP that you want DLSw to switch. The router prompts for interface numbers. To open commonly-used SNA SAPs (4, 8, and C), specify SNA. Minimally, open SAPs 0 and 4. To open the NetBIOS SAP, specify NB or F0. To open the LNM SAPs, specify LNM or, minimally, 0 and F4.
5. Use the **add tcp** command to add the IP address of each DLSw peer that you want to configure. If you want the router to accept connections from non-configured peers, use the **enable-dynamic neighbor** command. TCP connections also can be established using multicast OSPF and the **join-group** command.

   Note: A router can participate in a group ***only*** if its peer router is an MSS-based platform running DLSw. If you configure one DLSw router for a group, you must enable OSPF and MOSPF on all DLSw routers in the group.

Sample DLSw Configuration

The following is a description of a sample DLSw configuration for server.

Sample Configuration Commands

This section provides examples of the following:

- " Configuring Protocols"
- " Implementing Protocol Filtering" on page 6-17
- " Configuring DLSw" on page 6-18
- "8210 Configuration Example" on page 6-20

Configuring Protocols

Once device configuration is complete, you must configure the necessary protocols. To run over DLSw you must configure IP, OSPF (or RIP), ASRT, and the DLSw protocol.

1. ***Configure IP***

   This example begins with the IP configuration:

   ```
   Config>protocol ip
   Internet protocol user configuration
   ```

   The **list all** command shows the default IP configuration.

```
IP config>list all
Interface addresses
IP addresses for each interface:
   intf  0   192.1.1.3        255.255.255.0    Local wire broadcast, fill 1
   intf  1                                     IP disabled on this interface
   intf  2                                     IP disabled on this interface

Routing

Protocols
BOOTP forwarding: disabled
IP Time-to-live: 64
Source Routing: enabled
Echo Reply: enabled
Directed broadcasts: enabled
ARP subnet routing: disabled
ARP network routing: disabled
Per-packet-multipath: disabled
OSPF: enabled
BGP: disabled
RIP: enabled
RIP default origination: disabled
  Per-interface address flags:
     intf  0   192.1.1.3        Send net, subnet, static and default routes
                                Received RIP packets are ignored.
     intf  1                    IP & RIP are disabled on this interface
     intf  2                    IP & RIP are disabled on this interface

Accept RIP updates always for:
[NONE]
```

This example shows the creation of a minimal IP configuration. For more information on this important protocol, see Chapter 15, “Using IP” on page 15-1.

- The first thing to do is to add an internet address and assign it to an interface over which you intend to run IP traffic:

  ```
  IP config>add address
  Which net is this address for [0]? 1
  New address [0.0.0.0]? 128.185.236.33
  Address mask [255.255.0.0]? 255.255.255.0
  ```

- Set the internal IP Address. This is the address that remote DLSw routers use to connect to the router you are configuring. If RIP is the routing protocol selected for IP, the internal IP address must match the IP address configured for an interface.

  ```
  IP config>set internal-ip-address 128.185.236.49
  ```

- Subsequent use of the **list** command displays the newly added information.

```
IP config>list all
Interface addresses
IP addresses for each interface:
   intf  0   192.1.1.3        255.255.255.0    Local wire broadcast, fill 1

   intf  1   128.185.236.33   255.255.0.0      Local wire broadcast, fill 1

   intf  2                                     IP disabled on this interface
Internal IP address: 128.185.236.49

Routing

Protocols
BOOTP forwarding: disabled
IP Time-to-live: 64
Source Routing: enabled
Echo Reply: enabled
Directed broadcasts: enabled
ARP subnet routing: disabled
ARP network routing: disabled
Per-packet-multipath: disabled
OSPF: enabled
BGP: disabled
RIP: enabled
RIP default origination: disabled
  Per-interface address flags:
     intf  0   192.1.1.3        Send net, subnet, static and default routes
                                Received RIP packets are ignored.
     intf  1   128.185.236.33   Send net, subnet, static and default routes
                                Received RIP packets are ignored.
     intf  2                    IP & RIP are disabled on this interface

Accept RIP updates always for:
[NONE]

     IP config>exit
```

2. ***Configure OSPF or RIP***

   In this configuration, OSPF is used rather than RIP. You can use either of these routing protocols. However, if you choose RIP, you will not be able to use DLSw Group function.

   First, enter a **list** command. The command displays the default OSPF configuration. You must modify this configuration to run DLSw.

```
Config>protocol ospf
Open SPF-Based Routing Protocol configuration console
OSPF Config>list all

                --Global configuration--
         OSPF Protocol:          Enabled
         # AS ext. routes:       1000
         Estimated # routers:    50
         External comparison:    Type 2
         AS boundary capability: Disabled
         Multicast forwarding:   Disabled

                --Area configuration--
Area ID       AuType     Stub?   Default-cost Import-summaries?
0.0.0.0       0=None     No      N/A          N/A
```

   - Now, enable OSPF and estimate the number of external routes and OSPF routers.

```
 OSPF Config>enable ospf
Estimated # external routes [0]? 100
Estimated # OSPF routers [0]? 25
```

   - Because this example implements DLSw Group Function, you must enable multicast OSPF, as shown:

```
 OSPF Config>enable multicast
Inter-area multicasting enabled? [No]:
```

   - Issue the **set interface** command for every physical IP interface that will use OSPF. This example assumes that the backbone is the OSPF area (0.0.0.0). At this point, only one IP interface has been defined.

```
OSPF Config>set interface 128.185.236.33
Attaches to area [0.0.0.0]?
Retransmission Interval (in seconds) [5]?
Transmission Delay (in seconds) [1]?
Router Priority [1]?
Hello Interval (in seconds) [10]?
Dead Router Interval (in seconds) [40]?
Type Of Service 0 cost [1]?
Authentication Key [ ]?
Retype Auth. Key [ ]?
Forward multicast datagrams? [Yes]:
Forward as data-link unicasts? [No]:
IGMP polling interval (in seconds) [60]?
IGMP timeout (in seconds) [180]?
OSPF Config>
```

- The following example shows the OSPF display after it has been configured. To see what has changed in the configuration, compare this display with the display of the default OSPF configuration shown earlier.

```
OSPF Config>list all

      --Global configuration--
OSPF Protocol:          Enabled
# AS ext. routes:       100
Estimated # routers:    25
External comparison:    Type 2
AS boundary capability: Disabled
Multicast forwarding:   Enabled
Inter-area multicast:   Disabled

                  --Area configuration--
Area ID      AuType       Stub? Default-cost Import-summaries?
0.0.0.0      0=None       No         N/A           N/A

                  --Interface configuration--
IP address       Area     Cost  Rtrns  TrnsDly  Pri  Hello  Dead
192.1.1.3        0.0.0.0     1      5       1     1     10    40
128.185.236.33   0.0.0.0     1      5       1     1     10    40

                          Multicast parameters
IP address    MCForward    DLUnicast    IGMPPoll    IGMPtimeout
192.1.1.3         On           Off          60           180
128.185.236.33    On           Off          60           180

OSPF Config>exit
```

3. ***Configure ASRT***

   Configure the router for source route bridging and enable the port as shown:

```
Config (only)>protocol asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config>enable bridge
```

- The **list port** command shows that the port defaults to transparent bridging. Transparent bridging is what you want if your attached device is Ethernet, but it will not work if your device is token-ring. Note that port number 1 is port 1 on interface 0. In other words, port 1 is the logical bridge port for interface 0.

```
ASRT config>list port
Port Id (dec)    : 128:01, (hex): 80-01
Port State       : Enabled
STP Participation: Enabled
Port Supports    : Transparent Bridging Only
Assoc Interface  : 0
Path Cost        : 0
++++++++++++++++++++++++++++++++++++++++++++
```

- To run over an LLC data link, DLSw requires SRB (source route bridging). In this case, the first thing to do is disable transparent bridging on the port.

```
ASRT config>disable transparent
Port Number [1]?

ASRT config>enable source-routing
```

- Now, assign a segment number for the port. You only have to assign segment numbers when configuring a source route bridge device. In this example **b0b** is the hexadecimal number assigned to the device.

```
Port Number [1]?
Segment Number for the port in hex(1 - FFF) [1]? b0b
Bridge number in hex (1 - 9, A - F) [1]?
```

  Next enable DLSw on the bridge port.

```
ASRT config>enable dls
```

After completing these steps, enable DLSw as shown. Listing the bridge configuration will confirm that you have configured ASRT correctly.

```
ASRT config>list bridge

          Source Routing Transparent Bridge Configuration
          ===============================================
Bridge:                  Enabled                 Bridge Behavior:
Unknown
                   +----------------------------+
------------------| SOURCE ROUTING INFORMATION |-----------------------------
                   +----------------------------+
Bridge Number:           01                      Segments:  1
Max ARE Hop Cnt:         14                      Max STE Hop cnt: 14
1;N SRB:          Not Active             Internal Segment: 0x000
LF-bit interpret:        Extended

                   +-------------------+
------------------| SR-TB INFORMATION |-------------------------------------
                   +-------------------+
SR-TB Conversion:        Disabled
TB-Virtual Segment:  0x000                       MTU of TB-Domain:  0

                   +-----------------------------------+
------------------| SPANNING TREE PROTOCOL INFORMATION |----------------------
                   +-----------------------------------+
Bridge Address:          Default                 Bridge Priority: 32768/0x8000
STP Participation:       IEEE802.1d

                   +-------------------------+
------------------| TRANSLATION INFORMATION |--------------------------------
                   +-------------------------+
FA<=>GA Conversion:      Enabled                    UB-Encapsulation: Disabled
DLS for the bridge:      Enabled

                   +------------------+
------------------| PORT INFORMATION |-------------------------------------
                   +------------------+
Number of ports added: 1
Port:   1      Interface:       0      Behavior:    SRB Only   STP: Enabled
```

Implementing Protocol Filtering

This is an important step that is often neglected when configuring DLSw.

Because DLSw, rather than bridging, will be used to forward traffic on SAPs (service access points) 04, 08, 0C, we must add a special protocol filter to the bridging setup.

Note: You need to implement the filter described here only if bridging, in addition to DLSw, has been configured across the WAN links. This is not the case in this example. In this example, the procedure for creating a SAP filter is provided for reference purposes only.

The filter's purpose is to prevent the bridge from forwarding, on other ports, packets that should be handled only by DLSw. It is not optimal for DLSw and the bridging function to forward the same packets. When this occurs, race conditions develop that can cause degradation of network performance.

This command creates a filter that works on all packets with a destination SAP of 4. The **list** command issued subsequently displays the filter characteristics.

```
ASRT config>add prot-filter dsap 4
Filter packets arriving on all ports?? [No]: yes

ASRT config>list prot-f dsap
Protocol Class: DSAP
Protocol Type : 04
Protocol State: FILTERED
Port Map      : 1
=========================
No ETHER type Filter Records Associated
No SNAP Filter Records Associated
```

Once the filtering you need is in place, exit the ASRT configuration.

```
ASRT config>exit
```

Configuring DLSw

The final step is configuring the DLSw protocol. The following **list** command shows the defaults.

```
Config>protocol dls
DLSw protocol user configuration

DLSw config>list dls
DLSw is                                 DISABLED
LLC2 send Disconnect is                 ENABLED
Dynamic Neighbors is                    ENABLED
SRB Segment number                      000
MAC <-> IP mapping cache size           128
Max DLSw sessions                       1000
DLSw global memory allotment            141312
LLC per-session memory allotment        8192
NetBIOS UI-frame memory allotment       40960

Dynamic Neighbor Transmit Buffer Size   5120
Dynamic Neighbor Receive Buffer Size    5120
Dynamic Neighbor Maximum Segment Size   1024
Dynamic Neighbor Keep Alive             DISABLED
Dynamic Neighbor SessionAlive Spoofing  DISABLED
Dynamic Neighbor Priority               MEDIUM

Type of local MAC list                  NON-EXCLUSIVE
Use of local MAC list is                ENABLED
Use of remote MAC list is               ENABLED
```

You enable DLSw, and set the SRB segment number. The segment number refers to the token-ring device.

```
DLSw config>enable dls
DLSw config>set srb 020
```

Configuring DLSw Groups and Static Sessions: This example defines both a group and a configured TCP session. Configuring DLSw does not require this. However, you must define one or the other (either a DLSw group or a configured TCP session) to connect-out to a neighbor DLSw router. If you want non-configured routers to connect-in, issue the **enable dynamic-neighbors** command.

The Join-Group Command: The **join-group** command is used to create a DLSw group. You designate each group member as Client/Server or Peer. Peer is the default.

Here, the **join-group** command is executed for R1 , designating this DLSw router as a Client in group 1. To join this group, R2 would have to be added as a Server, and the **join-group** command issued on R2.

```
DLSw config>join
Configure group member (G) or specific multicast address (M) -  [G]?
Group ID (1-64 Decimal) [1]?
Client/Server or Peer Group Member(C/S/P)- [P]? c
Connectivity Setup Type (a/p) [p]?
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal) [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive (E/D) [D]?
Enable/Disable NetBIOS SessionAlive Spoofing (E/D) [D]?
Neighbor Priority (H/M/L) [M]?

DLSw config>list group

   Group#                 Xmit    Rcv      Max      Keep-    SessAlive
Mcast IP Addr Role    CST Bufsize Bufsize  Segsize  alive    Spoofing  Priority
------------- ------- --- ------- -------- -------- -------- --------- --------
Group  1      CLIENT   p    5120    5120     1024   DISABLED DISABLED  MEDIUM
```

The Add TCP Command: The **add TCP** command is used to define explicitly configured DLSw neighbors. The neighbor DLSw IP Address added here is the internal IP Address of the peer DLSw router (called R2). You also can configure R2 with the neighbor IP Address of R1, or you can configure R2 to accept dynamic neighbors.

```
DLSw config>add tcp
Enter the DLSw neighbor IP Address [0.0.0.0]? 128.185.122.234
Connectivity Setup Type (a/p) [p]?
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal) [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive (E/D) [D]?
Enable/Disable  NetBIOS SessionAlive Spoofing (E/D)[D]?
Neighbor Priority (H/M/L) [M]?

DLSw config>list tcp
                    Xmit    Rcv     Max      Keep-    SesAlive
Neighbor        CST Bufsize Bufsize Segsize  Alive    Spoofing Priority
--------------- --- ------- ------- -------  -------- -------- ---------
128.185.122.234  p     5120    5120    1024   DISABLED DISABLED MEDIUM
```

Open Service Access Points (SAPs): The next thing to do is open service access points (SAPs) on each of the bridging interfaces.

SAP numbers 0, 4, 8, and C are commonly used SNA SAPs. To open all of these SAPs, use the SNA option with the **open-sap** command as shown. To open SAPs for NetBIOS, choose the NB option. If you prefer, you can also enter SAPs individually by entering a hexadecimal number.

```
DLSw config> open-sap
Interface #[1]?
Enter SAP in hex (range 0–F4), 'SNA', 'NB', or LNM [4]? sna
SAPs 0 4 8 C opened on interface 1

DLSw config>
```

The following is the DLSw display after configuring.

```
DLSw config>list dls
DLSw is                                 ENABLED
LLC2 send Disconnect is                 ENABLED
Dynamic Neighbors is                    ENABLED
SRB Segment number                      020
MAC <-> IP mapping cache size           128
Max DLSw sessions                       1000
DLSw global memory allotment            141312
LLC per-session memory allotment        8192
NetBIOS UI-frame memory allotment       40960

Dynamic Neighbor Transmit Buffer Size   5120
Dynamic Neighbor Receive Buffer Size    5120
Dynamic Neighbor Maximum Segment Size   1024
Dynamic Neighbor Keep Alive             DISABLED
Dynamic Neighbor SessionAlive Spoofing  DISABLED
Dynamic Neighbor Priority               MEDIUM

Type of local MAC list                  NON-EXCLUSIVE
Use of local MAC list is                ENABLED
Use of remote MAC list is               ENABLED
```

When you have finished configuring DLSw, exit the DLSw configuration and reload the router.

8210 Configuration Example

```
*t 6
Gateway user configuration

Config>p dls
DLSw protocol user configuration

DLSw config>en dls

DLSw config>set srb
Enter segment number in hex (1-FFF) [000]? fab

DLSw config>li dls glo
DLSw is                                 ENABLED
LLC2 send Disconnect is                 ENABLED
Dynamic Neighbors is                    ENABLED
IPv4 DLSw Precedence is                 ENABLED
SRB Segment number                      FAB
MAC <-> IP mapping cache size           128
Max DLSw sessions                       1000
DLSw global memory allotment            141312
LLC per-session memory allotment        8192
NetBIOS UI-frame memory allotment       40960

Dynamic Neighbor Transmit Buffer Size   5120
Dynamic Neighbor Receive Buffer Size    5120
Dynamic Neighbor Maximum Segment Size   1024
Dynamic Neighbor Keep Alive             DISABLED
Dynamic Neighbor SessionAlive Spoofing  DISABLED
Dynamic Neighbor Priority               MEDIUM
Type of local MAC list                  NON-EXCLUSIVE
Use of local MAC list is                ENABLED
Use of remote MAC list is               ENABLED
```

```
DLSw config>open
Interface # [0]?
Enter SAP values in hex (0-FE) or one of the following:
  'SNA', 'NB', 'LNM' [4]? sna
SAP(s)  0  4  8  C opened on interface 0
DLSw config>li open
Interface SAP(s)
    0      0  4  8  C

DLSw config>add tcp
Enter the DLSw neighbor IP Address [0.0.0.0]? 192.2.2.22
Connectivity Setup Type (a/p) [p]?
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal) [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive (E/D) [D]?
Enable/Disable NetBIOS SessionAlive Spoofing (E/D) [D]˚?
Neighbor Priority (H/M/L) [M]?

DLSw config>li tcp
                    Xmit    Rcv     Max     Keep-    SesAlive
Neighbor        CST Bufsize Bufsize Segsize Alive    Spoofing Priority
--------------- --- ------- ------- ------- -------- -------- --------
192.2.2.22       p    5120    5120    1024  DISABLED DISABLED MEDIUM

DLSw config>ex

Config>p ip
Internet protocol user configuration

IP config>set int
Internal IP address [0.0.0.0]? 192.2.2.23

IP config>add add
Which net is this address for [0]?
New address []? 192.2.2.23
Address mask [255.255.255.0]?

IP config>li add
IP addresses for each interface:
   intf     0   192.2.2.23       255.255.255.0    Local wire broadcast, fill
1
Internal IP address: 192.2.2.23

IP config>ex
```

```
Config>p asrt
Adaptive Source Routing Transparent Bridge user configuration

ASRT config>add port
Interface Number [0]?
Port Number [1]?
Use PVC? [Yes]:
VPI, Range 0..255 [0]?
VCI, Range 0..65535 [0]?

ASRT config>dis trans
Port Number [1]?

ASRT config>en source
Port Number [1]?
Segment Number for the port in hex(1 - FFF) [001]˚?
Bridge number in hex (0 - 9, A - F) [0]? 1

ASRT config>en dls

ASRT config>li br all

                Source Routing Transparent Bridge Configuration
                ===============================================

Bridge:                 Enabled                 Bridge Behavior: SRB
                    +----------------------------+
------------------  SOURCE ROUTING INFORMATION  -------------------------------
                    +----------------------------+
Bridge Number:          01                      Segments:          1
Max ARE Hop Cnt:        14                      Max STE Hop cnt:   14
1:N SRB:                Not Active              Internal Segment:  0x000
LF-bit interpret:       Extended
                    +-------------------+
------------------  SR-TB INFORMATION  ----------------------------------------

                    +-------------------+
SR-TB Conversion:       Disabled
TB-Virtual Segment:     0x000                   MTU of TB-Domain:  0
                    +-----------------------------------+
------------------  SPANNING TREE PROTOCOL INFORMATION  ----------------------

                    +-----------------------------------+
Bridge Address:         Default                 Bridge Priority:   32768/0x8000

STP Participation:      IBM-SRB proprietary
                    +-------------------------+
------------------  TRANSLATION INFORMATION  ---------------------------------

                    +-------------------------+
FA<=>GA Conversion:     Enabled                 UB-Encapsulation:  Disabled
DLS for the bridge:     Enabled
                    +------------------+
------------------  PORT INFORMATION  -----------------------------------------
                    +------------------+
Number of ports added: 1
Port:   1      Interface:       0      Behavior:    SRB Only   STP:  Enabled
 VPI:   0  VCI:     0

ASRT config>ex

Config>w
Config Save: Using bank A and config number 2
```

Chapter 7. Configuring and Monitoring DLSw

This chapter describes how to configure and monitor the Data Link Switching protocol. It includes the following sections:

- "Accessing the DLSw Configuration Environment"
- "Preconfiguration Requirements"
- "DLSw Configuration Commands"
- "Accessing the DLSw Monitoring Environment" on page 7-19
- "DLSw Monitoring Commands" on page 7-19

Accessing the DLSw Configuration Environment

Use the CONFIG process to change the configuration of the router. The new configuration takes effect when the device is reloaded.

To enter the configuration process, enter **talk 6** (or **t 6**), at the OPCON (*) prompt. This brings you to the CONFIG> prompt as shown in the following example:

```
MOS Operator Control

* talk 6
Gateway user configuration

CONFIG>
```

If the CONFIG> prompt does not appear immediately, press the **Enter** key again.

All DLSw configuration commands are entered at the DLS config> prompt. To access this prompt, enter the **protocol DLSw** command as shown:

```
Config>protocol dls
DLSw protocol user configuration
DLSw config>
```

Preconfiguration Requirements

Before you begin any configuration procedure, use the **list device** command from the **config** prompt to list the interface numbers of different devices. If you need any further configuration command explanations, see the configuration commands described in this chapter.

DLSw Configuration Commands

This section summarizes and explains the DLSw configuration commands. The DLSw configuration commands allow you to create or modify a DLSw configuration. Table 7-1 on page 7-2 provides a brief summary of each command. Enter all the DLSw configuration commands following the DLSw Config> prompt. Defaults for any command and its parameters are enclosed in brackets immediately following the prompt.

Changes made to the router's configuration do not take effect immediately, but become part of the router's SRAM configuration when it is restarted.

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Table 7-1. DLSw Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds a TCP neighbor IP address, cache entries, MAC address list entries, or circuit priority overrides.
Close-Sap	Closes a currently-opened service access point (SAP). DLSw uses SAPs for communication on interfaces that support LLC.
Delete	Removes configured TCP neighbor IP address, cache entries, MAC address list entries, or circuit priority overrides.
Disable	Disables the DLSw protocol, SDLC link station, LLC disconnect function, dynamic neighbors, a QLLC station or interface, or local and remote MAC address list use.
Disable	Disables the DLSw protocol, LLC disconnect function, dynamic neighbors, or local and remote MAC address list use.
Enable	Enables the DLSw protocol, LLC disconnect function, dynamic neighbors, or local and remote MAC address list use.
Join-Group	Allows DLSw neighbors to dynamically find each other.
Leave-Group	Removes the router from the specified DLSw group.
List	Displays information for SAPs, circuit priority, DLSw groups, DLSw global information, cache entries, or MAC address list entries. The command also provides detailed information on TCP connections.
NetBIOS	Provides access to the NetBIOS configuration prompt.
Open-SAP	Allows DLSw to transmit data over the specified SAP. DLSw uses SAPs for communication on interfaces that support LLC.
Set	Configures LLC2 parameters, number of DLSw sessions, SRB segment number, TCP buffer size, memory allocation, protocol timers, circuit priority, parameters for dynamic neighbors, and MAC address list-related parameters.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to configure a TCP neighbor IP address, cache entries, MAC address list entries and circuit priority overrides.

Syntax:

add cache-entry
mac-list
priority
tcp

cache-entry

Adds a configured MAC cache entry. This cache entry maps a specific MAC address to a specific DLSw peer. One MAC address can be mapped to multiple DLSw peers by adding multiple cache entries.

Example: `add cache-entry`

```
Enter MAC Address [400000000000]? 10005a123456
Enter the DLSw neighbor IP Address [0.0.0.0]? 128.185.122.234

MAC cache entry has been created.
```

MAC Address
: MAC address that is to be mapped to a DLSw peer.

DLSw neighbor IP Address
: IP address of the DLSw peer to which the MAC address is to be mapped.

mac-list Adds a local MAC address list entry. All added local MAC address list entries make up the local MAC address list. The local MAC address list is sent to each DLSw peer to indicate the set of MAC addresses that are reachable using this DLSw.

Example: `add mac-list`

```
Enter MAC Address Value[400000000000]? 10005a000000
Enter MAC Address Mask ffffff000000

MAC list entry has been created.

For the new entry to take effect, you must restart or commit the change using
  't 5': SET MAC LIST
```

Enter MAC Address Value and Enter MAC Address Mask
: These two fields when combined represent a set of MAC addresses reachable using this DLSw. If a frame is received at a peer DLSw, then these two fields are used in the following algorithm:

```
if ( (<frame's destination MAC address> AND <MAC Address Mask>)
     == <MAC Address Value> )
match on MAC address list found; forward frame to this DLSw
```

priority Adds a circuit priority override entry. When a DLSw session is being established, the list of circuit priority overrides is searched in the order that they are configured. If a match on the source SAP range and source MAC address range and destination SAP range and destination MAC address range is found, then the matching circuit priority override entry's session and explorer priorities are used. If no match with any circuit priority override entry is found, then the default circuit priority values are used.

Example: `add priority`

```
Enter range of source SAPs .....
  Lower source sap value [0]?
  Upper source sap value [FE]?

Enter range of source MAC addresses .....
  Lower source MAC address [000000000000]?
  Upper source MAC address [FFFFFFFFFFFF]?

Enter range of destination SAPs .....
  Lower destination sap value [0]?
  Upper destination sap value [FE]? c

Enter range of destination MAC addresses .....
  Lower destination MAC address [000000000000]? 10005a000000
  Upper destination MAC address [FFFFFFFFFFFF]? 10005affffff

Enter desired circuit priorities .....
Priority for session traffic (C/H/M/L) [M]? c
Priority for explorer traffic (C/H/M/L) [M]? m

Enter position in circuit priority override list to insert new entry .....
  Record number (0=add at end of list) [0]?
Circuit priority override record has been created.
```

Lower source sap value

Upper source sap value
These two fields when combined represent the range of source saps assigned to this circuit priority override. If the value of the source sap does not matter, then specify the full range of source sap values (lower source value = 0 and upper source value = fe).

Lower source MAC address

Upper source MAC address
These two fields when combined represent the range of source MAC addresses assigned to this circuit priority override. If the value of the source MAC address does not matter, then specify the full range of source MAC address values (lower source MAC address = 000000000000 and upper source MAC address = ffffffffffff).

Lower destination sap value

Upper destination sap value
These two fields when combined represent the range of destination saps assigned to this circuit priority override. If the value of the destination sap does not matter, then specify the full range of destination sap values (lower destination sap value = 0 and upper destination sap value = fe)

Lower destination MAC address

Upper destination MAC address
These two fields combined represent the range of destination MAC addresses assigned to this circuit priority override. If the value of the destination MAC address does not matter, then specify the full range of destination MAC address values (lower destination MAC address = 000000000000 and upper destination MAC address = ffffffffffff).

Priority for session traffic
The circuit priority to assign to all session traffic that matches this circuit priority override entry's range of source SAPs, source MAC addresses, destination SAPs, and destination MAC addresses.

Priority for explorer traffic
The circuit priority to assign to all explorer traffic that matches this circuit priority override entry's range of source SAPs, source MAC addresses, destination SAPs, and destination MAC addresses.

Position in circuit priority override list to insert new entry
Since the first matching circuit priority override match is used, the order in which the circuit priority override entries are configured is important. This field specifies where in the current circuit priority override list to insert this new entry. The **list priority** command can be used to see the current circuit priority override list. A value of zero for this field specifies to add the new entry at the end of the current list.

tcp Adds the internal address of a DLSw peer with which this DLSw can make a connection.

Example: `add tcp`

```
Enter the DLSw neighbor IP Address [0.0.0.0]? 128.185.14.1
Connectivity setup type (a/p) [p]?
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal)  [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive? (E/D) - [D]?
Enable/Disable NetBIOS SessionAlive Spoofing (E/D) [D]?
Neighbor Priority (H/M/L) [M]?
```

Enter the DLSw neighbor IP Address
: Indicates the IP address of the remote DLSw peer in the IP network to which you want to make a connection.

Connectivity setup type
: Indicates whether the TCP connection to this DLSw should be made at router startup (Active), or as needed (Passive). For an overview of these options, see "TCP Connections, Neighbor Discovery, and Multicast Exploration" on page 6-4.

Transmit Buffer Size
: The size of the packet transmit buffer from 1024 to 32768. Default is 5120.

Receive Buffer Size
: The size of the packet receive buffer from 1024 to 32768. The default size is 5120.

Maximum Segment Size
: The maximum size of the TCP segment from 64 to 16384. The default is 1024.

Enable/Disable Keepalive (E/D)
: Indicates whether you want DLSw to send TCP connection Keepalive messages. The default is D (Disable).

Enable/Disable NetBIOS SessionAlive Spoofing (E/D)
: Indicates whether you want to discard NetBIOS SessionAlive I-Frames (do not forward to the DLSw partner). The default is D (Disable) meaning do not discard frame.

Neighbor Priority
: Allows you to specify the neighbor priority as High, Medium, or Low. If a destination station is reachable through several neighbor routers with different priorities, DLSw tries to establish circuits to that station through the highest-priority neighbor.

Close-Sap

Use the **close-sap** command to disable DLSw switching for the specified service access point (SAP). These SAPs are used by LLC for configuration on the network.

Syntax:

close-sap

Example: `close-sap`

```
Interface #[1]?
Enter SAP in hex (range 0–F4), 'SNA', 'NB', or LNM [4]? sna
SAPs 0 4 8 C closed on interface 1
Closing SAP 0 disables all SNA DLSw function on interface 1
```

Interface #
: The interface number used by the open SAP.

Enter SAP

You can enter individual SAPs in hex or you can enter SNA, NB (NetBIOS), or LNM (LAN Network Manager).

If you enter SAPs in hex, the range is 0 to FE and the SAP must be an even number.

If you enter SNA, SAPs 0, 4, 8, and C are closed.

If you enter NB, SAP F0 is closed.

If you enter LNM, SAPs 0, 2, D4, F2, F4, F8, and FC are closed.

Delete

Use the **delete** command to remove a TCP neighbor IP address, cache entries, MAC address entries, and circuit priority overrides from the DLSw configuration.

Syntax:

del**ete**	cache-entry
	mac-list
	priority
	tcp

cache-entry

Removes a configured MAC cache-entry.

Example: `delete cache-entry`

```
Enter mac cache record number [1]? 1
MAC cache entry has been deleted
```

mac cache record number

The record number of the MAC cache entry to be deleted. The record number can be determined by doing a **list cache all** configuration command.

mac-list Removes a local MAC address list entry.

Example: `delete mac-list`

```
Enter mac list record number [1]? 1
Local MAC list entry 10005A000000 / FFFFFF000000 has been deleted.

For the deletion to take effect, commit the change using
  't 5': SET MAC-LIST.
```

mac list record number The record number of the MAC list entry to be deleted. The record number can be determined by doing a **list mac-list all** configuration command.

priority Removes a circuit priority override entry.

Example: `delete priority`

```
Enter circuit priority override record number [1]? 1
Circuit priority override record has been deleted.
```

Circuit priority override record number

The record number of the circuit priority override entry to be deleted. The record number can be determined by doing a **list priority** configuration command.

tcp Removes the IP address (*ip_address*) of the DLSw peer to which you can make a TCP connection.

Syntax:

del**ete** t**cp** *ip_address*

Example: `delete tcp`

```
IP Address [0.0.0.0]? 128.185.14.1
```

Disable

Use the **disable** command to disable the DLSw protocol, the LLC disconnect function, dynamic neighbors, or use of local and remote MAC address lists.

Syntax:

di**sable** dls
dynamic-neighbors
llc
mac-list

dls Prevents the bridging router from performing DLSw functions over all DLSw configured interfaces.

Example: `disable dls`

dynamic-neighbors
Prevents the router from accepting incoming DLSw TCP connections from IP addresses *other than* those of DLSw neighbors that are configured using the **add tcp** command.

Example: `disable dy`

llc Prevents the router from terminating an LLC connection actively by issuing a DISC LLC frame. Instead, it terminates LLC connections passively. This causes the LLC connection at the end-station to detect the link termination. The IBM host responds differently to active and passive disconnections.

This command does not affect switching function for LLC in DLSw. Use the **close-sap** command to stop LLC switching function.

Example: `disable llc`

mac-list Disables the use of local or remote MAC address lists.

Syntax:

m**ac-list** local
remote

Example: `disable mac-list local`

```
Use of local MAC list is  DISABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET MAC-LIST'.
```

Example: `disable mac-list remote`

```
Use of remote MAC list is  DISABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET MAC-LIST'.
```

Enable

Use the **enable** command to enable the DLSw protocol, LLC disconnect function, dynamic neighbors, or use of local and remote MAC address lists.

Syntax:

enable	dls dynamic-neighbors llc mac-list

dls — Enables DLSw operation on the router.

Example: `enable dls`

dynamic-neighbors — Sets the router to accept incoming DLSw TCP connections from IP addresses *other than* those of neighbors configured using the **add tcp** command. This is the default state.

llc — Allows the router to terminate an LLC connection upon the loss of the TCP connection.

mac-list — Disables the use of local or remote MAC address lists.

Syntax:

mac-list	local remote

Example: enable mac-list local

```
Use of local MAC list is  ENABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET MAC-LIST'.
```

Example: enable mac-list remote

```
Use of remote MAC list is  ENABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET MAC-LIST'.
```

Join-Group

Use the **join-group** command to allow DLSw neighbors to dynamically find and to create TCP sessions with each other, and to enable multicast exploring and frame forwarding. For an overview of these functions, see “TCP Connections, Neighbor Discovery, and Multicast Exploration” on page 6-4. To use this command, the IP internet that is being used must support multicast routing, and you must configure OSPF and MOSPF from the `OSPF Config>` prompt.

When you add a DLSw router to a group, you select whether you want to use the group ID model of group identification (where the router constructs the corresponding multicast addresses), or specify the multicast addresses yourself. The group ID model is simpler to configure, but you must specify the multicast addresses yourself if you wish to have multicast connectivity with non-IBM DLSw Version 2 products. A router may be a member of both styles of groups at the same time.

You may join a maximum of 64 groups using the Group ID model. When you assign a DLSw router to a group, the DLSw protocol automatically adds one of two addresses to the group number to form a multicast address. The router transmits the multicast address to identify itself to other group members and to transmit

packets to those members. The two addresses that are added to the group number are 225.0.1.0 for DLSw clients and peers, and 225.0.1.64 for DLSw servers. For example, the multicast address for a client in group 2 would be 225.0.1.2.

Syntax:

join-group

join-group

Example:

The following example is for the default [G]. The descriptions following the example contains information for both (G) and (M).

```
DLSw config>join
Configure group member (G) or specific multicast address (M) -  [G]?
Group ID (1-64 Decimal) [1]? 2
Client/Server or Peer Group Member(C/S/P)- [P]? c
Connectivity Setup Type (A/P/) [P]?
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal) [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive (E/D) [D]?
Enable/Disable NetBIOS SessionAlive Spoofing (E/D) [D]?
Neighbor Priority (H/M/L) [M]?
```

Group member or specific multicast address
Selects whether you want the router to construct multicast addresses for you, or whether you want to supply the multicast addresses.

Multicast IP address
The multicast IP address is a DLSw Version 2 compliant multicast IP address in the range of 224.0.10.0 to 224.0.10.191 that is used to send and/or receive DLSw explorer traffic.

Read Only , Write Only or Read Write
This parameter indicates whether the configured multicast IP address should be used to only receive explorer traffic (Read Only), only send explorer traffic (Send Only), or to both send and receive explorer traffic (Read Write).

Group ID The number of the group that you want this router to join.

Client/Server or Peer Group Member
The role this router should assume within the group: C for client, S for server, or P for peer.

Connectivity setup type
Indicates whether the router should join the group as an Active or Passive member. This controls when TCP connections are established with other group members, as described in “TCP Connections, Neighbor Discovery, and Multicast Exploration” on page 6-4.

Transmit Buffer Size
The size of the packet transmit buffer from 1024 to 32768. Default is 5120.

Receive Buffer Size
The size of the packet receive buffer from 1024 to 32768. The default size is 5120.

Maximum Segment Size
The maximum size of the TCP segment from 64 to 16384. The default is 1024.

Enable/Disable Keepalive
Indicates whether you want DLSw to send TCP Keepalive messages on connections brought up within this group. Default is D (Disable).

Enable/Disable NetBIOS SessionAlive Spoofing (E/D)
Indicates whether you want to discard NetBIOS SessionAlive I-Frames (do not forward to the DLSw partners associated with this group). The default is D (Disable) meaning do not discard frames.

Neighbor Priority (H/M/L) [M]?
Allows you to specify the neighbor priority as High, Medium, or Low. If a destination end-station is reachable through several neighbor routers with different priorities, DLSw tries to establish circuits to that end-station through the highest-priority neighbor.

Leave-Group

Use the **leave-group** command to remove the router from a group that was configured using the **join-group** command, or to stop using a configured multicast address.

Leave-group does not affect existing TCP connections belonging to the specified group.

Syntax:

l**eave-group**

Example: leave-group

```
Configure group member (G) or specific multicast address (M) -  [G]?
Group ID (1-64 Decimal) [1]? 2
```

List

Use the **list** command to display DLSw information on circuit priority, SAPs, TCP neighbors, groups, dynamic neighbors, and cache entries.

Syntax:

list	cache
	dls
	groups
	llc2
	mac-list
	open
	priority
	tcp
	timers

cache Lists configured MAC address cache entries.

Syntax:

cache	all
	entry-number

cache all

Example: `cache all`

```
Entry  Mac Address   IP Address
-----  ------------  ---------------
    1  10005A123456  128.185.236.49
    2  10005A789ABC  128.185.236.49
```

cache entry-number

Example: `cache entry-number`

```
Enter mac cache record number [1]?

Entry  Mac Address   IP Address
-----  ------------  ---------------
    1  10005A123456  128.185.236.49
```

dls Displays the information that was configured with the **enable** and **set** commands.

Example: `list dls`

(Output from the **list dls** command is the same as the output from the **list dls global** command.)

groups Displays group information for this DLSw peer that was configured with the **groups config** command. See “List” on page 7-22 for more information.)

llc2 Displays the LLC2 parameters that were configured with the **set llc2** command. (For a complete explanation of these parameters see the **set llc2** command 7-15.) These parameters are set per interface. If no changes to the LLC2 parameters were made using the **set llc2** command, no output will be generated.

Example: `list llc2`

```
SAP     t1   t2   ti   n2   n3   tw   rw   nw   acc
 0       1    1   30    8    1    2    2    1    0
```

SAP SAP number.

t1 Reply timer.

t2 Receive Ack timer.

ti Inactivity timer.

n2 Maximum retry value.

n3 Number of I-frames received before sending ACK.

tw Transmit window.

rw Receive window.

nw ACKs needed to increment Ww.

acc The current LLC2 implementation does not use access priority. As a result, this parameter always defaults to 0.

mac-list Lists configured MAC address list entries.

Syntax:

m**ac**	a**ll**
	e**ntry-number**

mac-list all

Example: `list mac-list all`

```
Entry  Mac Value     Mac Mask
-----  ------------  ------------
    1  10005A000000  FFFFFF000000
    2  400031740000  FFFFFFFF0000
```

mac-list entry-number

Example: `list mac-list entry-number`

```
Enter mac list record number [1]?

Entry  Mac Value     Mac Mask
-----  ------------  ------------
    1  10005A000000  FFFFFF000000
```

open Displays all open SAPs and their associated interfaces.

Example: `list open`

```
Interface    SAP
0             0
0             4
1             8
```

priority Lists the circuit priorities selected for SNA and NetBIOS circuits, the transmit ratios between the various circuit priorities, and the largest frame size configured for NetBIOS.

```
DLSw config> list priority
Default priority for SNA DLSw session traffic is           MEDIUM
Default priority for NetBIOS DLSw session traffic is       MEDIUM
Default priority for SNA DLSw explorer traffic is          MEDIUM
Default priority for NetBIOS DLSw explorer traffic is      MEDIUM


Message allocation by C/H/M/L priority is   4/3/2/1
Maximum frame size for NetBIOS is           2052


    Source/  SAP      MAC Address                  Session   Explorer
ID  Dest     Range    Range                        Priority  Priority
--  -------  -------  ---------------------------  --------  --------
 1  Source:  00 - FE  000000000000 - FFFFFFFFFFFF  CRITICAL  MEDIUM
    Dest  :  00 - 0C  10005A000000 - 10005AFFFFFF
 2  Source:  04 - 04  400031740000 - 40003174FFFF  CRITICAL  MEDIUM
    Dest  :  00 - FE  000000000000 - FFFFFFFFFFFF
```

Circuit priorities are Critical, High, Medium, or Low. The router uses the priority value you assign to selectively limit the burst-length of specific types of traffic. For example, if you assign SNA traffic a priority of Critical and NetBIOS session traffic a priority of Medium, with a message allocation of 4/3/2/1, the router processes 4 SNA session frames before it processes 2 NetBIOS frames, and so on. In this example, two-thirds of available bandwidth is dedicated to SNA traffic. When the router allocates bandwidth using priorities you specify, *it counts frames rather than bytes*.

tcp Displays configured DLSw TCP neighbors. The neighbors were configured with the **add tcp** command.

Example: `list tcp`

```
                    Xmit    Rcv     Max     Keep-    SesAlive
Neighbor        CST Bufsize Bufsize Segsize Alive    Spoofing Priority
--------------- --- ------- ------- ------- -------- -------- --------
128.185.122.234  p    5120    5120    1024  DISABLED DISABLED MEDIUM
128.185.14.1     p    5120    5120    1024  DISABLED DISABLED MEDIUM
```

Neighbor The IP address of the TCP neighbor

CST Connectivity setup type, either Active or Passive.

Xmit Bufsize
The size of the packet transmit buffer from 1024 to 32768. The default is 5120.

Rcv Bufsize
The size of the packet-receive buffer from 1024 to 32768. The default is 5120.

Max Segsize
The maximum size of the TCP segment from 64 to 16384. The default is 1024.

Keepalive
The status of the Keepalive function, enabled or disabled.

SesAlive Spoofing
The status of the NetBIOS SesAlive spoofing function, enabled or disabled.

Priority The priority of the neighbor router in the selection process. Neighbor priority is High, Medium, or Low.

timers The user-specified time to wait for various activities.

Example: `list timers`

```
Database age timer                1200  seconds
Max wait timer for ICANREACH      20    seconds
Wait timer for LLC test response  15    seconds
Join Group Interval               900   seconds
Neighbor priority wait timer      2.0   seconds
Neighbor Inactivity Timer           5   minutes
```

For additional information, refer to the **list timers** command.

NetBIOS

Displays the NetBIOS configuration prompt.

For a description of NetBIOS commands, see “NetBIOS Commands” on page 9-3.

Syntax:

n**etbios**

Open-Sap

Issue the **open-sap** command for all SAPs you wish DLSw to use, either as the originator or as the target of DLSw circuits. The commonly-used SNA SAP values are 00, 04, 08, and 0C; all these SAPs can be opened together using the mnemonic “SNA.” The NetBIOS SAP is F0 and can be referred to as “NB.” SAPs related to the LAN Network Manager function are referred to collectively as “LNM.” Open the SAPs for the protocols you select, on the interfaces through which DLSw will be reaching SNA or NetBIOS end stations, LNM, or the bridges that LNM is managing.

Syntax:

o**pen-sap**

Example: `open-sap`

```
Interface #[1]?
Enter SAP in hex (range 0–F4), 'SNA', 'NB', or LNM [4]? sna
SAPs 0 4 8 C opened on interface 1
```

Interface #

The number of the interface over which you want to open the SAP.

Enter SAP in hex

You can enter individual SAPs in hex or you can enter SNA, NB (for NetBIOS), or LNM (for LAN Network Manager).

If you enter SAPs in hex, the range is 0 to FE and the SAP must be an even number. If you enter SAP 4, 8, or C without having previously opened SAP 0 on the same interface, SAP 0 will be opened automatically for you.

If you enter SNA, SAPs 0, 4, 8, and C are opened.

If you enter NB, SAP F0 is opened.

If you enter LNM, SAPs 0, 2, D4, F2, F4, F8, and FC are opened.

Set

Use the **set** command to configure the size of the MAC address-to-IP address mapping cache, the LLC2 parameters, the maximum number of DLSw sessions, the SRB segment number, protocol timers, TCP receive buffer size, TCP dynamic neighbors, MAC address list related parameters and circuit priority overrides.

Syntax:

set	cache
	dynamic-tcp
	llc2
	mac-list
	maximum
	memory
	priority
	srb
	timers

cache The **set cache** command allows you to specify the size of the MAC address-to-IP address mapping cache.

DLSw uses information stored in this cache to discover routes to remote stations. The larger the cache, the better the chances of DLSw finding a desired remote station without sending out CANUREACH frames to all known TCP/IP neighbors.

Nonetheless, you should avoid setting this cache size too large. Doing so will use up memory on the router and cut into the memory needed for actual DLSw sessions. The effect will be a reduction in the number of DLSw sessions that can be handled by the router.

Example: `set cache`

```
MAC  IP cache size (4 - 65535) [128]?
```

dynamic-tcp

Allows you to specify various TCP parameters for dynamic neighbor TCP connections (that is, those that connect-in from neighbors not defined by the **add tcp** command). DLSw uses these values only if dynamic neighbors are enabled.

Example: `set dyn`

```
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal) [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive (E/D) [D]?
Enable/Disable NetBIOS SessionAlive Spoofing (E/D) [D]?
Neighbor Priority (H/M/L) [M]?
```

For a description of the parameters listed here, see the **add tcp** command on page 7-4.

llc2 Allows you to configure specific LLC2 attributes for a specific SAP.

Example: `set llc2`

```
Enter SAP in hex (range 0-F0)  [0]?  04
Reply timer (T1) in sec. [1]?
Receive Ack timer (T2) in 100 millisec. [1]?
Inactivity Timer (Ti) in sec. [30]?
Transmit Window (Tw), 1-127, 0=default [2]?
Receive Window (Rw), 127 Max [2]?
Acks needed to increment Ww (Nw) [1]?
Max Retry value (N2) [8]?
Number I-frames received before sending ACK (N3) [1]?
```

Enter SAP in hex

The SAP number that you want to tune. Values in the range 0 - FE.

Reply timer (T1)

This timer expires when the LLC2 peer fails to receive a required acknowledgment or response from the other LLC2 peer.

Receive Ack timer (T2)

The delay it takes to send an acknowledgment for a received I-format frame in milliseconds.

Inactivity Timer (Ti)

This timer expires when the LLC does not receive a frame for a specified time. When this timer expires, the LLC2 peer transmits an RR until the LLC2 peer responds or the N2 retry count is exceeded. Default is 30 seconds.

Transmit Window (Tw)

The maximum number of I-frames that can be sent before receiving an RR. Values in the range 1–127. 0 sets Tw to the default. Default is 2.

Receive Window (Rw)

The maximum number of unacknowledged sequentially numbered I-frames that an LLC2 peer can receive from a remote host.

Acks needed to increment Ww (Nw)

This affects the way the dynamic windowing algorithm works. Specifies the number of Acknowledgments after an error condition. Default is 1. The working window (Ww) is a dynamically changing shadow of the transmit window (Tw). After an LLC error is detected, the working window (Ww) is reset to 1. The 'Acks needed to increment Ww' value specifies the number of acks that the station must receive before incrementing Ww by 1. The Ww will continue to be incremented in this fashion until Ww = Tw.

Max Retry value (N2)

The maximum number of times the LLC2 peer transmits an RR without receiving an acknowledgment when the inactivity timer (Ti) expires.

Number I-frames received before sending ACK (N3)

The value is used with the T2 timer to reduce acknowledgment traffic for received I-frames. This counter is set to a specified value and decrements each time an I-frame is received. When this counter reaches 0 or the T2 timer expires, an acknowledgment is sent.

To ensure good performance, set N3 to a value less than the remote LLC's Tw. Default is 1.

mac-list Modifies the local MAC address list exclusivity.

Example: `set mac-list`

```
Local MAC list exclusivity (E=exclusive, N=non-exclusive) [N]? e

MAC list parameter set.

For the change to take effect, restart or commit the change using
  't 5' : 'SET MAC-LIST'.
```

Local MAC list exclusivity

Indicates whether the local MAC list is exclusive (represents all MAC addresses to be accessible via this DLSw) or non-exclusive (represents a set of MAC addresses to be accessible via this DLSw).

maximum

Sets the maximum number of DLSw sessions that the DLSw protocol can support. This includes both SNA and NetBIOS sessions (circuits).

Example: `set maximum`

```
Maximum number of DLSw sessions (1-60000) [1000]?
```

memory Allows you to specify the total amount of memory available to DLSw, and the amount of memory available to each DLSw session and for NetBIOS UI-frames. The router uses the per-session and UI-frame values to set limits at which flow control algorithms will begin/stop applying backward pressure to data sources, and begin/stop discarding UI-frame traffic.

The router does not currently use the overall DLSw allocation value, so this can be left at its default. Any DLS.161 messages that refer to the global transmit and receive pools (not the NetBIOS UI-frame pool) can be ignored. Instead of using these logical pools, DLSw pacing algorithms use the status of physical memory to determine the window sizes to advertise.

The LLC session allocation values provide per-circuit (end-station pair) limits on the buffering of data flowing from LLC-attached devices to TCP. When the router reaches these limits, it sends RNRs/RRs to the appropriate end stations. The state of the per-session pools is visible from the DLSw monitoring command **list dlsw memory** as part of the list of active sessions.

Example: `set memory`

```
Number of bytes to allocate for DLSw (at least 2638)[140800]?
Number of bytes to allocate per LLC session [8192]?
Number of bytes to allocate for NetBIOS UI-frames [40960]?
```

The NetBIOS UI-frame allocation controls how many UI-frames (includes NetBIOS DATAGRAM, NAME_QUERY, ADD_NAME_QUERY, and so on) DLSw can buffer at any one time. When at this limit, DLSw discards received NetBIOS UI-frames and they must be retransmitted by the originating end-station. Setting this limit too low can therefore cause intermittent failure of NetBIOS circuit establishment attempts. The router reports a frame discard condition using ELS message DLS.161 (referring to the global NetBIOS UI-frame pool).

priority

Lets you specify the circuit priorities to use for SNA circuits and NetBIOS circuits as well as letting you specify a traffic ratio *between* these priorities. You can use the **set priority** command to specify circuit priority as Critical, High, Medium, or Low (in descending order from Critical to Low). The router uses the priority values you assign to selectively limit the burst-length of specific types of traffic it is transmitting to its neighbors.

This function operates only during periods of congestion, when DLSw messages queue up before being sent to TCP. For example, you might assign SNA traffic a session and explorer priority of Critical, which corresponds by default to a message allocation value of 4. If you then assign NetBIOS session and explorer traffic a priority of Medium, which corresponds to a message allocation of 2, the router transmits 4 SNA frames before it transmits 2 NetBIOS frames. When the router processes 2 NetBIOS frames, it processes 4 SNA frames again, and so on. When allocating bandwidth using your assigned priorities, the router counts frames rather than bytes. Also, a particular circuit's priority is negotiated with the neighbor router at circuit bring-up time; consequently, the neighbor router may establish a new circuit's priority using some policy other than one based on configuration values you specified for this router. You might also want to assign different priorities to your SNA and NetBIOS session and explorer traffic.

You also can use the **set priority** command to set a maximum frame size for all NetBIOS circuits going through this router. NetBIOS end-stations have a tendency to generate the largest frames allowed, resulting in a single frame on a low-speed link occupying that link for several seconds, thus adversely affecting interactive SNA traffic. To reduce this effect, you can set a smaller maximum frame size value which the router signals to NetBIOS end stations using standard source-route bridging mechanisms. If you have transparently bridged (TB) segments in your network that are running NetBIOS, set the maximum NetBIOS frame size to at least 1470.

Example: `set priority`

```
Default priority for SNA DLSw session traffic (C/H/M/L) [M]?
Default priority for NetBIOS DLSw session traffic (C/H/M/L) [M]?
Default priority for SNA DLSw explorer traffic (C/H/M/L) [M]?
Default priority for NetBIOS DLSw explorer traffic (C/H/M/L) [M]?
Message allocation by C/H/M/L priority (4 digits) [4/3/2/1]?
Maximum NetBIOS frame size (516, 1470, 2052, or 4399) [2052]? 516
```

srb Sets the Source Routing Bridge (SRB) segment number that identifies DLSw on token-ring networks. Specify the segment number as a three-digit hexadecimal value.

Example: `set srb`

```
Enter segment number hex (1-FFF) [5]?
```

timers Sets the DLSw protocol timers.

Example: `set timers`

```
DLSw config>set timers
Database age timeout (0-10000 secs. Decimal) [1200]? 480
Max wait timer ICANREACH (1-1000 secs. Decimal) 20?
Wait timer LLC test response (1-1000 secs. Decimal) [15]?
Group join timer interval (1-60000 secs. Decimal) [900]? 180
Neighbor priority wait timer (1.0-5.0 secs. Decimal) [2.0]?
Neighbor Inactivity Termination Timer (0-255 minutes) [5]?
```

Database age timeout

Specifies how long to hold unused DLSw entries. Database entries map destination MAC addresses into the set of DLSw peers that can reach them.

A value of zero indicates that entries in this database should not be aged. This may be useful when running neighbor TCP connections over dial interfaces, but is not generally recommended because it disables a number of other DLSw functions.

Max wait timer

Specifies how long to wait for an ICANREACH response for a previously transmitted CANUREACH.

Wait timer LLC test response

Specifies how long to wait for an LLC test response before giving up.

Group join timer interval

The amount of time the router waits before broadcasting clusters of group advertisement messages. This can affect how long it takes for group-based DLSw functions to recover from intermediate router failure, and can affect the amount of overhead required for the multicast function to operate. This value is not used if you configure TCP connections rather than use the IP multicast features of DLSw.

Neighbor priority wait timer

Amount of time to wait during exploration before selecting a neighbor. This allows a higher priority neighbor to be selected even if it is not the first to respond with an ICANREACH message.

Inactive neighbor termination timer

The time DLSw waits before taking down an inactive (zero sessions) passive TCP connection.

DLSw Monitoring Commands

This section describes the DLSw monitoring commands. These commands take effect immediately but do not become part of router's SRAM configuration. Thus, while monitoring commands allow you to make real-time changes to the router's configuration, these changes are overridden by the SRAM configuration when the router is restarted. Monitoring consists of these actions:

- Monitoring the protocols and network interfaces currently in use by the router.
- Displaying ELS (Event Logging System) messages relating to router activities and performance.
- Making real-time changes to the DLSw configuration without permanently affecting the SRAM configuration.

Accessing the DLSw Monitoring Environment

To enter the DLSw monitoring environment (GWCON process), enter **talk 5** (or **t 5**) at the OPCON (*) prompt and **protocol dls** at the GWCON (+) prompt as shown in the following example:

```
MOS Operator Control

* talk 5
+ protocol dls
DLS>
```

DLSw Monitoring Commands

This section describes the DLSw Monitoring commands listed in Table 7-2. Use these commands to gather information from the database.

Table 7-2 (Page 1 of 2). DLSw Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Add	Dynamically adds a TCP neighbor IP address, cache entries, MAC address list entries, or circuit priority overrides to the current configuration.
Close-Sap	Dynamically closes a currently opened LLC SAP. LLC interfaces use SAPs for communication on the network.
Delete	Dynamically removes a DLSw session, a TCP neighbor IP address, cache entries, mac address list entries, and circuit priority overrides.
Disable	Dynamically disables the LLC switching function, dynamic neighbors, or use of local and remote mac address lists.
Enable	Dynamically enables the LLC switching function, an SDLC link station, dynamic neighbors, a QLLC station or interface, or use of local and remote mac address lists.
Enable	Dynamically enables the LLC switching function, dynamic neighbors, or use of local and remote mac address lists.
Join-Group	Dynamically adds the router to a DLSw group that is different from the SRAM configuration.
Leave-Group	Dynamically removes the router from the specified DLSw group.

Table 7-2 (Page 2 of 2). DLSw Monitoring Commands Summary

Command	Function
List	Displays information for SAPs, circuit priority, DLSw groups, DLSw sessions, cache entries, and mac address list entries. The command also provides detailed information on TCP capabilities, connections, and statistics.
NetBIOS	Provides access to the NetBIOS Support prompt.
Open-SAP	Dynamically opens an LLC SAP.
Set	Dynamically changes the LLC2 parameters, the maximum DLSw sessions, memory allocation, protocol timers, circuit priority, parameters for dynamic neighbors, parameters for QLLC operation, or mac address list related parameters.
Set	Dynamically changes the LLC2 parameters, the maximum DLSw sessions, memory allocation, protocol timers, circuit priority, parameters for dynamic neighbors, or mac address list related parameters.
Test	Test particular MAC addresses against the current MAC address cache and MAC address lists.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to dynamically configure a TCP neighbor IP address, cache entries, mac address list entries, and circuit priority overrides without affecting the SRAM configuration.

Syntax:

add cache-entry
mac-list
priority
tcp

For examples and field descriptions, see the **add** command in the configuration chapter at “Add” on page 7-2.

Close-SAP

Use the **close-sap** command to dynamically disable DLSw's use of the specified SAP without affecting the DLSw SRAM configuration.

Syntax:

close-sap

Example: `close-sap`

```
Interface #[1]?
Enter SAP in hex (range 0-F4), 'SNA', 'NB', or LNM [0]? 04
SAP 4 closed on interface 1
```

(An explanation of the **close-sap** parameters can be found on page 7-5.)

Delete

Use the **delete** command to dynamically remove a DLSw session, a TCP neighbor IP address, cache entries, mac address list entries, or circuit priority overrides without affecting the DLSw SRAM configuration. Use of this command also terminates any existing session.

Syntax:

delete cache-entry
dls
mac-list
priority
tcp

cache-entry

Deletes the specified cache entry

Example: `delete cache-entry`

```
Enter MAC Address [400000000000]? 10005a123456
MAC 10005A123456 / IP address 128.185.122.234 configured cache entry deleted.
```

dls Removes a currently active DLSw session.

Example: `delete dls`

```
Session identifier [1]?
```

mac-list Deletes the specified mac address list entry.

Example: `delete mac-list`

```
Enter mac list record number [1]?

Local MAC list entry 10005A000000 / FFFFFF000000 has been deleted.
```

priority Deletes the specified circuit priority override entry.

Example: `delete priority`

```
Enter circuit priority override record number [1]?
Circuit priority override record has been deleted.
```

tcp Removes the IP address (*ip_address*) of the DLSw peer to which the TCP connection is made. The TCP connection is closed.

Example: `delete tcp`

```
IP Address [0.0.0.0]? 128.185.14.1
```

Disable

Use the **disable** command to dynamically disable the LLC disconnect function, the DLSw protocol, dynamic neighbors, or use of local and remote mac address lists without affecting the DLSw SRAM configuration. Disabling the ***entire*** DLSw function from monitoring is not supported.

Syntax:

disable dynamic-neighbors
llc
mac-list

(Examples using parameters of the **disable** command can be found beginning on page 7-7.)

Enable

Use the **enable** command to dynamically enable the LLC disconnect function, dynamic neighbors, or use of local and remote address lists without affecting the DLSw SRAM configuration.

Syntax:

en**able**	dynamic-neighbors
	llc
	mac-list

(Examples using parameters of the **enable** command can be found beginning on page 7-8.)

Join-Group

Use the **join-group** command to cause DLSw to start performing neighbor discovery, multicast exploration, and multicast frame forwarding functions.

For additional information and an example, see Chapter 6, “Using DLSw” on page 6-1.

Syntax:

jo**in-group**

Leave-Group

Use the **leave-group** command to cause DLSw to stop performing neighbor discovery, multicast exploration, and multicast frame forwarding functions in the specified group or using the specified multicast address. This change is made without affecting the DLSw SRAM configuration. **Leave-group** terminates existing TCP connections brought up under the specified group or multicast address. For additional information and an example, see Chapter 6, “Using DLSw” on page 6-1.**Syntax:**

le**ave-group**

Example:

```
Configure group member (G) or specific multicast address (M) -  [G]?
Group ID (1-64 Decimal) [1]? 2
```

List

Use the **list** command to display DLSw information on circuit priority, SAPs, TCP neighbors, groups, dynamic neighbors, configured cache entries, and mac address list entries.

Syntax:

l**ist**	dls...
	groups...
	llc2...
	mac-list
	priority...
	tcp...
	timers

dls Displays information that pertains to the DLSw protocol. The options (global, memory, sessions, and cache) for the DLSw parameters are described below and on the following pages.

Global Displays the operational values of configured general DLSw parameters.

Memory Displays configured DLS memory information and current memory usage.

Sessions Displays current DLS session information including source, destination, state, flags, destination IP address, and a session ID.

cache Lists the addresses in the DLSw MAC address cache.

dls global

Displays DLS global parameter information.

Example: `list dls global`

```
DLSw is                                ENABLED
LLC2 send Disconnect is                ENABLED
Dynamic Neighbors is                   ENABLED
SRB Segment number                     020
MAC <-> IP mapping cache size          128
Max DLSw sessions                      1000
DLSw global memory allotment           141312
LLC per-session memory allotment       8192
NetBIOS UI-frame memory allotment      40960
Dynamic Neighbor Transmit Buffer Size  5120
Dynamic Neighbor Receive Buffer Size   5120
Dynamic Neighbor Maximum Segment Size  1024
Dynamic Neighbor Keep Alive            DISABLED
Dynamic Neighbor SessionAlive Spoofing DISABLED
Dynamic Neighbor Priority              MEDIUM
Type of local MAC list                 NON-EXCLUSIVE
Use of local MAC list is               ENABLED
Use of remote MAC list is              ENABLED
```

DLSw is Status of the DLSw protocol, enabled or disabled.

LLC2 send disconnect is
Status of preventing the router from terminating an LLC2 connection upon the loss of the TCP connection. Values are enabled or disabled.

Dynamic Neighbors
Indicates whether DLSw is accepting incoming TCP connection attempts from DLSw routers that are not configured (that is, using the **add tcp** command).

SRB Segment number
The SRB segment that identifies DLSw in the RIF.

MAC<->IP mapping cache size
Specifies the size of the MAC-IP mapping cache.

Max DLSw Sessions
The maximum number of DLSw sessions that the DLSw protocol can support (both SNA and NetBIOS sessions).

DLSw global memory allotment
The maximum amount of memory allowed for use by DLSw.

LLC per-session memory allotment
The maximum amount of memory allowed for use by LLC DLSw session.

NetBIOS UI-frame memory allotment
The maximum amount of memory allowed for all NetBIOS UI-frames being forwarded by DLSw.

Dynamic Neighbor Transmit Buffer Size
The size of the TCP transmit buffer for dynamic TCP connections.

Dynamic Neighbor Receive Buffer Size
The size of the TCP receive buffer for dynamic TCP connections.

Dynamic Neighbor Maximum Segment Size
The maximum TCP segment size for dynamic TCP connections.

Dynamic Neighbor Keep Alive
Whether TCP Keep alive messages are to be sent on new dynamic TCP connections.

Dynamic Neighbor NetBIOS SessionAlive Spoofing
Whether NetBIOS SessionAlive I-frames are forwarded to DLSw peers established on new dynamic TCP connections.

Dynamic Neighbor Priority
The neighbor priority to be used for all new dynamic TCP connections.

dls sessions all
Displays current dls session information.

Example: `list dls session all`

```
      Source           Destination        State       Flags  Dest. IP Addr   Id
  1. 400000000003 04  500000000003 04   Connected           128.185.236.51   2
```

Source The source MAC address and SAP of the session. For sessions with an APPN source, the MAC address is replaced by the following character strings so that these sessions can be identified easily:

```
DLC Type        Characters      Content
  APPN            1-4           "APPN"
                  5-12          "        "
```

Destination
The destination MAC address of the session.

State The state of the session. The following states can be displayed:

DISCONECT
Indicates the initial state with no circuit or connection established.

RSLV_PEND
Indicates that the target DLSw either is awaiting an SSP_STARTED indication or follows an SSP_START request.

CIRC_PEND
Indicates that the target DLSw is awaiting a SSP_REACHACK response to an SSP_ICANREACH message.

CIRC_EST
Indicates that the end-to-end circuit has been established.

CIR_RSTRT
Indicates that the DLSw that originated the reset is awaiting the restart of the data link and a SSP_RESTARTED response to an SSP_RESTART message.

CONN_PEND
Indicates that the origin DLSw is awaiting an SSP_CONTACTED response to an SSP_CONTACT message.

CONT_PEND
Indicates that the target DLSw is awaiting an SSP_CONTACTED confirmation to an SSP_CONTACT message.

CONNECTED
Indicates that the circuit is fully active for connection-oriented data transfer.

DISC_PEND
Indicates that the DLSw that originated the disconnect is awaiting an SSP_HALTED response to an SSP_HALT message.

HALT_PEND
Indicates that the remote DLSw is awaiting an SSP_HALTED indication following an SSP_HALT request.

REST_PEND
Indicates that the local DLSw has received a RESTART_DL but not yet returned a DL_RESTARTED.

CIRC_STRT
Indicates that the local DLSw has sent a CANUREACH_cs but not yet received an ICANREACH_cs.

HLT_NOACK
Indicates that the local DLSw has received a HALT_DL_NOACK but has not completed closing the link station.

Flags Flags can be one of the following:

A - CONTACT MSG PENDING

B - SAP RESOLVE PENDING

C - EXIT BUSY EXPECTED

D - TCP BUSY

E - DELETE PENDING

F - CIRCUIT INACTIVE

Dest. IP Addr
The IP address of the remote DLSw peer.

Id The number used to identify the session. Use this number in any command that requires the session ID.

dls sessions appn

Displays dls session information on sessions that have APPN in this router as an end-point.

Example: `list dls sess appn`

```
       Source        Destination      State     Flags    Dest IP Addr    Id
   --------------  --------------  ---------  -------  --------------  ----
  1 APPN         04  400000000011 04  CONNECTED           187.7.239.11       0
  2 APPN         04  400000000014 04  CONNECTED           142.7.245.14       1
```

dls sessions dest

Displays dls session information by destination MAC address.

Example: `list dls session dest`

```
Destination MAC Address [40000000001]? 50000000003

Source              Destination       State       Flags  Dest. IP Addr  Id
1. 400000000003 04  500000000003 04   Connected           128.185.236.51  2
2. 400000000002 04  500000000003 04   Connected           128.185.236.52  3
```

dls sessions detail

Displays detailed dls session information.

Example: `list dls session detail`

```
                     Session Identifier [1]?

Source           Destination         State       Dest. IP Addr    Id
1. 400000000003 04  500000000003 04     Connected   128.185.236.512  2

                     Personality:      TARGET
                     XIDs sent:        2
                     XIDs rcvd:        0
                     Datagrams sent:   0
                     Datagrams rcvd:   0
                     Info frames sent: 15
                     Info frames rcvd: 0
                     RIF:              0620 0202 B0B 0
                     Local CID:        0136AF74:7E000021
                     Remote CID:       014AB030:7E000003
                     Priority:         MEDIUM
```

Personality
The ORIGINATOR (initiator) or TARGET (recipient) of the connection.

XIDs sent XIDs rcvd
The total number of XIDs that this DLSw peer has sent and received from the remote DLSw peer.

Datagrams sent Datagrams rcvd
The total number of datagrams that this DLSw peer has sent and received from the remote DLSw peer.

Info frames sent Info frames rcvd
The total number of I-frames that this DLSw peer has sent and received from the DLSw peer.

RIF The information that is included in the RIF of the LLC test frame.

Local CID
The DLSw circuit ID assigned by this router.

Remote CID
The DLSw circuit ID assigned by the neighbor router.

Priority The DLSw circuit priority established for this circuit when it was initiated.

dls sessions ip

Displays dls sessions to a specified TCP-connected neighbor.

Example: `list dls session ip`

```
Enter the DLS neighbor IP address [0.0.0.0]? 128.185.236.512

     Source        Destination      State      Dest. IP Addr     Id
1. 400000000003 04  500000000003 04  Connected  128.185.236.512   2
```

dls sessions nb

Lists information about the current active circuits that support NetBIOS.

Example: `list dls sessions nb`

```
      Source        Destination      State      Dest. IP Addr     Id
1. 400000000003 F0  500000000003 F0  Connected  128.185.236.512   2
```

dls sessions range

The range of dls sessions that you want to display. This number is located to the left of the source MAC address.

Example: `list dls session range`

```
         Start [1]?
         Stop  [1]?

   Source           Destination      State       Dest.  IP Addr    Id
1. 400000000003 04  500000000003 04  Connected   128.185.236.512   2
```

dls sessions src

Displays all dls session information by source MAC Address.

Example: `list dls session src`

```
        Source MAC Address [400000000001]?

   Source        Destination      State       Flags Dest. IP Addr  Id
1.10005A789ABC   400000000002 04    Connected      10.1.49.401        1
2.10005A789ABC   400000000003 04    Connected      128.185.236.512 1
```

dls sessions state

Displays all dls sessions in a specified state.

Example: `list dls session state`

```
        DISCONECT = 0,  RSLV_PEND = 1
        CIRC_PEND = 2,  CIRC_EST  = 3
        CIR_RSTRT = 4,  CONN_PEND = 5
        CONT_PEND = 6,  CONNECTED = 7
        DISC_PEND = 8,  HALT_PEND = 9
        REST_PEND = 10  WT_HALTNA = 11
        CIRC_STRT = 12  HLT_NOACK = 13

        Enter state value (0-10) [7]?

    Source            Destination      State       Flags  Dest. IP Addr Id
1. 400000000003 04  10005AF181A4 04  Connected          128.185.236.84  0
2. 400000000002 04  400000000088 04  Connected          128.185.236.84  1
```

list dls cache all

The **list dls cache all** command lists the entries in the DLSw MAC address cache. This cache contains a database of the most recent MAC address-to-IP neighbor translations. It provides the MAC address, time to live (in seconds) in the cache, and the neighbor's IP address.

Example: `list dls cache all`

```
     Mac Address   Entry Type  Secs to live      IP Address(es)   LFSize
  1.  10005A123456  PERMANENT   (not being timed) 128.185.236.84   0
  2.  10005A789ABC  STATIC      (not being timed) 128.185.236.84   0
  3.  10005AF1809B  DYNAMIC        810            128.185.236.84   2052
  4.  10005AF181A4  DYNAMIC        1170           128.185.236.84   2052
  5.  400000000088  DYNAMIC        1170           128.185.236.84   2052
```

dls cache config

Displays DLSw configured MAC cache entries.

Example: `list dls cache config`

```
Mac Address   IP Address       Source     Last Mod
------------  ---------------  ---------  ---------
10005A123456  128.185.236.84   PERMANENT  UNCHANGED
10005A789ABC  128.185.236.84   STATIC     ADDED
```

list dls cache range

Displays information for a specified range of cache entries.

Example: `list dls cache range`

```
Start [1]?
Stop ]1]? 20
       Mac Address   Entry Type  Secs to live      IP Address(es)   LFSize
   1.  10005A123456  PERMANENT   (not being timed) 128.185.236.84   0
   2.  10005A789ABC  STATIC      (not being timed) 128.185.236.84   0
   3.  10005AF1809B  DYNAMIC        810            128.185.236.84   2052
   4.  10005AF181A4  DYNAMIC        1170           128.185.236.84   2052
   5.  400000000088  DYNAMIC        1170           128.185.236.84   2052
```

dls memory

This command lists all existing DLSw sessions and the amount of memory in use by each session.

Example: `list dls memory`

```
Total DLSw bytes requested:             153600
Global receive pool bytes granted:       92160
 Currently in use:                          0
Global transmit pool bytes granted:      61440
 Currently in use:                         232

NetBIOS UI-frame pool total bytes:       40960
 Currently in use:                          0


                                      Session    Initial  Current  Congest  DLC Xmits
Id Source            Destination        State      alloc   alloc    State     Queued
5. 10005AF181A4  04  400000000003  04  Connected   16384   16384    READY       0
6. 400000000003  04  0000c9001119  04  Connected   16384   16384    READY       0
```

The “Currently in use” field shows the total amount of memory currently allocated by DLS. This includes all session allocations and control messages.

The “Congest State” field provides information on flow control and can be any of the following:

Ready Indicates that the session is not congested.

Session Indicates that the session has used most of its session allotment and probably has flow controlled the data link.

Global Indicates that the session is congested due to a shortage of memory in the router.

Ses/gbl Indicates that the session is congested due to a combination of session and global memory shortage.

The “DLC Xmits Queued” field shows the total number of frames queued for transmit in DLS to LLC plus the number queued within the DLC awaiting acknowledgment by the attached end station.

mac-list all

Displays all local and remote MAC address list entries.

Example: `list mac-list all`

```
MAC Value     MAC Mask      IP Address
------------  ------------  ---------------
10005AF17F23  FFFFFFFFFFFF  Local
10005AF1809B  FFFFFFFFFFFF  128.185.236.84
4000189E2000  FFFFFFFFF000  128.185.236.84
4000189E3000  FFFFFFFFF000  Local
```

mac-list config

Displays all locally configured MAC address list entries.

Example: `list mac-list config`

```
Entry  Mac Value     MAC Mask      Source     Last Mod
-----  ------------  ------------  ---------  ---------
    1  10005AF17F23  FFFFFFFFFFFF  STATIC     UNCHANGED
    2  4000189E3000  FFFFFFFFF000  STATIC     UNCHANGED
```

mac-list local

Displays all active local MAC address list entries.

Example: `list mac-list local`

```
LOCAL MAC List
Type of MAC List (active) ....... EXCLUSIVE
Type of MAC List (pending) ...... EXCLUSIVE


MAC Value     MAC Mask
------------  ------------
10005AF17F23  FFFFFFFFFFFF
4000189E3000  FFFFFFFFF000
```

mac-list remote

Displays ALL active remote MAC address list entries for a specific DLSw peer.

Example: `list mac-list remote`

```
Enter the DLSw neighbor IP Address [0.0.0.0]? 128.185.236.84
 Partner IP Address .............. 128.185.236.84
Type of MAC List ................ EXCLUSIVE
Use of remote MAC lists ......... ENABLED


MAC Value     MAC Mask
------------  ------------
10005AF1809B  FFFFFFFFFFFF
4000189E2000  FFFFFFFFF000
```

groups config

Displays group information for this DLSw peer that was configured with the **join-group** command.

Example: `list groups config`

```
   Group#                     Xmit    Rcv     Max     Keep-    SesAlive
Mcast IP Addr   Role      CST Bufsize Bufsize Segsize Alive    Spoofing Priority
--------------- --------- --- ------- ------- ------- -------- -------- --------
224.0.10.0      READWRITE  p    5120    5120    1024  DISABLED DISABLED MEDIUM
Group  2        PEER       p    5120    5120    1024  DISABLED DISABLED MEDIUM
```

Group # / Mcast IP Addr

For client/server/peer groups, the number of the group. For DLSw Version 2 groups, the multicast address is configured to read from or write to.

Role For client/server/peer groups, the role that this router is configured to assume within the group. For DLSw Version 2 groups, the read/write role of the configured multicast address: read-only, write-only, or read-write.

CST The Connectivity Setup Type this router is configured to use within the group, either Active (a) or Passive (p).

Xmit Bufsize
The size of the packet transmit buffer from 1024 to 32768. Default is 5120.

Rcv Bufsize
The size of the packet receive buffer from 1024 to 32768. The default is 5120.

Max Segsize
The maximum size of the TCP segment from 64 to 16384. The default is 1024.

Keepalive
Displays the status of the Keepalive function, enabled or disabled.

SesAlive Spoofing
Displays the status of the NetBIOS SessionAlive Spoofing function, enabled or disabled.

Priority Displays the priority of the neighbor router in the selection process. Neighbor priority is High, Medium, or Low.

groups statistics
Displays statistics on the use of DLSw groups for explorer traffic since the last restart of the router or creation of the group.

Example: `list groups stat`

```
Group number    Data pkts   Data Bytes   Ctrl pkts   CURex pkts   NQex pkts
    or              Sent         Sent        Sent         Sent        Sent
Multicast IP@       Rcvd         Rcvd        Rcvd         Rcvd        Rcvd
-------------   ---------   ---------   ----------   ----------   ---------
Group 1                 0           0          116           24          10
                        0           0           25           10           2
224.0.10.0              0           0          224           33           0
                        0           0           21            8           0
```

llc2 open Displays information for all currently open SAPs on interfaces between LLC2 peers.

Example: `list llc2 open`

```
Interface   SAP
  0          0
  0          4
```

llc2 SAP parameters
Displays LLC2 parameter configuration information. Only configurations that were changed will be displayed. If the **set llc2** command was not used, no output will be generated.

Example: `list llc2 sap parameters`

```
SAP             t1    t2    ti    n2    n3    tw    rw    nw    acc
---             --    --    --    --    --    --    --    --    ---
 0               1     1    30     8     1     2     2     1     0
```

llc2 sessions all
Displays current information for all LLC2 sessions.

Example: `list llc2 sessions all`

```
    SAP   Int.   Remote Addr    Local Addr    State      RIF
1. 04    6      400000000003   500000000003  CONTACTED  0620 0202 B0B0
```

State The state of the llc session. The following states can be displayed:

DISCONNECTED
Indicates the data link control structure exists but no data link is established.

CONNECT_PEND
The connect pending state is entered when a test command frame to NULL SAP is received or when a DLC_START_DL command is received from the DLS.

RESOLVE_PEND
The resolve pending state is entered when a DLC_RESOLVE_C command has been sent to DLS.

CONNECTED
This is a steady state where LLC Type 1 level services are available through the DLS cloud. This state is entered when a DLC_RESOLVE_R command is received from DLS or when a TEST response frame is received from the network.

CONTACT_PEND
This state is entered whenever a response to a transmitted or received SABME is outstanding.

CONTACTED
This is a steady state that is entered whenever an UA response for a transmitted SABME has been received, or an UA has been previously transmitted for a received SABME. In this state LLC2 information frames are exchanged over the DLS cloud.

DISCONNECT_PENDING
This state is entered whenever a DISC command has been transmitted or received, or a DLC_HALT has been received from DLS.

llc2 sessions nb
Displays current information for LLC2 sessions carrying NetBIOS protocol traffic.

llc2 sessions range
Displays current information for the selected range of LLC2 sessions.

Example: `list llc2 sessions range`

```
Start[1]?
Stop[1]?
                SAP   Int.   Remote Addr   Local Addr    State      RIF
            1. 04    6      400000000003  500000000003  Contacted  0620 0202 B0B0
```

priority Displays DLSw circuit priority information.

Example: `list priority`

```
Default priority for SNA DLSw session traffic is          HIGH
Default priority for NetBIOS DLSw session traffic is      MEDIUM
Default priority for SNA DLSw explorer traffic is         MEDIUM
Default priority for NetBIOS DLSw explorer traffic is     LOW

Message allocation by C/H/M/L priority is   4/3/2/1
Maximum frame size for NetBIOS is           516

    Source/  SAP      MAC Address                  Session   Explorer
ID  Dest     Range    Range                        Priority  Priority
--  -------  -------  ---------------------------  --------  --------
 1  Source:  00 - FE  000000000000 - FFFFFFFFFFFF  CRITICAL  MEDIUM
    Dest  :  00 - 0C  10005A000000 - 10005AFFFFFF
 2  Source:  04 - 04  400031740000 - 40003174FFFF  CRITICAL  MEDIUM
    Dest  :  00 - FE  000000000000 - FFFFFFFFFFFF
```

tcp capabilities

Displays the information received from a partner DLSw router in its capabilities exchange message.

Example: `list tcp capabilities`

```
          Enter the DLSw neighbor IP Address [0.0.0.0]? 128.185.236.84
Vendor ID:                  10005A
Vendor product version:     IBM 2210 Nways MRS 5765-B86 Feature 5045 V1 R
Initial pacing window:      12
Preferred TCP connections:  1
Supported SAPs:             00 04 08 0C F0
MAC List Exclusivity:       Complete List
MAC List:                   08005ACEEA1C [FFFFFFFFFFFF]
                            4000189E2000 [FFFFFFFFF000]
NetBIOS Exclusivity:        (not supplied)
NetBIOS Name List:          (none supplied)
Multicast Version:          01
IBM CST:                    Passive Transport
IBM Multicast:              Available
IBM Capex Correlator:       19660
```

Vendor ID

The IEEE Organizational Unique Identifier (OUI) of the vendor of the neighbor DLSw. IBM's OUI is X'10005A'.

Vendor version

A text string that the neighbor DLSw sent to describe itself. "(not available)" indicates that the neighbor implementation did not send such a string.

Initial pacing window

The number of paced SSP messages this DLSw is allowed to send to the neighbor DLSw upon receiving the initial pacing grant for each new circuit.

Preferred TCP connections

The number of TCP connections (1 or 2) that this neighbor would like to have. The IBM 8210 adjusts to the requested number, and will have only 1 full-duplex TCP connection to neighbors who request this.

Supported SAPs

The list of SAPs that the neighbor DLSw has open or will automatically open, on any of its LAN interfaces or representing its attached SDLC stations.

MAC List Exclusivity

Indicates whether the MAC address list sent by this neighbor is to be considered as a complete or partial list of the MAC addresses that are local to that neighbor. A response of "(not supplied)" indictates that this neighbor did not send a MAC address list as part of its capabilities.

MAC List Displays all MAC list values and masks that this neighbor sent in its MAC address list. A response of "(none supplied)" indicates that this neighbor did not send a MAC address list as part of its capabilities.

NetBIOS Exclusivity
Indicates whether the NetBIOS name list sent by this neighbor is to be considered as a complete or partial list of the NetBIOS names that are local to that neighbor. A response of "(not supplied)" indicates that this neighbor did not send a NetBIOS name list as part of its capabilities.

NetBIOS Name List
Displays all the NetBIOS name qualifiers that this neighbor sent in its NetBIOS name list. A response of "(none supplied)" indicates that this neighbor did not send a NetBIOS name list as part of its capabilities.

Multicast Version
Indicates what version of Multicast this neighbor supports as defined by the AIW standard. A response of *not supplied* indicates that this neighbor did not send a Multicast Version as part of its capabilities.

IBM CST Indicates which IBM Connectivity Setup Type (CST) this neighbor has configured. A response of *not supplied* indicates that this neighbor did not send an IBM CST as part of its capabilities.

IBM Multicast
Indicates whether or not specific IBM Multicast functions are available at this neighbor. A response of indicates *not supplied* that this neighbor did not send an IBM Multicast as part of its capabilities.

IBM Capex Correlator
Indicates the value of the last IBM Capex Correlator received from this neighbor. A response of *not supplied* indicates that this neighbor did not send an IBM Capex Correlator as part of its capabilities.

tcp config
Displays the configuration parameters for all configured TCP connections to peer DLSw routers.

Example: `list tcp config`

```
                    Xmit    Rcv     Max     Keep-    SesAlive
Neighbor        CST Bufsize Bufsize Segsize Alive    Spoofing Priority
--------------- --- ------- ------- ------- -------- -------- --------
128.185.236.84   p    5120    5120    1024  DISABLED DISABLED MEDIUM
```

tcp sessions
Displays the status of all known TCP sessions to peer DLSw routers.

Example: `list tcp sessions`

```
   Group   IP Address      Conn State     CST  Version  Active Sess Sess Creates
   ------- --------------- -------------- ---  -------- ----------- ------------
1          128.185.236.49  ESTABLISHED     p   AIW V1R0      2           4
```

Group The group through which the neighbor was discovered, if applicable

IP Address
The neighbor IP address used for DLSw

Conn State
The state of the transport connection (which may consists of 1 or 2 TCP connections) to this neighbor. The valid states are:

DOWN TCP session not established; no capabilities exchanged (passive partners only).

CAPEX FAILED
Attempt to exchange capabilities failed; TCP session is brought down.

Unicasting
TCP session not established; capabilities successfully exchanged (passive partners only) (ready for DLSw explorer traffic)

PENDING R/W
This box has attempted to establish a TCP session with neighbor.

RD EST/WR PEND
TCP session between neighbor and this box is active, but TCP session between this box and neighbor is not active.

RD EST/WR PEND
TCP session between this box and neighbor is active, but TCP session between neighbor and this box is not active.

CAPEX PENDING
TCP session established; in process of exchanging capabilities.

ESTABLISHED
TCP session established; capabilities exchanged (ready for use for DLSw sessions).

CLOSING
Bringing down TCP session.

RECONNECT WAIT
TCP session not established; waiting for timer to expire in order to attempt to re-establish TCP session.

CST Current Connectivity Setup Type, as follows:

```
a - Locally configured as active
p - Locally configured as passive
A - Locally configured as passive, but operating in active mode
    due to neighbor requirements
D - Not locally configured, but a dynamic neighbor TCP connection
```

Version The neighbor's DLSw protocol level. May be one of AIW VnRm for AIW standard-compliant routers, RFC1434+ for pre-AIW V1R0 implementations, or UNKNOWN.

Active Sess
The current number of active (in any state) DLSw sessions (circuits) on this transport connection

Sess Creates
The total number of DLSw sessions (circuits) that ever entered the CIRC_EST state, since the last restart of the router or "add tcp" of this transport connection.

tcp statistics
Displays statistics on the use of TCP transport connections since the last restart of the router or "add tcp" of this transport connection.

Example: `list tcp statistics`

```
          Enter the DLSw neighbor IP Address -0.0.0.0-? 192.1.1.3
                                    Transmitted           Received
                                    -----------           -----------
Data Messages                            214                   231
Data Bytes                             372997                413259
Control Messages                           16                    34

CanYouReach Explorer Messages               0                     0
ICanReach Explorer Messages                 0                     0
NameQuery Explorer Messages                 1                     2
NameRecognized Explorer Messages            2                     1
```

timers The user-specified time to wait for various activities.

Example: `list timers`

```
Database age timer                1200  seconds
Max wait timer for ICANREACH      20    seconds
Wait timer for LLC test response  15    seconds
Join Group Interval               900   seconds
Neighbor priority wait timer      2.0   seconds
Neighbor Inactivity Timer           5   minutes
```

Database age timer
The time to hold unreferenced MAC address-to-IP address database entries. Zero indicates that entries in this database are not being timed.

Max wait timer for ICANREACH
The time the router waits for a response to a CANUREACH message before deciding that the session will not come up.

Wait timer for LLC test response
The time the router waits for an LLC test response before retransmitting an LLC test frame.

Join Group Interval
The time between DLSw group advertisement broadcasts.

Neighbor priority wait timer
The time DLSw waits before selecting a neighbor during a given session-establishment attempt.

Neighbor Inactivity Timer
The time DLSw waits before taking down an inactive (zero sessions) passive TCP connection.

NetBIOS

Displays the NetBIOS monitoring prompt.

Syntax:

n**etbios**

Example: `netbios`

```
NetBIOS Support User Configuration
NetBIOS config>
```

For a description of NetBIOS commands, see Chapter 9, “Configuring and Monitoring NetBIOS” on page 9-1.

Open-Sap

Use the **open-sap** command to dynamically enable DLSw switching for the specified service access point (SAP) without affecting the DLSw SRAM configuration.

Syntax:

op**en-sap**

Example: **`open-sap`**

Refer to “Open-Sap” on page 7-13 for additional information and an explanation of the **open-sap** parameters.

Set

Use the **set** command to dynamically change the LLC2 parameters, the maximum number DLSw sessions, protocol timers, TCP dynamic neighbors, mac address list related parameters, and circuit priority parameters without affecting the DLSw SRAM configuration.

Syntax:

se**t** dynamic-tcp
llc2
mac-list
memory
priority
timers

dynamic-tcp

Allows you to specify various TCP parameters for dynamic neighbor TCP connections (that is, those that connect-in from neighbors not defined by the **add tcp** command). DLSw uses these values only if dynamic neighbors are enabled.

Syntax: dynamic-tcp

Example: `set dyn`

```
Transmit Buffer Size (Decimal) [5120]?
Receive Buffer Size (Decimal) [5120]?
Maximum Segment Size (Decimal) [1024]?
Enable/Disable Keepalive (E/D) [D]?
Enable/Disable NetBIOS SessionAlive Spoofing (E/D) [D]?
Neighbor Priority (H/M/L) [M]?
```

For a description of these parameters, see the **add tcp** command in Chapter 6, “Using DLSw” on page 6-1.

llc2 Allows you to configure specific LLC2 attributes for a specific SAP.

Example: `set llc2`

(An example of the **set llc2** command can be found on page 7-15).

mac-list Allows you to set the local MAC address exclusivity. This command also allows you to commit all changes that have been previously made through the following monitoring commands:

- enable mac-list local
- enable mac-list remote
- disable mac-list local
- disable mac-list remote
- add mac-list
- delete mac-list
- set mac-list

As a result of this command, a new run-time capabilities will be sent to all DLSw peers to communicate the new information.

Syntax: mac-list

Example: `set mac-list`

```
Local MAC list exclusivity (E=exclusive, N=non-exclusive) [N]? e

MAC list parameter set.

For the change to take effect, commit the change (next question).

The next question allows you to commit
any of the following changes (permanent and temporary):
  - changes made using ENABLE MAC-LIST LOCAL
  - changes made using ENABLE MAC-LIST REMOTE
  - changes made using DISABLE MAC-LIST LOCAL
  - changes made using DISABLE MAC-LIST REMOTE
  - changes made using ADD MAC-LIST
  - changes made using DELETE MAC-LIST
  - changes made using SET MAC-LIST

Would you like to commit the MAC list changes? [No]: y

Use of local MAC list remains    ENABLED.
Use of remote MAC list remains    ENABLED.
Type of local MAC list has changed from NON-EXCLUSIVE to EXCLUSIVE    .
Entry added temporarily:   08005ACEE5D9 / FFFFFFFFFFFF.
Entry added temporarily:   4000189E3000 / FFFFFFFFF000.
Would you still like to commit the MAC list changes? [No]: y


MAC address list changes have been committed.
```

memory This command allows you to dynamically specify the total amount of memory allocated to DLSw, and the total amount of memory to be allotted to each DLSw session.

Example: `set memory`

An example of the use of the **set memory** command can be found on page 7-16.

priority Allows you to specify the circuit priorities to use for SNA circuits and NetBIOS circuits. You can configure circuit priorities of Critical, High, Medium, or Low (in descending order from Critical to Low).

This command also allows you to configure the ratio of transport transmits for each circuit priority, and to set the maximum frame size to

use for NetBIOS. If your network contains any transparently bridged (TB) segments, use a maximum NetBIOS frame size of at least 1470.

Example: `set priority`

For more information on the **set priority** command, see page 7-17.

timers Sets the DLSw protocol timers.

Example: `set timers`

An example of the **set timers** command can be found on page 7-18.

Test

Use the **test** command to perform tests against the currently active MAC address cache and MAC address list.

Syntax:

test cache
mac-list

cache Allows you to determine how a frame destined for a particular MAC address would be forwarded based upon current cache and DLSw peer information.

Syntax: cache

Example: `test cache`

```
MAC address to be tested [000000000000]? 10005af1809b
 Enter largest frame size to perform test against [2052]?

Destination MAC address being tested .... 10005AF1809B

MAC cache entry found:
  Entry type = DYNAMIC

Handling of SNA explorer SSP messages ....
  Explorer SSP message not sent (information found locally).

Handling of SNA circuit setup SSP messages ....
  Circuit Setup SSP message would be forwarded to 128.185.236.84

Handling of NetBIOS explorer SSP messages ....
  Explorer SSP message would be broadcast.
  How explorer destined for this MAC address is forwarded to DLSw partners
.....
    Send to all partners with non-exclusive mac address lists.
  There are currently no DLSw partners to forward the explorer to.

Handling of NetBIOS circuit setup SSP messages ....
  No currently known transport that can support circuit setup for given lfsize.
```

mac-list Allows you to match a given MAC address against all currently active MAC address list entries (local and remote). This is useful in resolving MAC address list conflict problems.

Syntax: mac-list

Example: `test mac-list`

```
MAC address to be tested [000000000000]? 10005af1809b

Destination MAC address being tested .... 10005AF1809B


MAC address value  MAC address mask   IP Address
-----------------  -----------------  ---------------
10005AF1809B       FFFFFFFFFFFF       128.185.236.84
```

Chapter 8. Using NetBIOS

This chapter describes IBM's implementation of NetBIOS over bridged networks and over DLSw networks. It includes the following topics:

- "About NetBIOS"
- "Reducing NetBIOS Traffic" on page 8-3
- "Frame Type Filtering" on page 8-4
- "NetBIOS Host Name and Byte Filtering Configuration Procedures" on page 8-15

About NetBIOS

The NetBIOS protocol was designed for use on a Token-Ring LAN. It is not a routable protocol, but can be bridged, or switched using DLSw. Both of these methods of handling NetBIOS traffic are supported.

NetBIOS relies on broadcast frames for most of its functions other than data transfer. While this may not present a problem in LAN environments, if uncontrolled, it may easily present a problem in WAN environments.

The following sections describe NetBIOS names and the different types of NetBIOS broadcast communication.

NetBIOS Names

The key to communication between NetBIOS stations are the NetBIOS names. Each NetBIOS entity is assigned a NetBIOS name. In order to communicate with another NetBIOS entity, its NetBIOS name must be known. The names are used in broadcast NetBIOS frames to indicate the source NetBIOS entity of the frame and the desired target NetBIOS entity to receive the frame.

All names in NetBIOS frames are 16 ASCII characters. There are two types of NetBIOS names:

Individual (or unique)
: Represents a single NetBIOS client or server. This name should be unique within the NetBIOS network.

  This name is used to communicate with this particular NetBIOS entity.

Group
: Represents a group of NetBIOS stations (an OS/2 LAN Server domain, for example). This name should not be the same as any individual NetBIOS names in the network.

  This name is used to allow communication between a group of NetBIOS entities.

A single NetBIOS station (single MAC address) can have multiple individual and/or group names associated with it. These names are generated by the NetBIOS application based upon a name or names configured at the NetBIOS station by a network administrator.

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NetBIOS Name Conflict Resolution

When a NetBIOS entity is preparing to use an individual NetBIOS name as its own, it checks the network to make sure that no other NetBIOS station has already used this name.

It checks the NetBIOS name by repeatedly broadcasting a particular NetBIOS UI frame to all NetBIOS stations. If no stations respond, then the name is assumed to be unique and can be used. If a station does respond, the new station should not attempt to use this name.

NetBIOS Session Setup Procedure

To establish a NetBIOS session in order to do data transfer types of operations, the NetBIOS client first resolves the MAC address of the NetBIOS server and the LLC route to the NetBIOS server.

It does this by repeatedly broadcasting a particular NetBIOS UI frame to all NetBIOS stations. This frame contains the NetBIOS name of the server with which this client is establishing a session. When the server receives this frame with its NetBIOS name in it, the server responds with a corresponding broadcast NetBIOS UI frame to the client. When the client receives the response frame, the frame contains the MAC address and the route to the NetBIOS server.

For some NetBIOS applications, finding the NetBIOS server is a multiple step process. For example, the first step may be to find a domain controller that tells the client which domain server to use. Then the client finds this domain server.

Once the MAC address of NetBIOS server and the route to the NetBIOS server are found, the NetBIOS client can take either of the following actions:

- Establish an LLC2 connection with the NetBIOS server to communicate with the server using I-frames.
- Begin communicating with the NetBIOS server using specifically routed NetBIOS UI frames.

NetBIOS Broadcast Data Flows

For some NetBIOS applications, it is common to periodically broadcast data frames. This may be done if a station has a single frame's worth of data to send to another NetBIOS station. It can do this by broadcasting a particular NetBIOS UI frame (with the target NetBIOS station's name in the frame) to all NetBIOS stations.

Another case is when NetBIOS stations within a group (or domain) need to communicate with each other. This can be done by broadcasting a particular NetBIOS UI frame (with the target NetBIOS group name in the frame) to all NetBIOS stations. This is commonly done.

NetBIOS Status Flows

A less commonly used NetBIOS function is the ability to obtain status from any NetBIOS station. This is done by broadcasting a particular NetBIOS frame (with the target NetBIOS station's name in the frame) to all NetBIOS stations. When the target NetBIOS station receives this frame, it responds with a corresponding broadcast NetBIOS response frame.

NetBIOS All-Stations Broadcast Frames

There are two types of NetBIOS functions that are rarely used. Both of these functions involve broadcasting a NetBIOS frame to all NetBIOS stations. There is no target NetBIOS name in the frames. The two functions are:

- NetBIOS general broadcast function – which sends a data frame to all NetBIOS stations on the network.
- NetBIOS terminate trace function – which allows a network administrator to terminate NetBIOS trace functions in all NetBIOS stations on the network from a single point. A particular NetBIOS frame is broadcast to all NetBIOS stations on the network.

Reducing NetBIOS Traffic

To stabilize a network, the goal is to reduce the amount of broadcast NetBIOS traffic that is forwarded through the bridged or DLSw switched networks. This can be done in two ways:

- Filter as many broadcast NetBIOS frames as possible before bridging or DLSw switching them.
- Forward unfiltered NetBIOS UI frames on as few bridge ports or DLSw TCP sessions as possible.

Table 8-1 lists the filters that IBM provides.

Table 8-1. NetBIOS Filters

Filter Type	Filters
MAC Address	Frames by either the source or destination MAC address.
Byte	Frames by byte offset and field length within a frame.
Name	Frames by NetBIOS source and destination names.
Duplicate Frame	Duplicate frames.
Response	Responses for which the router did not forward a NetBIOS broadcast frame.

Once the router filters frames, NetBIOS name lists and NetBIOS name caching and route caching controls how the remaining frames are forwarded. “NetBIOS Byte Filtering” on page 3-5 and “NetBIOS host-name Filtering” on page 3-4 describe byte and name filtering, respectively. The *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide* describes MAC address filtering.

For an introduction to host-name filtering and byte filtering, see “NetBIOS Name and Byte Filters” on page 3-4.

The following sections describe frame type, duplicate frame, response frame filtering, NetBIOS name lists, NetBIOS name and route caching.

Frame Type Filtering

Frame type filtering allows certain categories of NetBIOS frames to be filtered entirely for bridge traffic, DLSw traffic, or both DLSw and bridge traffic.

The three categories of NetBIOS frames that can be filtered are:

- Name Conflict Resolution frames

  These are the broadcast NetBIOS frames used to make sure that a NetBIOS name to be used is unique in the network.

  In NetBIOS networks, it is critical that the NetBIOS names of stations to which a NetBIOS session is established (typically the NetBIOS servers) be unique. It is also usually critical that the individual NetBIOS names of stations within the same group (or domain) be unique. But it is often not critical that the NetBIOS names of stations from which a NetBIOS session is setup (typically the NetBIOS clients) be unique, especially across domains.

  For this reason, networks in which there is good control over the server names can gain advantage by filtering name conflict resolution frames. This is especially true for DLSw switched networks.

  The NetBIOS name-conflict resolution frames are Add-Name-Query, Add-Group-Name-Query, and Add-Name-Response.

- General Broadcast frames

  This is the broadcast NetBIOS frame used to send data to all NetBIOS stations in a network. This frame is rarely used and can typically be filtered.

  The NetBIOS General Broadcast frame is Datagram-Broadcast.

- Terminate Trace frames

  These are the broadcast NetBIOS frames used to terminate NetBIOS traces in all NetBIOS stations in a network. These frames are rarely used and can typically be filtered.

  The NetBIOS Terminate Trace frame is Terminate-Trace.

The default is to not filter any of the above frame types for bridged NetBIOS traffic, and to filter all of the above frame types for DLSw switched NetBIOS traffic. However, it may be advantageous to filter the above frame types if NetBIOS traffic is being bridged on WAN links.

For bridging, enter **set filters bridge** to turn frame type filtering on or off. For DLSw, enter **set filters dlsw** to turn frame type filtering on or off.

For example:

```
NetBIOS config>set filters bridge

Filter Name Conflict frames? [Yes]:

Name conflict filtering is              ON

Filter General Broadcast frames? [Yes]:

General broadcast filtering is          ON

Filter Trace Control frames? [Yes]:

Trace control filtering is              ON
```

Duplicate Frame Filtering

All of the broadcast NetBIOS frames that could have a response are sent a fixed number of times (default 6), at a fixed interval (default 1/2 second apart) by the origin NetBIOS station. In the following explanation, these frames are called *NetBIOS command* frames and the possible response frames are called *NetBIOS response frames.*

The NetBIOS command frames are the:

- Name conflict resolution frames – Add-Name-Query and Add-Group-Name-Query
- NetBIOS session setup frames – Name-Query
- NetBIOS status frames – Status-Query

The command frames are sent multiple times to increase the odds of successful delivery (these frames are connectionless frames). Each response frame is sent only once in response to each command frame received.

In a DLSw-switched network, the forwarding of each retry across the WAN sessions can be very costly. So, when the first command frame is received, it is forwarded to the appropriate neighbor DLSw and bridge ports and a copy is saved. All retries of the same NetBIOS command frame received during a configurable time period are discarded.

There is one configurable time period for the bridge network and one configurable time period for the DLSw network.

The configurable time period for the bridge network is controlled by two commands:

- **enable duplicate-filtering / disable duplicate-filtering**, which controls whether duplicate NetBIOS command frames are filtered on the bridge network at all.
- **set general** ("Duplicate frame filter timeout value in seconds" parameter)

  If duplicate frame filtering is enabled for the bridge network, this value specifies for how long a period to discard duplicate NetBIOS command frames after a NetBIOS command frame has been bridged.

  If a duplicate NetBIOS command frame is received after the timeout expires, the frame is forwarded to the bridge network.

The configurable time period for the DLSw network is controlled by a single parameter:

- **set cache-parms** ("Reduced search timeout value in seconds" parameter)

  This value specifies for how long a period to discard duplicate NetBIOS command frames after a NetBIOS command frame has been forwarded to the DLSw network.

  If a duplicate NetBIOS command frame is received after the timeout expires, the frame is forwarded to the DLSw network.

  Note: Filtering of duplicate NetBIOS command frames to a DLSw network is always enabled.

When a NetBIOS command frame is received by a DLSw neighbor, the frame is forwarded to the bridge network and a copy is saved. At a configurable interval (1/2 second) for a configurable number of times (default 6), the neighbor DLSw function

forwards a retry of the command frame to the bridge function. The bridge function handles the command frame based upon the configured bridge duplicate frame parameters.

The configurable number of retries and interval are controlled by the following command and parameters:

- **set general** (“Command frame retry count” and “Command frame retry timeout value in seconds” parameters)

There is one last parameter that controls how long the command frame is saved in order to perform the above bridge and DLSw network forwarding:

- **set general** ("Duplicate frame detect timeout value in seconds" parameter)

  This parameter indicates how long a received NetBIOS command frame is saved for duplicate frame and response frame processing. After the timeout expires, the command frame is deleted and the duplicate frame filter timer and reduced search timer associated with it are cancelled. The first duplicate command frame received after the timeout period is treated as the first command frame received. All response frames received after the timeout period are discarded.

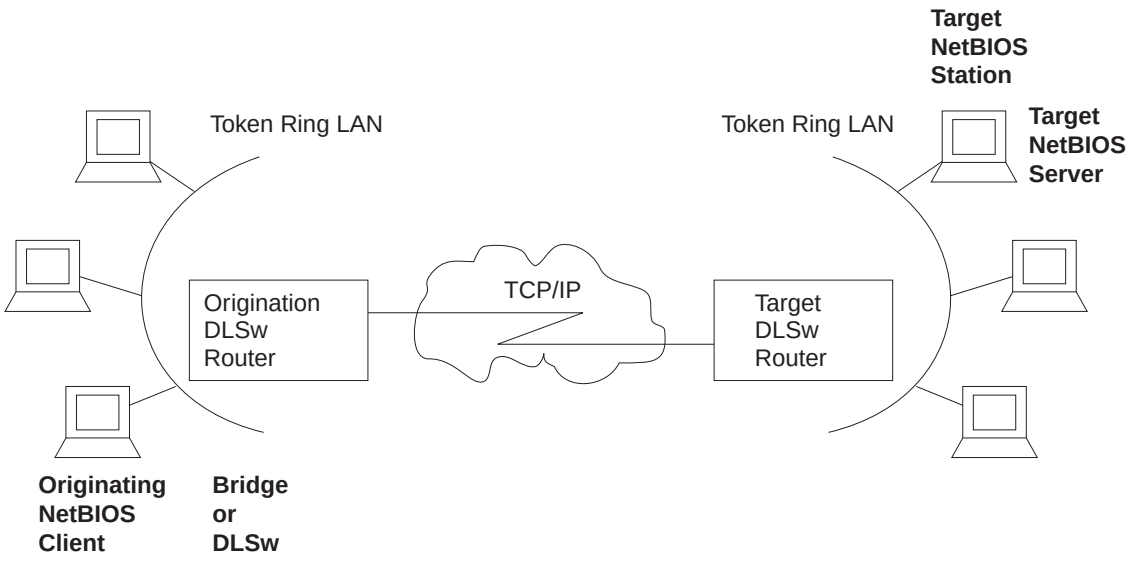
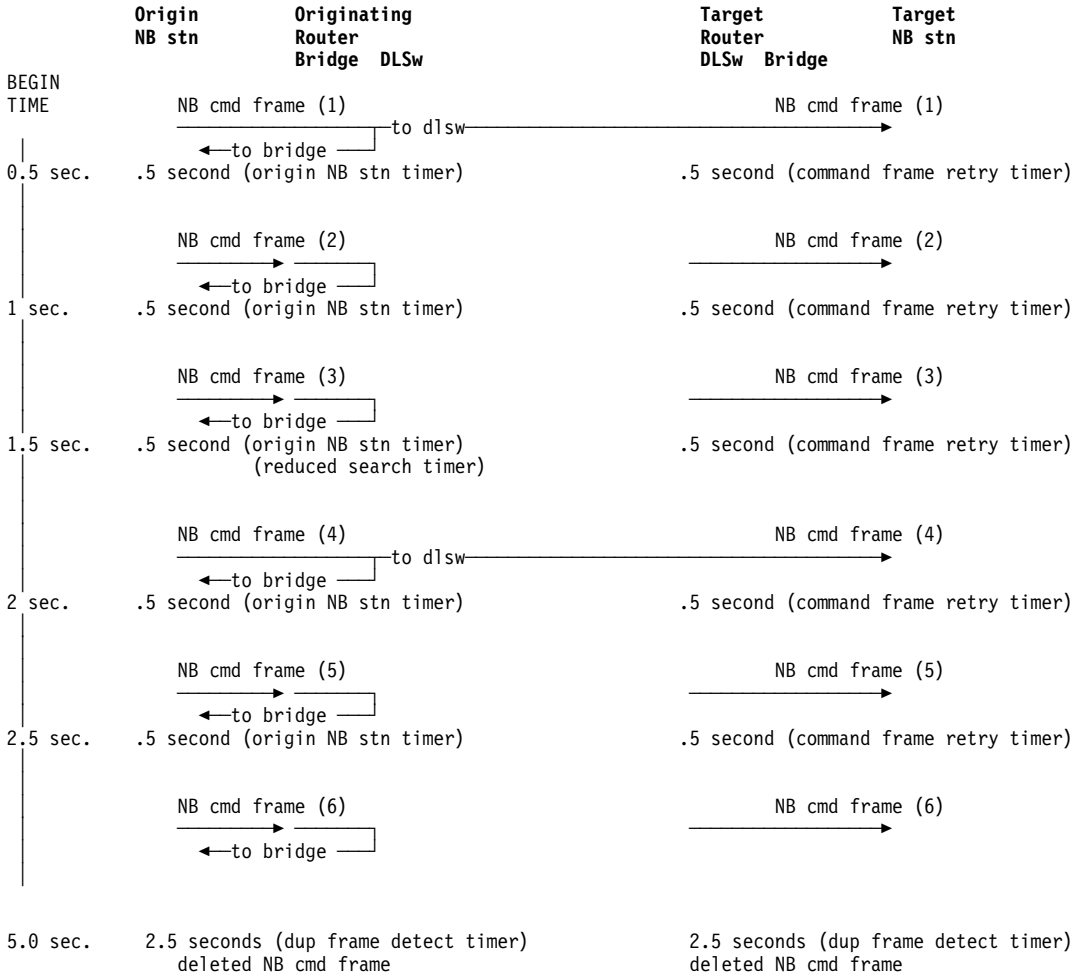


Figure 8-1. Setting Up a NetBIOS Session Over DLSw. Duplicate filtering reduces the number of broadcast frames forwarded over the DLSw WAN.

Figure 8-1, together with the following sequence, is an example using all of the defaults describe the process. To simplify the example, it is assumed that no response frame is received.



The sequence of events is as follows:

1. The first NetBIOS command frame is received on a bridge port at the origin DLSw router. A copy of the NetBIOS command frame is saved. Because bridging is enabled, the frame is forwarded onto the bridge network. Because duplicate-filtering on the bridge network is disabled as the default, the duplicate frame filter timer is not started. Because DLSw NetBIOS is enabled, the frame is forwarded onto the DLSw network and the reduced search timer is started (default 1-1/2 seconds). The duplicate frame detect timer (default 5 seconds) is also started.
2. The target router DLSw function receives the first NetBIOS command frame. A copy of the NetBIOS command frame is saved. Because bridging is enabled, the frame is forwarded onto the bridge network. Because duplicate-filtering on the bridge network is disabled as the default, the duplicate frame filter timer is not started. The retry command timer (default 1/2 second) and the duplicate frame detect timer (default 5 seconds) are started.
3. At the origin router, the second NetBIOS command frame (first retry) is received. Because duplicate-filtering on the bridge network is disabled as the default, the frame is forwarded onto the bridge network. Because the reduced search timeout has not expired, the frame is not forwarded onto the DLSw network.

4. At the target router, the DLSw function forwards a first retry of the NetBIOS command frame (generated locally) to the bridge function. Because duplicate-filtering on the bridge network is disabled as the default, the frame is forwarded onto the bridge network. The retry command timer (default 1/2 second) is started.
5. At the origin router, the third NetBIOS command frame (second retry) is handled in the same manner as the second NetBIOS command frame.
6. At the target router, the second retry of the NetBIOS command frame is handled in the same manner as the first retry.
7. At the origin router, the fourth NetBIOS command frame (third retry) is received. Because duplicate-filtering on the bridge network is disabled as the default, the frame is forwarded onto the bridge network. Because the reduced search timeout has now expired, the frame is forwarded onto the DLSw network. The reduced search timer is restarted.
8. At the target router, the DLSw function forwards a third retry of the NetBIOS command frame (generated locally) to the bridge function. Because duplicate-filtering on the bridge network is disabled as the default, the frame is forwarded onto the bridge network. The retry command timer (default 1/2 second is started). The target router also receives the forwarded NetBIOS command frame from the origin router, but discards it as a duplicate.
9. At the origin router, the fifth NetBIOS command frame (fourth retry) is handled in the same manner as the second NetBIOS command frame.
10. At the target router, the fourth retry of the NetBIOS command frame is handled in the same manner as the first retry.
11. At the origin router, the sixth NetBIOS command frame (fifth retry) is received. Because duplicate-filtering on the bridge network is disabled as the default, the frame is forwarded onto the bridge network. Because the reduced search timeout has not expired, the frame is not forwarded onto the DLSw network.
12. At the target router, the DLSw function forwards a fifth retry of the NetBIOS command frame (generated locally) to the bridge function. Because duplicate-filtering on the bridge network is disabled as the default, the frame is forwarded onto the bridge network. Because the retry count is now exhausted, the command retry timer is not restarted.
13. After 2-1/2 more seconds at the origin router, the duplicate frame detect timer expires and the saved NetBIOS command frame is deleted.
14. After 2-1/2 more seconds at the target router, the duplicate frame detect timer expires and the saved NetBIOS command frame is deleted.

Response Frame Filtering

The NetBIOS session setup command frame and the NetBIOS status command frame each expect a corresponding NetBIOS response frame. If no response frame is received, the command frame is retried as in the example above.

When the first NetBIOS response frame is received on the bridge network at the target router, it is forwarded back to the origin router and the saved NetBIOS command frame is deleted. Any subsequent response frame received at the target router is discarded because no corresponding NetBIOS command frame is found.

At the origin router, the received response frame is forwarded on the bridge network and the saved NetBIOS command frame is deleted. Any subsequent response frames received at the origin router (from the DLSw or bridge network) are discarded.

The NetBIOS name conflict command frames may cause, but do not require, a corresponding NetBIOS response frame. In addition, all received response frames are used (to determine whether there is more than one conflict).

Therefore, all NetBIOS name conflict frames received are forwarded, but the NetBIOS command frame is not deleted until the Duplicate Frame Detect timer expires.

NetBIOS Name Lists

NetBIOS name lists is a DLSw-only vehicle for limiting the number of DLSw partners to which a NetBIOS UI frame is forwarded.

A local NetBIOS name list can be configured at each router. This name list represents all of the NetBIOS names attached to the router's locally bridged network that can be accessed by DLSw partners. The router sends the local NetBIOS name list to all DLSw partners. These partners use the list to limit the NetBIOS traffic the partner sends to this router.

The NetBIOS name lists are useful in environments in which there is good control over the NetBIOS names; particularly those environments that should be accessed remotely through DLSw.

Configuring Local NetBIOS Name Lists

A NetBIOS name list is a set of NetBIOS name list entries. Configuring of the local NetBIOS name list involves:

- Adding up to 30 entries into a name list
- Configuring whether this list represents all of the NetBIOS names reachable by the router's DLSw partners.

You configure the name list entries at the `NetBIOS config>` prompt with the *add name-list* command. Each entry consists of the following information:

name qualifier

A name qualifier represents one or more NetBIOS names. Each name qualifier may be up to 16 characters. You can represent multiple NetBIOS names by using wildcards (either an imbedded ? or a trailing *) within the name.

The ? (question mark) signifies that the character in that position in the NetBIOS name may have any value.

The * (asterisk) as the last character of a name to signifies that all of the remaining characters in the NetBIOS name may be any value.

Note: In the majority of client/server NetBIOS applications, the only names required in the name lists are those of servers or domains. Individual client names do not need to be configured in name lists.

name qualifier type

NetBIOS names can be individual names or group names. Each name qualifier represents either a set of individual NetBIOS names or a set of group

NetBIOS names. The name qualifier type specifies which type of NetBIOS names (individual or group) the corresponding name qualifier represents.

As a general rule, domain names are group names and client or server names are individual names.

The name list itself has an attribute that is configured at the `NetBIOS config>` prompt using the SET NAME-LIST command. That attribute is *name list exclusivity.*

The attribute indicates whether the set of name list entries represents all NetBIOS names that this router's DLSw partners can reach (exclusive) or represents some but not necessarily all NetBIOS names that this router's DLSw partners can reach (non-exclusive).

An exclusive name list does the best job of limiting NetBIOS DLSw traffic on the network. Only frames destined to a NetBIOS name represented by a router's exclusive name list are forwarded to that router.

A non-exclusive name list helps limit NetBIOS DLSw traffic on the network though not as well as an exclusive name list. Frames destined to a NetBIOS name represented by a router's non-exclusive name list will be forwarded to that router first.

If the router receives a frame destined to a NetBIOS name not represented by any router's name lists, the router forwards the frame to all routers with non-exclusive name lists.

It is possible to control how a particular router uses its local NetBIOS name list and the name lists received from its DLSw partners using the following parameters:

use local NetBIOS name list

This function is configured with the **enable name-list local** or **disable name-list local** command at the `NetBIOS config>` prompt.

If you enable use local NetBIOS name list, the router sends the local NetBIOS name list configured at the router to all DLSw partners.

If you disable use local NetBIOS name list, the router does not send the local NetBIOS name list configured at the router to all DLSw partners.

use remote NetBIOS name lists

This function is configured with the **enable name-list remote** or **disable name-list remote** command at the `NetBIOS config>` prompt.

If you enable use remote NetBIOS name lists, the router uses all NetBIOS names lists received from the router's DLSw partners to determine how to forward certain NetBIOS frames.

If you disable use remote NetBIOS name lists, the router ignores all NetBIOS name lists received from the router's DLSw partners.

Committing NetBIOS Name List Changes

You can change all the NetBIOS name list parameters either permanently at the `NetBIOS config>` prompt or temporarily at the `NetBIOS>` prompt.

Because each change made requires the router to send information to each DLSw partner, you must indicate that the name list changes are ready for use by entering **set name-list** at the `NetBIOS>` command prompt.

Using NetBIOS Name Lists

The router uses NetBIOS name lists to determine how to forward the following NetBIOS frames:

- NetBIOS session setup command frame (Name-Query)
- NetBIOS status command frame (Status-Query)
- NetBIOS connectionless data transfer frame (Datagram)

Using Exclusive NetBIOS Name Lists Effectively: Configure exclusive NetBIOS name lists whenever possible. If you configure and send an exclusive name list to all DLSw partners, then the only NetBIOS frames received from the DLSw partners will be the frames whose destination name matches one of the name list entries.

A useful exclusive NetBIOS name list is the empty NetBIOS name list. If a particular router has no NetBIOS servers that are to be accessed by any of its DLSw partners, you should use an empty exclusive name list.

Using Non-Exclusive NetBIOS Name Lists: If a router has many DLSw partners all on different bridged networks, you can use non-exclusive name lists. Name list entries could be configured for the most frequently used servers so that traffic destined for these servers would go to this router first. Specifying the name list as non-exclusive allows traffic to go to less frequently used servers without having to configure the servers in the name list. Use this configuration in a network without tight control of the NetBIOS names; particularly the servers to be accessed remotely through DLSw.

Another use of non-exclusive NetBIOS name lists is in configurations that contain parallel DLSw paths between bridged networks. If two routers are on the same bridged network, one router could configure a NetBIOS name list representing one set of servers to be accessed remotely through DLSw on the bridged network and the other router could configure a NetBIOS name list representing a different set of servers. When both routers are active, the NetBIOS traffic is distributed between the two routers. If one router is inactive, all NetBIOS traffic will go through the other router because it has a non-exclusive list.

The default name list is an empty non-exclusive NetBIOS name list. This indicates that a router wants its DLSw partners to send all unforwardable NetBIOS traffic to the router.

NetBIOS Name Caching and Route Caching

NetBIOS Name Caching is the function in the router that classifies the type of NetBIOS name and the information necessary to reach the NetBIOS name. This information is used to best determine how to forward unfiltered NetBIOS frames to as few DLSw neighbors and as few bridge ports as possible. The possible types of NetBIOS names and the information saved for each are:

Individual remote
: This is a NetBIOS name known to be reachable remotely via a particular DLSw TCP session. The best TCP sessions are saved.

Individual local
: This is a NetBIOS name known to be reachable locally via the bridge network. The MAC address associated with the name is saved. If route caching is enabled, the best LLC route between the router and the NetBIOS station is also saved.

Group

This is a NetBIOS name known to be a group name. It may be reachable remotely and/or locally and may represent multiple NetBIOS stations. No other information is saved.

Unknown

Information about the NetBIOS name is not yet known, indicating that a search for the name is not complete. No other information is saved.

Whenever NetBIOS session setup frames or connectionless data transfer frames are received, the name cache is used to determine how to forward the frame. If one of these frames is received on the bridge network at a router, one of the following actions is taken:

- If the destination name in the NetBIOS frame is not in the router's NetBIOS name cache, then all DLSw partner names lists are searched for a match.

  If matches with group name qualifiers are found, a NetBIOS name cache entry is created with the name type *group.* The frame is forwarded on all bridge ports and to all DLSw partners with non-exclusive name lists or exclusive name lists with a matching name list entry.

  If matches with individual name qualifiers are found, a NetBIOS name cache entry is created with the name type *individual remote.* The frame is forwarded to each DLSw partner with a matching name list entry.

  If no matches are found, a NetBIOS name cache entry is created with the name type *unknown.* The frame is forwarded on all bridge ports and to all DLSw partners with non-exclusive name lists.

- If the destination name in the NetBIOS frame is in the router's NetBIOS name cache and is classified as individual remote, then the frame is forwarded on the learned best DLSw TCP session.

  If multiple equally best TCP sessions are learned, they will be used alternately on different NetBIOS session setup frames.

- If the destination name in the NetBIOS frame is in the router's NetBIOS name cache and is classified as individual local, then the saved MAC address will replace the NetBIOS frame's destination MAC address.

  If route caching is disabled, the NetBIOS frame's routing information is left alone, and the frame is forwarded to all bridge ports.

  If route caching is enabled, the NetBIOS frame's routing information is updated with the saved routing information and the frame is forwarded to the proper bridge port (determined by the MAC address and route).

- If the destination name in the NetBIOS frame is in the router's NetBIOS name cache and is classified as group or unknown, the frame is forwarded on all bridge ports and to all DLSw neighbors.

Learning NetBIOS Names

NetBIOS names are learned and classified from information in the NetBIOS session setup frames (Name-Query and Name-Recognized).

Configuring NetBIOS Name Cache Entries

It is possible to configure individual remote NetBIOS names and associate them with a particular DLSw TCP session. This can greatly reduce the search overhead. To improve performance, it is recommended to configure the remote NetBIOS servers that are accessed commonly by NetBIOS clients in the router's local bridge network.

It is not possible to configure individual local NetBIOS names and associate them with a particular MAC address and route.

There are three types of NetBIOS name cache entries:

- Permanent entries are those that are added at the NetBIOS configuration prompt (`NetBIOS config>`). The router saves permanent entries in its configuration when the router is restarted.

  Enter **add cache-entry** at the `NetBIOS config>` prompt to add a permanent entry. You are prompted to enter the NetBIOS name and the associated IP address.

- Static entries are those that are added at the NetBIOS monitoring prompt (`NetBIOS>` console). The router does not save static entries when the router is restarted.

  Enter **add cache-entry** at the `NetBIOS>` console prompt to add a static entry. You are prompted to enter the NetBIOS name and the associated IP address.

- Dynamic entries are those that are ***not*** added at the NetBIOS configuration or monitoring prompts, but are learned dynamically from the NetBIOS session setup frames. The router does not save dynamic entries when the router is restarted.

Configuring Name Cache Parameters

To prevent one type of NetBIOS name from filling up the entire name cache, there are two configurable NetBIOS name cache limits:

- Maximum number of local name cache entries specifies the maximum number of individual local NetBIOS name cache entries that can be cached at one time. Least recently used entries are overridden by new entries.
- Maximum number of remote name cache entries specifies the maximum combined number of individual remote, group, and unknown NetBIOS name cache entries that can be cached at one time. Least recently used entries are overridden by new entries.

If an entry is not referenced for a configurable timeout period, then it is automatically deleted. This timeout out period is the unreferenced entry timeout value.

The association of a NetBIOS name with either a TCP session or a MAC address and route is made at one instance in time. Because networks are changing and the best path to a NetBIOS name may change, the association between a NetBIOS name and a TCP session or a MAC address and route is saved for only a configurable period of time. After this period of time, a new best path association is learned. The parameter that controls this configurable period of time is the best path aging timeout value.

Another useful configuration parameter is the reduced search timeout value. In addition to controlling for what period of time duplicate command frames are filtered to the DLSw network, it also controls how long to wait before expanding the search for a NetBIOS name. If a NetBIOS session setup frame is received and the destination NetBIOS name is found in the router's NetBIOS name cache as an individual remote frame, then the frame is forwarded to the corresponding TCP session. If no response to this frame is received, it could be due to the name no longer being accessible via this path. The first duplicate NetBIOS session setup frame received after the reduced search timer expires is forwarded to all DLSw TCP sessions, thus expanding the search to look for a better path.

The last parameter, significant characters in name, controls how many of the 16 characters in a NetBIOS name are needed to consider it a unique NetBIOS name. Some NetBIOS applications use the 16th character of the NetBIOS name to distinguish between certain entities associated with a single NetBIOS name (for example, print server and file server). In these cases, it is best to specify significant characters in name as 15. This causes any frame in which the first 15 characters of the destination NetBIOS name matches the first 15 characters of the router's NetBIOS name cache entry to be forwarded according to the name cache entry information. Thus multiple NetBIOS names can be represented with a single NetBIOS name cache entry.

All of the above NetBIOS name cache related parameters can be configured using the **set cache-parms** command as follows.

```
NetBIOS config>set cache-parms

Significant characters in name [15]?
Best path aging timeout value in seconds [60.0]?
Reduced search timeout value in seconds [1.5]?
Unreferenced entry timeout value in minutes [5000]?
Max nbr local name cache entries [500]?
Max nbr remote name cache entries [100]?

Cache parameters set
```

See "NetBIOS Commands" on page 9-3 for more information on the **set cache-parms** command.

Displaying Cache Entries

The router provides the following commands that let you view cache entries. From the NetBIOS configuration prompt, you can use the **list cache** commands in Table 8-2.

Table 8-2. NetBIOS List Cache Configuration Commands

Command	Displays . . .
list cache all	All permanent entries. Does not show static and dynamic entries.
list cache entry-number	A permanent cache entry according to its entry number.
list cache NetBIOS-name	A permanent cache entry for a specific NetBIOS name.
list cache ip-address	A permanent cache entry for a specific IP address.

From the NetBIOS monitoring prompt, you can use the list cache commands in Table 8-3 on page 8-15.

Table 8-3. NetBIOS List Cache Monitoring Commands

Command	Displays . . .
list cache active	All active entries in the router's name cache, including permanent, static, and dynamic entries.
list cache config	Static and permanent entries. Does not show dynamic entries.
list cache group	Entries that exist for NetBIOS group names.
list cache local	Local cache entries. Local cache entries are those that the router learns over the bridged network.
list cache name	A cache entry for a specific NetBIOS name.
list cache remote	Remote cache entries. These are entries that the router learns over the DLSw WAN.
list cache unknown	Entries where the type of NetBIOS entry is unknown. The router considers all entries unknown until it learns the type of entry.

NetBIOS Host Name and Byte Filtering Configuration Procedures

The following sections provide examples of how to set up NetBIOS filtering. The first explains how to create a host-name filter. The second demonstrates how to configure a byte filter. For more information on the commands used in these examples, see "NetBIOS Commands" on page 9-3.

To create a host-name filter, enter commands at the `NetBIOS Filter config>` prompt.

```
Config>protocol asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config>NetBIOS

NetBIOS Support User Configuration

NetBIOS config>set filter name
NetBIOS Filtering configuration
NetBIOS Filter config>
```

Creating a Host-name Filter

Use the following procedure to create a host-name filter.

1. Create an empty name filter list.

   ```
   NetBIOS Filter config>create name-filter-list
   Handle for Name Filter List []? boston
   ```

2. Add the filter items to the name filter list.

   Enter **update** to get to the prompt for that specific filter list. From this prompt, you can add filter items to the filter list.

   ```
   NetBIOS Filter config>update
   Handle for Filter List []? boston
   Name Filter List Configuration
   NetBIOS Name boston config>
   ```

3. Add filter items to the filter list with the **add** command. The way filter items are configured determines which NetBIOS packets are bridged or dropped.

Configure host-name filter items with the following parameters entered in this order:

- *Inclusive* (bridged) or *Exclusive* (dropped).
- *ASCII* or *HEX* - how the hostname is represented.
- *host name* - the actual host name represented in either an ASCII or hex string (see “NetBIOS Commands” on page 9-3 for syntax).

  Note: This entry is case sensitive.
- <*LAST-hex-number*> - an optional parameter for use with ASCII strings containing fewer than 16 characters.

The following example adds a filter item to the host-name filter list **boston**, which allows packets containing the hostname **westboro** (an ASCII string) to be bridged (configured as *inclusive*). No <*LAST-hex-number*> parameter has been configured for this entry.

```
NetBIOS Name boston config>add inclusive ascii
Hostname []? westboro
Special 16th character in ASCII hex (<CR> for no special char) []?
```

You can enter all parameters as one string on the command line if you do not want to be prompted. Be sure to use a space between each parameter.

4. Verify the filter item entry.

   Type **list** to verify your entry:

```
NetBIOS Name boston config>list

NAME Filter List Name: boston
NAME Filter List Default: Inclusive

 Item #   Type    Inc/Ex    Hostname         Last Char

   1      ASCII    Inc      westboro
```

5. Add additional filter items to the filter list.

   Repeat the first four steps to add additional filter items to the filter list. The order in which you enter filter items is important because this determines how the router applies the filter items to a packet. The first match stops the application of filter items and the router either forwards or drops the packet, depending on whether the filter item is Inclusive or Exclusive.

   Entering the most common filter items first makes the filtering process more efficient because the software is more likely to make a match at the beginning of the list.

   If the packet does not match any of the filter items, the router uses the default condition (Inclusive or Exclusive) of the filter list. You can change the default condition of the list by entering **default inclusive** or **default exclusive** at the filter list configuration prompt. For example:

```
NetBIOS Name boston config> default exclusive
```

6. When you have finished adding filter items to the filter list, enter **exit** to return to the NetBIOS Filter config> prompt.

```
NetBIOS Name boston config>exit
NetBIOS Filter config>
```

7. Add the filter to your configuration.

   The filter list containing the filter items can now be added as a filter to your bridging router configuration. Use the **filter-on** command to do this. Configure host-name filters with the following parameters (entered in this order):

- *Input* (to filter all NetBIOS packets received on that port) or output (to filter all NetBIOS packets transmitted on that port).
- *Port#*, which is the desired configured bridge port number on the router.
- *Filter-list*, which is the name of the filter list (containing filter items) that you want to be included in this filter.
- An optional operator entered as either AND or OR in all capital letters. If an operator is present, it must be followed by a filter list name. Filters with more than one filter list are called complex filters.

The following example adds a host-name filter to affect packets input on port #3. It is comprised of the host-name filter list **boston**. All packets input on port #3 are evaluated according to the rules provided by the filter items contained in the filter list **boston**. This means that all packets input on port #3 containing the hostname **westboro** are bridged.

```
NetBIOS Filter config>filter-on input
Port Number [1]? 3
Filter List []? boston
```

8. Verify the newly created filter.

   Enter **list** to verify your entry:

```
NetBIOS Filter config>list

NetBIOS Filtering: Disabled

NetBIOS Filter Lists
--------------------

    Handle           Type
    nlist            Name
    newyork          Name
    HELLO            Byte
    boston           Name

NetBIOS Filters
---------------

    Port #      Direction      Filter List Handle(s)
       3          Output       nlist
       1          Input        newyork OR HELLO
       3          Input        boston
```

9. Globally enable NetBIOS filtering.

   Use the **enable** command to globally enable NetBIOS filtering on the router.

```
NetBIOS Filter config>enable NetBIOS-filtering
```

10. Restart the router to activate all NetBIOS filtering configuration changes.

    Enter **exit** followed by **Ctrl-P** to return to the * prompt. From this prompt, enter **restart** to activate all software changes made during the NetBIOS filtering configuration process.

```
NetBIOS Filter config>exit
ASRT config>exit
Config> Ctrl-P
* restart
```

Creating a Byte Filter

Use the following procedure as a guideline for creating a byte filter. Enter all commands at the `NetBIOS filtering config>` prompt.

```
Config>protocol asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config>NetBIOS

NetBIOS Support User Configuration

NetBIOS config> set filter byte
NetBIOS Filtering configuration
NetBIOS Filter config>
```

1. Create an empty filter list using the **create byte-filter-list** command.

   ```
   NetBIOS Filter config>create byte-filter-list
   Handle for Byte Filter List []? westport
   ```

2. Add the filter items to the byte filter list.

   Enter **update** to get to the prompt for that specific filter list. From this prompt you can add filter items to the filter list.

   ```
   NetBIOS Filter config>update
   Handle for Filter List []? westport
   Byte Filter List Configuration
   NetBIOS Byte westport config>
   ```

   Begin adding filter items to the filter list with the **add** command. The way filter items are configured determines which NetBIOS packets are bridged or dropped. Byte filter items are configured with the following parameters (entered in this order):

   - Inclusive (bridged) or Exclusive (dropped).
   - Byte Offset - the number of bytes (in decimal) to offset into the packet being filtered. This starts at the NetBIOS header of the packet. Zero specifies that the router will examine all bytes in the packet.
   - Hex pattern - a hexadecimal number used to compare with the bytes starting at the byte offset of the NetBIOS header. See “NetBIOS Commands” on page 9-3 for syntax rules.
   - Hex mask - (if present) must be the same length as hex pattern and is logically ANDed with the bytes in the packet starting at byte-offset before the result is compared for equality with hex pattern. If the *hex-mask* argument is omitted, it is considered to be all binary ones.

   The following example adds a filter item to the Byte filter list **westboro** that allows packets with a hex pattern 0x12345678 at byte offset of 0 to be bridged (configured as inclusive). No hex mask is present.

   ```
   NetBIOS Byte westport config>add inclusive
   Byte Offset [0]? 0
   Hex Pattern []? 12345678
   Hex Mask (<CR> for no mask) []?
   ```

3. Verify the filter item entry with the **list** command.

   ```
   NetBIOS Byte westport config>list

   BYTE Filter List Name: westport
   BYTE Filter List Default: Inclusive

    Item #   Inc/Ex   Offset  Pattern        Mask

      1       Inc        0    0x12345678     0xFFFFFFFF
   ```

4. Add additional filter items to the filter list.

   Repeat the first three steps to add additional filter items to the filter list.

5. When you have finished adding filter items to the filter list, type **exit** to return to the `NetBIOS Filter config>` prompt.

```
NetBIOS Byte westport config>exit
NetBIOS Filter config>
```

The order in which you enter filter items is important, because this determines how the router applies the filter to a packet. The first match stops the application of filter items and the router either forwards or drops the packet, depending on whether the filter item is Inclusive or Exclusive.

Entering the most common filter items first makes the filtering process more efficient because the software is more likely to make a match at the beginning of the list rather than having to check the whole list before making a match.

If the packet does not match any of the filter items, the router uses the default condition (Inclusive or Exclusive) of the filter list. You can change the default condition of the list by entering **default inclusive** or **default exclusive** at the filter list configuration prompt. For example:

```
NetBIOS Byte westport config> default exclusive
```

6. Add the filter to your configuration.

   The filter list containing the filter items can now be added as a filter to your bridging router configuration. Use the **filter-on** command to do this. Configure host-name filters with the following parameters (entered in this order):

   - *Input* (to filter all packets received on that port) or output (to filter all packets transmitted on that port).
   - *Port#* - the configured bridge port number.
   - *Filter-list* - the name of the filter list (containing filter items) that you want included in this filter,
   - An optional operator entered as either AND or OR entered in all capital letters. If an operator is present, it must be followed by a filter list name. Filters with more than one filter list are called complex filters. These are explained in more detail in “About NetBIOS Configuration and Monitoring Commands” on page 9-1.

   The following example adds a host-name filter to affect packets output on port #3. It is comprised of the byte filter list **westboro**. All packets output on port #3 will be evaluated according to the rules provided by the filter items contained in the filter list **westboro**.

   ```
   NetBIOS Filter config>filter-on output
   Port Number [1]? 3
   Filter List []? westboro
   ```

7. Verify the newly created filter.

   Enter **list** to verify your entry:

```
NetBIOS Filter config>list

NetBIOS Filtering: Disabled

NetBIOS Filter Lists
--------------------

    Handle           Type
    nlist            Name
    newyork          Name
    HELLO            Byte
    westboro         Byte

NetBIOS Filters
---------------

    Port #      Direction      Filter List Handle(s)
       3          Output       nlist
       1          Input        newyork OR HELLO
       3          Output       westboro
```

8. Globally enable NetBIOS filtering.

   Enter **enable** to globally enable NetBIOS filtering on the bridging router.

```
NetBIOS Filter config>enable NetBIOS-filtering
```

9. Restart the router to activate all NetBIOS filtering configuration changes.

   Enter **exit** followed by **Ctrl-P** to return to the * prompt. Enter **restart**.

```
NetBIOS Filter config>exit
ASRT config>exit
Config> Ctrl-P
* restart
```

Chapter 9. Configuring and Monitoring NetBIOS

This chapter describes IBM's configuring and monitoring of NetBIOS over bridged networks and over DLSw networks. It includes the following topics:

- "About NetBIOS Configuration and Monitoring Commands"
- "NetBIOS Commands" on page 9-3

About NetBIOS Configuration and Monitoring Commands

NetBIOS configuration commands are available at the ASRT/DLSW config> prompt. Changes you make to the router's configuration do not take effect immediately. They become part of the router's configuration memory when you restart it. This chapter refers to configuration changes as permanent.

NetBIOS monitoring commands are available at the ASRT/DLSW>prompt. Monitoring commands take effect immediately, but are not saved in the router's non-volatile configuration memory. Thus, while monitoring commands allow you to make real-time changes to the router's configuration, these changes are temporary. The router's configuration memory overwrites them when the router restarts. This chapter refers to changes you make at the monitoring prompt as static.

Accessing the NetBIOS Configuration Environment

You can display the NetBIOS config> prompt from either the ASRT configuration environment or the DLSw configuration environment. Changes you make at the NetBIOS config> prompt affect both bridging and DLSw.

To display the NetBIOS config> prompt from the ASRT configuration environment:

```
Config>protocol asrt
Adaptive Source Routing Transparent Bridge user configuration
ASRT config>NetBIOS

NetBIOS Support User Configuration

NetBIOS config>
```

To display the NetBIOS config> prompt from the DLSw configuration environment:

```
Config>protocol dls
DLSw protocol user configuration
DLSw config>NetBIOS

NetBIOS Support User Configuration

NetBIOS config>
```

Accessing the NetBIOS Monitoring Environment

You can display the NetBIOS> prompt from either the ASRT monitoring environment or the DLSw monitoring environment.

Changes you make at the NetBIOS> monitoring prompt affect both bridging and DLSw.

To display the NetBIOS> monitoring prompt from the ASRT monitoring environment:

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```
+ protocol asrt
ASRT>NetBIOS

NetBIOS Support User Console

NetBIOS>
```

To display the NetBIOS> prompt from the DLSw monitoring environment:

```
+ protocol dls
DLSw>NetBIOS

NetBIOS Support User Console

NetBIOS>
```

Configuring NetBIOS for DLSw

If you are sending NetBIOS traffic over DLSw, use this procedure at the DLSw config> prompt:

- Open NetBIOS SAPs.
- Set a priority for SNA and NetBIOS sessions.
- Set the maximum NetBIOS frame size.
- Set the number of bytes to allocate for NetBIOS UI frames.

Open NetBIOS SAPs

Open NetBIOS SAPs on both sides of the link to enable DLSw to transmit NetBIOS frames.

```
DLSw config> open-sap
Interface # [0]?
Enter SAP in hex(range 0-F0),'SNA', or 'NB'[4]? nb
SAP F0 opened on interface 0
```

Set a Priority for SNA and NetBIOS Sessions

You can prioritize SNA and NetBIOS traffic to prevent one type of session from using up too much of the available bandwidth during network congestion. To do so, enter **priority** to set a priority for SNA sessions and NetBIOS sessions. You also set a message allocation that corresponds to a session's priority.

Use the **set priority** command as shown in the following example:

```
DLSw config> set priority
Default priority for SNA DLSw session traffic (C/H/M/L) [M]?  C
Default priority for NetBIOS DLSw session traffic (C/H/M/L) [M]? L
Default priority for SNA DLSw explorer traffic (C/H/M/L) [M]?  H
Default priority for NetBIOS DLSw explorer traffic (C/H/M/L) [M]? M
Message allocation by C/H/M/L priority (4 digits) [4/3/2/1]?
Maximum NetBIOS frame size (516, 1470, 2052, or 4399) [2052]? 516
```

The default message allocation of 4/3/2/1, provides the following allocation to sessions:

4 - Critical
3 - High
2 - Medium
1 - Low

The router uses the priority and message allocation to selectively limit the burst length of specific types of traffic. For example:

- If you assign SNA traffic a priority of Critical, and Critical sessions have a message allocation of 4

and

- You assign NetBIOS traffic a priority of Medium, and Medium sessions have a message allocation of 2,

the router processes four SNA frames before it processes two NetBIOS frames. Once the router processes two NetBIOS frames, it processes four SNA frames, and so on.

In this scenario, the router dedicates two–thirds of available bandwidth to SNA traffic (a ratio of 4 to 2). Note that the router counts frames, rather than bytes, when allocating bandwidth according to the priorities you assign.

You can change the message allocation for sessions from the default of 4/3/2/1. You must always enter four digits, from 9 to 1, in descending order. For example, if the SNA priority is Critical and the NetBIOS traffic is Medium, and you change the message allocation to 8/7/6/5, the router processes eight SNA frames before it processes six NetBIOS frames.

Set the Maximum NetBIOS Frame Size

You can also use the DLSw **set priority** command to change the maximum NetBIOS frame size. The default is 2052. Set this parameter to the largest frame size you expect to need, and no larger. Setting the frame size larger than needed reduces the number of available buffers.

Set the Memory Allocation for NetBIOS UI Frames

Use the DLSw **set memory** command to set the number of bytes the router allocates as a buffer for NetBIOS UI frames. If the TCP transmit buffer becomes full, the router uses this buffer for NetBIOS UI frames.

Note that the number of bytes allocated for NetBIOS is global, and not per session.

```
DLSw config> set memory
Number of bytes to allocate for DLSw (at least 26368) [141056]?
Number of bytes to allocate per LLC session [8192]?
Number of bytes to allocate per SDLC session [4096]?
Number of bytes to allocate for NetBIOS UI-frames [40960]?
```

NetBIOS Commands

Table 9-1 on page 9-4 lists the NetBIOS configuration and monitoring commands.

Table 9-1. NetBIOS Configuration and Monitoring Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds cache entries to the router’s name cache, and adds name list entries to the router’s local name list.
Delete	Deletes cache entries or name list entries that you added using the **add** command.
Disable	Disables duplicate frame filtering, route caching and the use of local and remote NetBIOS name lists.
Enable	Enables duplicate frame filtering, route caching and the use of local and remote NetBIOS name lists.
List	Displays various NetBIOS name cache and name list configuration information depending on whether you are at the configuration prompt or the monitoring prompt.
Set	Configures parameters for name caching, duplicate frame filtering, frame type filtering, and name lists. Also displays the `NetBIOS Filter config>` prompt.
Test	This command is available only at the monitoring prompt and tests a particular NetBIOS name against the current NetBIOS name cache and name lists.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Adds a new name cache entry to the router’s permanent or static configuration, or adds a NetBIOS name list entry used to limit remote station access to local DLSWs. You can add name cache entries for DLSw neighbors only. The router ignores entries that you add for ASRT traffic.

Syntax:

add cache-entry
name-list

cache-entry

Adds a new entry to the router’s name cache.

- From the configuration prompt, adds a permanent entry.
- From the monitoring prompt, adds a temporary entry.

The router prompts you for the 16th character in hex only if you have indicated via **set cache-parms** that 16 characters are relevant in a NetBIOS name.

Multiple entries with different IP addresses may be added for a single NetBIOS name. This allows the name to be accessed through multiple DLSw neighbors.

Note: The NetBIOS name is case sensitive and must match the case of the network NetBIOS name.

Example: `add cache-entry`

```
Enter up to 15 characters of NetBIOS name (no wild cards)
Enter NetBIOS name[]? Accounting
Enter last character of NetBIOS name in hex [0]? 01
Enter IP Address [0.0.0.0]? 20.2.1.3
Name cache entry has been created
```

name-list Adds a new entry to the router's local name list.

From the configuration prompt, adds a permanent name list entry. The change does not take effect until the router is restarted or the change is committed from the NetBIOS> prompt using **set name-list** command.

From the monitoring prompt, adds a temporary name list entry. The change does not take effect until the change is committed from the NetBIOS> prompt using **set name-list** command. The change is lost when you restart the router.

The NetBIOS name qualifier represents one or more NetBIOS names reachable on this router's locally bridged network that are to be made reachable to other routers through DLSw.

The NetBIOS name qualifier may contain the following two types of wildcard characters:

? (question mark)
Indicates that a single character in a real NetBIOS name can be any value.

*** (asterisk)**
At the end of a name qualifier indicates that the remaining characters in a real NetBIOS name can be any value.

Notes:

1. If an asterisk does not appear at the end of a name qualifier, the remainder of the name qualifier up to the maximum of 16 characters is padded with nulls (hex zeroes).
2. The NetBIOS name qualifier is case sensitive and must match the case of the network NetBIOS names.

Example: `add name-list`

```
Enter up to 16 characters of NetBIOS name qualifier (wild cards OK).
  Enter name qualifier []? NY_SERV*
NetBIOS name qualifier type (I=individual, G=group) [I]?

Name list entry has been created

For the new entry to take effect, restart or commit the change using
  't 5' : 'SET NAME-LIST'.
```

Delete

Deletes name cache entries or NetBIOS name list entries.

Syntax:

de**lete**	cache-entry
	name-list

cache-entry

From the configuration prompt, deletes name cache entries from the router's permanent configuration. The router prompts for a record number, which is the number of the entry you want to delete. To see a list of entry numbers, enter **list cache all**.

From the monitoring prompt, deletes name cache entries from the router's static configuration or active cache. The router prompts for a cache entry name. To see a list of entries, enter **list cache conf** or **list cache active**.

Note: The NetBIOS name is case sensitive.

Example for Configuration: `delete cache-entry`

```
Enter name cache record number [1]? 2

Name cache entry has been deleted
```

Example for Monitoring: `delete cache-entry`

```
Enter up to 15 characters of NetBIOS name (no wild cards)
  Enter NetBIOS name []? ADMIN

Name cache entry NOT found in Active list for name entered
Name cache entry has NOT been deleted from Active list

Static name cache entry deleted from Config list
```

name-list Deletes an entry from the router's local name list.

From the configuration prompt, deletes a permanent name list entry. The router prompts for a record number that is the number of the entry you want to delete. To see a list of entry numbers, enter the **list name-list all** command. The change does not take effect until the router is restarted or the change is committed from the monitoring prompt using the **set name-list** command.

From the monitoring prompt, temporarily deletes a name list entry. The router prompts for a record number that is the number of the entry you want to delete. To see a list of entry numbers, enter the **list name-list config** command. The change does not take effect until the change is committed from the monitoring prompt using the **set name-list** command. The change is lost if the router is restarted.

Example: `delete name-list`

```
Enter name list record number [1]? 1

Name list entry NY_SERV*         / INDIVIDUAL has been deleted.

For the deletion to take effect, restart or commit the change using
  't 5' : 'SET NAME-LIST'.
```

Disable

Disables duplicate frame filtering, use of NetBIOS name lists, or route caching.

Syntax:

di**sable**	duplicate-filtering
	name-list local
	name-list remote
	route-caching

duplicate-filtering

Disables duplicate frame filtering for bridging. You cannot disable duplicate frame filtering for DLSw traffic.

Example: `disable duplicate-filtering`

```
Duplicate frame filtering is          OFF
```

name-list local

Disables the use of the local name list. The local name list entries will not be sent to any DLSw partners.

From the configuration prompt, permanently disables the use of the local name list. The change does not take effect until the router is restarted or the change is committed from the monitoring prompt using the **set name-list** command.

From the monitoring prompt, temporarily disables the use of the local name list. The change does not take effect until the change is committed from the monitoring prompt using the **set name-list** command. The change is lost if the router is restarted.

Example: `disable name-list local`

```
Use of local NetBIOS name list is  DISABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET NAME-LIST'.
```

name-list remote

Disables the use of remote name lists. NetBIOS name lists received from DLSw partners are not used.

From the configuration prompt, permanently disables the use of remote name lists. The change does not take effect until the router is restarted or the change is committed from the monitoring prompt using the **set name-list** command.

From the monitoring prompt, temporarily disables the use of remote name lists. The change does not take effect until the change is committed from the monitoring prompt using the **set name-list** command. The change is lost if the router is restarted.

Example: `disable name-list remote`

```
Use of remote NetBIOS name list is  DISABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET NAME-LIST'.
```

route-caching

Disables route caching for bridging and DLSw. Route caching is the process of converting broadcast frames to specifically routed frames (SRFs) using the entries in the NetBIOS name cache.

Example: `disable route-caching`

```
Route caching is                      OFF
```

Enable

Enables duplicate frame filtering, use of NetBIOS name lists, or route caching.

Syntax:

en**able**	duplicate-filtering
	name-list local

name-list remote
route-caching

duplicate-filtering

Enables duplicate frame filtering for bridging. Duplicate frame filtering is always enabled for DLSw. You cannot enable and disable it.

Example: `enable duplicate-filtering`

```
Duplicate frame filtering is           ON
```

name-list local

Enables the use of the local name list. The local name list entries will be sent to all DLSw partners.

From the configuration prompt, permanently enables the use of the local name list. The change does not take effect until either to router is restarted or the change is committed from the monitoring prompt using the **set name-list** command.

From the monitoring prompt, temporarily enables the use of the local name list. The change does not take effect until the change is committed from the monitoring prompt using the **set name-list** command. The change is lost if the router is restarted.

Example: `enable name_list local`

```
Use of local NetBIOS name list is   ENABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET NAME-LIST'.
```

name-list remote

Enables the use of remote name lists. All NetBIOS names lists received from DLSw partners are used.

From the configuration prompt, permanently enables the use of remote name lists. The change does not take effect until either the router is restarted or the change is committed from the monitoring prompt using the **set name-list** command.

From the monitoring prompt, temporarily enables the use of remote name lists. The change does not take effect until the change is committed from the monitoring prompt using the **set name-list** command. The change is lost if the router is restarted.

Example: `enable name_list remote`

```
Use of remote NetBIOS name list is   ENABLED

For the change to take effect, restart or commit the change using
  't 5' : 'SET NAME-LIST'.
```

route-caching

Enables route caching for bridging and DLSw. Route caching is the process of converting broadcast to specifically routed frames (SRFs) using the NetBIOS name cache.

Example: `enable route-caching`

```
Route caching is                       ON
```

List (Configuration)

Displays all cache entries or displays cache entries by type of entry. Displays filter configuration information or general configuration information. Displays local NetBIOS name list entries.

Syntax:

list
cache all
cache entry-number
cache name
cache ip-address
filters all
filters bridge
filters dlsw
general
name-list all
name-list *entry-number*

cache all Displays all permanent entries in the router's name cache. It does not display static or dynamic entries.

Example: `list cache all`

```
Entry  Name                IP Address
-----  ------------------  ---------------

    1  ACCOUNTING     <00>  20.2.1.3
    2  NOTES          <00>  20.2.3.4
```

cache entry-number *record#*
Displays a cache entry according to its entry number. Enter **list cache all** to see a list of entry numbers.

Example: `list cache entry-number`

```
Enter name cache record number [1]? 1

Entry  Name                IP Address
-----  ------------------  ---------------
    1  ACCOUNTING     <00>  20.2.1.3
```

cache name *name*
Displays a cache entry for a specific NetBIOS name. You can use the following wildcards to simplify your search:

***** (asterisk) stands for zero or more occurrences of any characters. For example, San* could produce:

- San Francisco
- Santa Fe
- San Juan

? (question mark) stands for any one character.

$ (dollar sign) has an effect only when the number of significant NetBIOS name characters is not 16, and when the search argument does not begin with an asterisk (*).

You can use as many wildcards as you like, up to the maximum number of characters in a NetBIOS name (15 or 16, depending on the configuration).

Note: The NetBIOS name is case sensitive.

Example: `list cache name`

```
Enter up to 15 characters of NetBIOS name (wild cards ok) []? Acc*

Entry  Name                IP Address
-----  ------------------  ---------------
    1  Accounting     <00>  20.2.1.3
```

cache ip-address

Lets you display all entries with a specific IP address.

Example: `list cache ip-address`

```
Enter IP Address [0.0.0.0]? 20.2.1.3

Entry  Name                IP Address
-----  ------------------  ---------------
    1  Accounting     <00>  20.2.1.3
```

filters all Displays whether frame type filtering is on or off for both bridging and DLSw. Use the **set filters bridge**s commands to turn these filters on or off.

Example: `list filters all`

```
Bridge name conflict filtering is       OFF
Bridge general bcast filtering is       OFF
Bridge trace control filtering is       OFF

DLS name conflict filtering is          ON
DLS general bcast filtering is          ON
DLS trace control filtering is          ON
```

filters bridge

Displays whether frame type filtering is on or off for bridging. Use the **set filters bridge** to turn these filters on or off.

Example: `list filters bridge`

```
Bridge name conflict filtering is       OFF
Bridge general bcast filtering is       OFF
Bridge trace control filtering is       OFF
```

filters dlsw

Displays whether or not frame type filtering is on or off for DLSw. Use the **set filters dlsw** to turn these filters on or off.

Example:

```
list filters dlsw
DLS name conflict filtering is          ON
DLS general bcast filtering is          ON
DLS trace control filtering is          ON
```

general Displays the current NetBIOS caching and filtering configuration.

Example:

```
list general
Bridge-only Information:

Bridge duplicate filtering is          OFF
Bridge duplicate frame filter t/o      1.5 seconds

DLS-only Information:
DLS command frame retry count            5
DLS max remote name cache entries      100
DLS command frame retry timeout        0.5 seconds
DLS type of local name list  NON-EXCLUSIVE
DLS use of local name list is     DISABLED
DLS use of remote name list is     ENABLED

Bridge Common Information:
Route caching is                        OFF
Significant characters in name           15
Max local name cache entries            500
Duplicate frame detect timeout          5.0 seconds
Best path aging timeout                60.0 seconds
Reduced search timeout                  1.5 seconds
Unreferenced entry timeout             5000 minutes
```

name-list all

Displays all permanently configured local NetBIOS name list entries. It does not display static entries.

Example:

```
list name-list all
Entry  Name Qualifier    Type
-----  ----------------  ----------
  1    NY_SERV*          INDIVIDUAL
  2    NY_DOMAIN*             GROUP
```

name-list *entry-number*

Displays a particular permanently configured local NetBIOS name list entry.

Example:

```
list name-list entry-number
Enter name list record number [1]? 1

Entry  Name Qualifier    Type
-----  ----------------  ----------
  1    NY_SERV*          INDIVIDUAL
```

List (Monitoring)

Displays various types of cache entries, filter configuration, general configuration information, NetBIOS name lists, or statistics on other things.

Syntax:

list

cache active
cache config
cache group
cache local
cache name
cache remote
cache unknown
filters all
filters bridge
filters dlsw
general
name-list all
name-list config
name-list local
name-list remote
statistics cache
statistics frames bridge
statistics frames dlsw
statistics general bridge
statistics general dlsw

cache active

Displays all active entries in the router's name cache.

The number in angle brackets is the 16th character of the NetBIOS name. This character, which you can enter in hexadecimal if you create the cache entry, is used by some NetBIOS applications for special purposes.

If the Name Type field does not specify LOCAL, it is a remote entry.

Example: `list cache active`

```
Cnt  NetBIOS Name         Name Type          Entry Type
---  -------------------  -----------------  ----------
  1  HYPERION       <01>  INDIVIDUAL LOCAL   DYNAMIC
  2  LANGROUP       <00>  UNKNOWN            STATIC
  3  ACCOUNTING     <00>  GROUP              PERMANENT
```

cache config

Displays all static and permanent name cache entries. Does not show dynamic entries.

The number in angle brackets is the 16th character of the NetBIOS name. This character, which you can enter in hexadecimal if you create the cache entry, is used by some NetBIOS applications for special purposes.

Example: `list cache config`

```
Name                IP Address      Source     Last Mod
------------------  --------------  ---------  ---------
Admin         <00>  20.3.120.8      STATIC     ADDED
Finance       <01>  20.4.96.8       PERMANENT  MODIFIED
Notes         <00>  20.8.210.3      PERMANENT  UNCHANGED
```

cache group

Displays cache entries that exist for NetBIOS group names.

Example: `list cache group`

```
Cnt  NetBIOS Name         Entry Type  Loc Path State  Rem Path State
---  -------------------  ----------  --------------  --------------
  2  HYPERION       <01>  DYNAMIC     UNKNOWN         GROUP
  3  EXCEL          <00>  DYNAMIC     GROUP           GROUP
```

cache local

Displays local cache entries. Local cache entries are those that the router learns via the local bridge network.

For NetBIOS clients the Local Path State is always Unknown and the MAC address and Routing information fields are always empty.

Example: `list cache local`

```
Cnt  NetBIOS Name     Loc Path State  MAC Address  Routing Information
---  ---------------  --------------  -----------  -------------------
  2  HYPERION   <01>  UNKNOWN
```

Cnt Number of the cache entry.

NetBIOS Name
The entry's NetBIOS name.

Loc Path State
Local Path State.

MAC Address
If the entry is a server, displays the MAC address of the server.

Routing Information
Displays standard RIF information.

cache name *name*

Displays a cache entry for a specific NetBIOS name. You can use the following wildcards to simplify your search:

***** (asterisk) stands for zero or more occurrences of any characters. For example, San* could produce:

- San Francisco
- Santa Fe

- San Juan

? (question mark) stands for any one character.

$ (dollar mark) has an effect only when the number of significant NetBIOS name characters is not 16, and when the search argument does not begin with an asterisk (*).

You can use as many wildcards as you like, up to the maximum number of characters in a NetBIOS name (15 or 16 depending on the configuration).

Note: NetBIOS names are case sensitive.

Example: `list cache name`

```
     NetBIOS Name         Name Type          Entry Type
     -------------------  -----------------  ----------
     HYPERION       <01>  INDIVIDUAL REMOTE  DYNAMIC

Count of name cache entry hits ............................... 20

Age of name cache entry ...................................... 689
Age of name cache last reference ............................. 85

Local path information:

  Loc Path State  Timestamp  MAC Address    LFS   Routing Information
  --------------  ---------  ------------  -----  -------------------
  UNKNOWN         689

Remote path information:

  Rem Path State  Timestamp   LFS   IP Address(es)
  --------------  ---------  -----  --------------
  BEST FOUND      85         2052   20.3.120.8
```

cache remote

Displays cache entries that the router learns over the DLSw WAN.

Example: `list cache remote`

```
Cnt  NetBIOS Name         Entry Type  Rem Path State  IP Address(es)
---  -------------------  ----------  --------------  --------------
  2  HYPERION       <01>  STATIC      BEST FOUND      20.3.120.8
  3  EXCEL          <00>  DYNAMIC     SEARCH ALL
```

Cnt Number of the cache entry.

NetBIOS Name

The entry's NetBIOS name.

Rem Path State

Remote Path State. Possible states are:

Best Found
: The router found the best route to this station.

Unknown
: The router has not yet found the best route to this station.

Group
: The router does not search for a best path for group names.

Search Limited
: The router is conducting a limited search for this NetBIOS name. See the **set cache-parms** command for more information on reduced search.

Search All
The router is conducting a full search. When the **set cache-parms** command's reduced search timer expires, the router conducts a full search.

IP Address(es)
If best path found, displays the IP address or addresses associated with the neighbor DLSw that can reach the NetBIOS station.

cache unknown
Displays cache entries where the type NetBIOS name is unknown. The router enters all dynamic entries as Unknown until it learns the type of name. It then marks entries as local, remote, or group.

Example: `list cache unknown`

```
Cnt  NetBIOS Name     Entry Type      Loc Path State  Rem Path State
---  ---------------  --------------  --------------  --------------
  2  HYPERION   <01>  STATIC          UNKNOWN          UNKNOWN
  3  EXCEL      <00>  STATIC          UNKNOWN          UNKNOWN
```

filters all

Displays whether or not frame type filtering is on or off for both bridging and DLSw.

Use the **set filters bridge** and **set filters dlsw** commands to turn these filters on or off.

Example: `list filters all`

```
Bridge name conflict filtering is       OFF
Bridge general bcast filtering is       OFF
Bridge trace control filtering is       OFF

DLS name conflict filtering is          ON
DLS general bcast filtering is          ON
DLS trace control filtering is          ON
```

filters bridge
Displays whether or not frame type filtering is on or off for bridging. Use the **set filters bridge** command to turn these filters on or off.

Example: `list filters bridge`

```
Bridge name conflict filtering is       OFF
Bridge general bcast filtering is       OFF
Bridge trace control filtering is       OFF
```

filters dlsw
Displays whether or not frame type filtering is on or off for both DLSw. Use the **set filters dlsw** command to turn these filters on or off.

Example: `list filters dlsw`

```
DLS name conflict filtering is          ON
DLS general bcast filtering is          ON
DLS trace control filtering is          ON
```

general Displays the current NetBIOS caching and filtering configuration.

Example: `list general`

```
Bridge-only Information:

Bridge duplicate filtering is          OFF
Bridge duplicate frame filter t/o      1.5 seconds

DLS-only Information:


DLS command frame retry count            5
DLS max remote name cache entries      100
DLS command frame retry timeout        0.5 seconds
DLS type of local name list  NON-EXCLUSIVE
DLS use of local name list is     DISABLED
DLS use of remote name list is     ENABLED

DLS-Bridge Common Information:

Route caching is                       OFF
Significant characters in name          15
Max local name cache entries           500
Duplicate frame detect timeout         5.0 seconds
Best path aging timeout               60.0 seconds
Reduced search timeout                 1.5 seconds
Unreferenced entry timeout            5000 minutes
```

name-list all

Displays all currently active NetBIOS name list entries both local and remote. If local name list entries have not been committed or the use of local name lists is disabled, local name list entries will not appear in the list. If use of the remote name lists is disabled, remote name list entries will not appear in the list.

Example: `list name-list all`

```
Name Qualifier    Type        IP Address
----------------  ----------  ---------------
LA_DOMAIN*             GROUP  20.2.1.3
LA_SERV*          INDIVIDUAL  20.2.1.3
NY_DOMAIN*             GROUP  Local
NY_SERV*          INDIVIDUAL  Local
SF_DOMAIN*             GROUP  20.2.3.4
SF_SERV*          INDIVIDUAL  20.2.3.4
TEMP_DOMAIN            GROUP  Local
TEMP_SERV01       INDIVIDUAL  Local
```

name-list config

Displays all permanently and temporarily configured local NetBIOS name list entries.

The source field can have one of the following values:

PERMANENT
Permanently configured entries.

STATIC Temporarily configured entries.

The LastMod field can have one of the following values:

ADDED The local name list entry has been added, but the change has not been committed.

DELETED
The local name list entry has been deleted, but the change has not been committed

UNCHANGED
The local name list entry has been added and the change has been committed

Example: `list name-list config`

```
Entry  Name Qualifier    Type        Source     LastMod
-----  ----------------  ----------  ---------  ---------
  1    NY_SERV*          INDIVIDUAL  PERMANENT  UNCHANGED
  2    NY_DOMAIN*             GROUP  PERMANENT  UNCHANGED
  3    TEMP_SERV01       INDIVIDUAL  STATIC     ADDED
  4    TEMP_DOMAIN            GROUP  STATIC     ADDED
```

name-list local

Displays all currently active local NetBIOS name list entries If local name list entries have not been committed or the use of local name lists is disabled, local name list entries will not appear in the list.

Example: `list name-list local`

```
LOCAL Name List
Type of Name List (active) .......     EXCLUSIVE
Type of Name List (pending) ...... NON-EXCLUSIVE

Name Qualifier    Type
----------------  ----------
NY_DOMAIN*             GROUP
NY_SERV*          INDIVIDUAL
TEMP_DOMAIN            GROUP
TEMP_SERV01       INDIVIDUAL
```

name-list remote

Displays all currently active remote NetBIOS name list entries for a particular DLSw partner. If use of the remote name lists is disabled, no entries will appear.

Example: `list name-list remote`

```
Enter IP Address [0.0.0.0]? 20.2.1.3

Partner IP Address ........... 20.2.1.3

Type of Name List .............     EXCLUSIVE
    Use of remote name lists ..... ENABLED

Name Qualifier    Type
----------------  ----------
LA_DOMAIN*             GROUP
LA_SERV*          INDIVIDUAL
```

statistics cache

Lists the following name cache statistics.

Example: `list statistics cache`

```
Local name cache entries                1
Remote name cache entries               1
Local individual names                  1
Remote individual names                 0
Group names                             0
Unknown names                           1
Name cache hits                      2194
Name cache misses                       2
```

statistics frames bridge

Lists the following name cache statistics for bridging.

Example: `list statistics frames bridge`

```
Frames in cache                         0
Name query frames                       0
Status query frames                     0
Add name frames                         0
Add group name frames                   0
Name in conflict frames                 0
Frames not filtered as duplicates       0
```

statistics frames dlsw

Lists the following name cache statistics for DLSw.

Example: `list statistics frames dlsw`

```
Name query frames                       0
Status query frames                     0
Add name frames                         0
Add group name frames                   0
Name in conflict frames                 0
Frames not filtered as duplicates       0
```

statistics general bridge

Displays frame counts for bridging.

Example: `list statistics general bridge`

```
Frames received                      1339
Frames discarded                        0
Frames forwarded to bridge           1339
Frames forwarded to DLS              1339
```

statistics general dlsw

Displays frame counts for DLSw.

Example: `list statistics general dlsw`

```
Frames received                      1339
Frames discarded                        0
Frames forwarded to bridge           1339
```

Set

Sets name caching parameters, turns frame type filtering on or off for either bridging or DLSw, adjusts duplicate frame filtering timers and frame retry timers, and sets NetBIOS name list parameters. Also displays the NetBIOS name and byte filtering prompt.

Syntax:

set
- cache-parms
- filters bridge
- filters byte
- filters dlsw
- filters name
- general
- name-list

cache-parms

Sets name caching parameters that apply to bridging or switching.

Example: `set cache-parms`

```
Significant characters in name [15]?
Best path aging timeout value in seconds [60.0]?
Reduced search timeout value in seconds [1.5]?
Unreferenced entry timeout value in minutes [5000]?
Max nbr local name cache entries [500]?
Max nbr remote name cache entries [100]?

Cache parameters set
```

Significant characters in name

Determines whether the router considers 15 or 16 characters when it looks up the NetBIOS name. If you enter 15, the router ignores the 16th character. If you select 16, the router includes the 16th character when it looks up cache entries.

The default is 15.

Best path aging timeout

Amount of time the router considers the address and route for a name cache entry to be the best path to that station. When this

timer expires, the router deletes the name cache entry and attempts to discover a new best path for the NetBIOS name.

To determine the best path, the router considers transmission time between nodes on all possible routes connecting those nodes, as well as largest frame size. The router does not consider a path suitable if it cannot accommodate the largest NetBIOS frame that could be transmitted over the path.

The default is 60 seconds. The range is 1.0 to 100000.0 seconds.

Reduced search timeout
When the router receives a Name-Query, Status-Query, or Datagram during the timeout period, it carries out a search based on current NetBIOS name cache information.

If the router receives a duplicate frame after this timer expires, it assumes the previous route is not longer valid and it widens its search. The router forwards the duplicate frame to both bridges and DLS. DLS broadcasts the corresponding SSP message to all possible DLS partners.

The default is 1.5 seconds. The range is 1.0 to 100.0 seconds.

Unreferenced entry timeout
The router keeps a name that is not referenced in its cache for this length of time before deleting it. If the cache fills up, the router removes entries sooner.

The default is 5000 minutes. The range is 1 to 100000 minutes.

Max nbr local name cache entries
Maximum number of locally-learned entries the router saves in the name cache.

The default is 500. The range is 100 to 30000. You can lower this value to save router memory. To optimize memory usage, processor usage, and the amount of broadcast traffic, set the number of local name cache entries as close as possible to the total number of NetBIOS stations (servers and clients) that are active on this router's local bridge network.

Max nbr remote name cache entries
Maximum number of remotely-learned entries, group name entries, and unknown entries that the router saves in the name cache.

The default is 100. The range is 100 to 30000. You can lower this value to save router memory. To optimize memory usage, processor usage, and the amount of broadcast traffic, set the number of remote name cache entries to the number of remote NetBIOS servers that are to be accessed by NetBIOS clients on this router's local bridge network, plus about 25%.

filters bridge
Turns frame-type filtering for bridging on or off.

Example: `set filters bridge`

```
Filter Name Conflict frames? [No]: y

Name conflict filtering is            ON

Filter General Broadcast frames? [No]:

General broadcast filtering is        OFF

Filter Trace Control frames? [No]:

Trace control filtering is            OFF
```

filters byte

From the NetBIOS config> prompt, displays the NetBIOS filtering configuration prompt (NetBIOS Filter config>). Configuring NetBIOS filtering is explained in Chapter 10, “Configuring and Monitoring NetBIOS Filtering” on page 10-1.

From the NetBIOS > monitoring prompt, displays the NetBIOS filtering monitoring prompt (NetBIOS Filter>). Monitoring NetBIOS filtering is explained in “Monitoring NetBIOS Filtering” on page 10-10.

This parameter allows you to access NetBIOS byte filtering.

Example: `set filters byte`

```
NetBIOS Filtering configuration
NetBIOS Filter config>
```

filters dlsw

Sets frame-type filters for DLSw traffic.

Example: `set filters dlsw`

```
Filter Name Conflict frames? [Yes]:

Name conflict filtering is             ON

Filter General Broadcast frames? [Yes]:

General broadcast filtering is         ON

Filter Trace Control frames? [Yes]:

Trace control filtering is             ON
```

filters name

From the NetBIOS config> prompt, displays the NetBIOS filtering configuration prompt (NetBIOS Filter config>). Configuring NetBIOS filtering is explained in Chapter 10, “Configuring and Monitoring NetBIOS Filtering” on page 10-1.

From the NetBIOS > monitoring prompt, displays the NetBIOS filtering monitoring prompt (NetBIOS Filter>). Monitoring NetBIOS filtering is explained in “Monitoring NetBIOS Filtering” on page 10-10.

This parameter allows you to access NetBIOS name filtering.

Example: `set filters name`

```
NetBIOS Filtering configuration
NetBIOS Filter config>
```

general Sets the duplicate frame timeout, duplicate frame-detect timeout, and the command frame retry count and timeout. See “Duplicate Frame Filtering” on page 8-5 for more information on how duplicate frame filters work.

Example: `set general`

```
ATTENTION! Setting Duplicate Frame Filter Timeout to zero...
disables duplicate frame checking!

Duplicate frame filter timeout value in seconds [1.5]?

Duplicate frame detect timeout value in seconds [5.0]?

General parameters set
```

If DLSw is enabled, the software also prompts you for:

```
Command frame retry count [5]?
Command frame retry timeout value in seconds [0.5]?
```

Duplicate frame filter timeout
Applies only to bridged traffic if duplicate filtering is enabled. During this timeout period, the router filters all duplicate frames it receives.

The range is 0.0 to 100.0 seconds. Zero disables duplicate frame checking. The default is 1.5 seconds.

Duplicate frame-detect timeout
Applies to both bridged and DLSw traffic. Amount of time during which the router saves entries in its duplicate frame filter database. When this timer expires, the router creates new entries for new frames that it receives.

The range is 0.0 to 100.0 seconds. The default is 5 seconds.

Command frame retry count
Applies only to DLSw traffic.

Number of duplicate NetBIOS UI frames the target DLSw router sends to its locally attached LAN. These frames are sent at intervals specified by the command frame retry timeout.

The range is 0 to 10. The default is 5.

Command frame retry timeout
Applies only to DLSw traffic. This is the interval at which a neighbor DLSw router retries sending duplicate NetBIOS UI frames to its local bridge network.

The range is 0.0 to 10.0 seconds. The default is 0.5 seconds.

name-list Sets parameters related to the local NetBIOS name list. Currently the only local NetBIOS name list related parameter is the local NetBIOS name list exclusivity.

From the configuration prompt, permanently sets the local NetBIOS name list parameters. The change does not take effect until either the router is restarted or the change is committed from the monitoring prompt using **set name-list** command.

From the monitoring prompt, this command temporarily sets the local NetBIOS name list parameters. The command also commits any NetBIOS name list changes that have been made from the configuration or monitoring prompts.

Test (Monitoring only)

Allows testing of real NetBIOS names against the current NetBIOS cache or the NetBIOS name list.

Syntax:

test cache
name-list

test cache

Displays a list of current DLSw partners to which a DLSw frame with a given NetBIOS destination name would be forwarded and how the frame will be forwarded.

Example (no corresponding NetBIOS cache entry): `test cache ABC`

```
Destination NetBIOS name being tested .... ABC           <20>

Name cache entry NOT found.

How frame destined for this NetBIOS name is forwarded to DLSw partners .....
  Send to all partners.
```

Example (corresponding NetBIOS cache entry): `test cache LA_SERV01`

```
Destination NetBIOS name being tested .... LA_SERV01     <00>

Name cache entry found:
  Name type = INDIVIDUAL REMOTE;   Entry type = DYNAMIC

How frame destined for this NetBIOS name is forwarded to DLSw partners .....
  Send to all name list learned and dynamically learned partners.

List of DLSw partners to which frame destined for this name is forwarded .....

  Send via TCP           to 20.2.1.3 ( Name list, Learned )
```

test name-list

Displays a list of NetBIOS name list entries (local or remote) that match the given NetBIOS name.

Example: `test name-list`

```
Enter up to 15 characters of NetBIOS name (no wild cards).
  Enter NetBIOS name []? LA_SERV01
Enter last character of NetBIOS name in hex [0]?

Name Qualifier    Type        IP Address
----------------  ----------  ---------------
LA_SERV*          INDIVIDUAL  20.2.1.3
```

Chapter 10. Configuring and Monitoring NetBIOS Filtering

This chapter describes the NetBIOS filtering configuration commands. These commands let you configure NetBIOS filtering as an added feature to ASRT bridging. Configuration commands are accessed from the `NetBIOS config>` prompt.

Accessing the ASRT and the DLSW Configuration Environments

To display the NetBIOS filtering prompt from the ASRT environment, enter the commands as shown in the following example:

```
Config> protocol asrt
Adaptive Source Routing Transparent Bridge user configuration

ASRT config> netbios
NetBIOS Support User Configuration

NetBIOS config> set filters name or byte
NetBIOS filtering configuration

NetBIOS filter config>
```

To display the `NetBIOS config>` prompt from the DLSw configuration environment:

```
Config> protocol dls
DLSw protocol user configuration

DLSw config> netbios
NetBIOS Support User Configuration

NetBIOS config> set filters name or byte
NetBIOS filtering configuration

NetBIOS filter config>
```

Table 10-1 shows the NetBIOS filtering configuration commands.

NetBIOS Filtering Configuration Commands

Table 10-1. NetBIOS Filtering Configuration Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Create	Creates byte filter and host-name filter lists for NetBIOS filtering.
Delete	Deletes byte filter and host-name filter lists for NetBIOS filtering.
Disable	Disables NetBIOS filtering on the bridging router.
Enable	Enables NetBIOS filtering on the bridging router.
Filter-on	Assigns a created filter to a specific port. This filter can then be applied to all NetBIOS packets input ***or*** output on the specified port.
List	Displays all information concerning created filters.
Update	Adds information to or deletes information from a host-name or byte filter list.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

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Create

Use the **create** command to create a byte filter-list or host-name filter list.

Syntax:

create byte-filter-list *filter-list*
name-filter-list *filter-list*

byte-filter-list *filter-list*

Creates a byte filter-list name for NetBIOS filtering. You can use up to 16 characters to identify the list being built. *Filter-list* must be a unique name that has not been used previously with the **create byte-filter-list** or **create name-filter-list** command.

Example: `create byte-filter-list newyork`

name-filter-list *filter-list*

Creates a host-name filter-list name for NetBIOS filtering. You can use up to 16 characters to identify the name filter-list being built. *Filter-list* must be a unique name that has not been used previously with the **create byte-filter-list** or **create name-filter-list** command.

Example: `create name-filter-list atlanta`

Delete

Use the **delete** command to delete byte filter lists, host-name filter lists, and filters created using the **filter-on input** or **filter-on output** command. The command removes all information associated with byte and host-name filter lists. It also frees the user-defined string as a name for a new filter list.

Syntax:

delete byte-filter-list *filter-list*
name-filter-list *filter-list*
filter input *port#*
filter output *port#*

byte-filter-list *filter-list*

Deletes a byte filter-list created for NetBIOS filtering. *Filter-list* is the user-defined string being used to identify the byte filter-list being deleted.

Example: `delete byte-filter-list newyork`

name-filter-list *filter-list*

Deletes a host-name filter-list created for NetBIOS filtering. *Filter-list* is the user-defined string that is used to identify the name-filter-list being deleted.

Example: `delete name-filter-list atlanta`

filter input *port#*

Deletes a filter that was created using the **filter-on input** command. The command removes all information associated with the filter and fills any resulting gap in filter numbers.

Example: `delete filter input 2`

filter output *port#*

Deletes a filter that was created using the **filter-on output** command. The command removes all information associated with the filter and fills any resulting gap in filter numbers.

Example: `delete filter output 2`

Disable

Use the **disable** command to globally disable NetBIOS name and byte filtering on the router.

Syntax:

disable netbios-filtering

Example: `disable netbios-filtering`

Enable

Use the **enable** command to globally enable NetBIOS name and byte filtering on the router.

Syntax:

enable netbios-filtering

Example: `enable netbios-filtering`

Filter-on

This command assigns one or more previously configured filter lists to the input or output of a specific port.

Syntax:

filter-on input *port# filter-list <operator filter-list . . . >*
output *port# filter-list <operator filter-list . . . >*

input *port# filter-list <operator filter-list . . . >*

This command assigns one or more filter lists to incoming packets on a specific port. The resulting filter is then applied to all NetBIOS packets input on the specified port.

Port# is a configured bridge port number on the router. The port number identifies this filter. Enter **list** to see a list of port numbers. Filter-list is a string previously entered using the **create** command. To add additional filter lists to this port, enter AND or OR in all capital letters followed by the filter list name.

Note: Multiple operators can be used to create a complex filter. If you enter multiple operators, they must all be entered at the same time on the same command line.

The filter created by this command is applied to all incoming NetBIOS packets on the specified port. Each filter list on the command line is evaluated left to right along with any operators that are present. An Inclusive evaluation of a filter list is equivalent to a True condition and an Exclusive evaluation is equivalent to a False condition. If the result of

the evaluation of the filter-lists is True, the packet is bridged. Otherwise, the packet is filtered (dropped).

If the packet is not one of the types supported by NetBIOS filtering then all host-name filter lists for this filter are designated “Inclusive” (True). If an input filter already exists for specified port number, an error message is displayed.

Example: `filter-on input 2 newyork AND boston`

output *port# filter-list <operator filter-list . . .>*

This command assigns one or more filters to outgoing packets on a port. This filter is then applied to all NetBIOS packets output on that port.

Port# is a configured bridge port number on the router. The port number identifies this filter. Enter **list** to see a list of port numbers. Filter-list is a string previously entered using the create command. Enter an optional operator as either AND or OR in all capital letters. If an operator is present, it must be followed by a filter-list name. The port number is used to identify this filter.

Note: Multiple operators can be used. This creates a complex filter. If one or more operators are present, they must all be entered at the same time on the same command line.

The filter created by this command is applied to all NetBIOS packets output on the specified port number. Each filter list on the command line is evaluated left to right along with any operators that are present. An Inclusive evaluation of a filter list is equivalent to a True condition and an Exclusive evaluation is equivalent to a False condition. If the result of the evaluation of the filter-lists is True, the packet is bridged. Otherwise, the packet is filtered (dropped).

If the packet is not one of the types supported by NetBIOS filtering then all host-name filter lists for this filter are designated “Inclusive” (True). If an output filter already exists for specified port number, an error message is displayed.

Example: `filter-on output 2 newyork OR boston`

List

Use the **list** NetBIOS Filtering command to display all information concerning created filters.

Syntax:

list

Example: `list`

```
NetBIOS Filtering: Disabled

NetBIOS Filter Lists
--------------------

Handle           Type

nlist            Name
newyork          Byte

NetBIOS Filters
---------------

Port #      Direction      Filter List Handle(s)

3           Output         nlist
```

NetBIOS Filtering:
Displays whether NetBIOS filtering is enabled or disabled.

NetBIOS Filter Lists
Displays the user-defined name (handle) of the configured filter lists. For type, “Name” indicates a host-name filter list and “Byte” indicates a byte filter list.

NetBIOS Filters
Displays the assigned port number and direction (input or output) of each filter. Filter List Handles displays the names of the filter lists making up the filter.

Update

Use the **update** command to add or delete information from host-name or byte filter lists. The filter-list is a string previously entered using the create byte (or name) filter-list prompt. This command brings you to the `NetBIOS Byte (or Name) filter-list Config>` prompt, which lets you perform update tasks to the specified filter list. At this prompt you can add, delete, list, or move filter-items from byte and host-name filter lists. At this prompt you can also set the default value of each filter list to Inclusive or Exclusive.

Using the add subcommand creates a filter item within the filter list. The first filter item created is assigned number 1, the next one is assigned number 2, and so on. After you enter a successful add subcommand, the router displays the number of the filter item just added.

Note: Adding more filter items to filter lists adds to processing time (due to the time it takes to evaluate each filter item in the list) and can affect performance in heavy NetBIOS traffic.

The order in which filter items are specified for a given filter list is important as this determines the way in which the filter items are applied to a packet. The first match that occurs stops the application of filter items, and the filter list is evaluated as either Inclusive or Exclusive (depending on the Inclusive or Exclusive designation of the matched filter item). If none of the filter items of a filter list produces a match, then the default condition (Inclusive or Exclusive) of the filter list is returned.

The delete subcommand specifies the number of a filter item to be deleted from the filter list. When a delete subcommand is given, any hole created in the list is filled in. For example, if filter items 1, 2, 3, and 4 exist and filter item 3 is deleted, then filter item 4 will be renumbered to 3.

The default subcommand lets you change the default setting of the filter list to either Inclusive or Exclusive. If a filter list evaluates as Inclusive, then the packet is bridged. Otherwise, the packet is filtered.

The move subcommand is available to renumber filter items within a filter list. The first argument to the move subcommand is the number of the filter list to be moved. The second argument to the move subcommand is the number of the filter list after which the first filter list should be moved.

Syntax:

update byte-filter-list . . .
name-filter-list . . .

byte-filter-list *filter-list*

Updates information belonging to a byte filter-list. The filter-list parameter is a string previously entered via the **create byte-filter-list** command. This command brings you to the next `NetBIOS BYTE filter-list Config>` command level (see example). At this level you can perform update tasks to the specified filter-list.

Example: `update byte-filter-list newyork`

```
NetBIOS Byte newyork Config>
```

At this prompt level you can execute several commands. Each available command is listed under "**Update Byte-Filter** Command Options."

name-filter-list *filter-list*

Updates information belonging to a name-filter list. This command is identical to the byte-filter-list command, except that it specifies a name-filter list rather than a byte-filter list. The filter-list parameter is a string previously entered using the create name-filter-list prompt. This command brings you to the next `NetBIOS Name filter-list Config>` command level (see example). At this level you can perform update tasks to the specified filter-list.

Example: `update name-filter-list accounting`

```
NetBIOS Name accounting Config>
```

At this prompt level you can execute several commands. Each available command is listed under "**Update Name-Filter** (Command Options)."

Update Byte-Filter-List (Command Options)

This section lists the command options available for the **update byte-filter-list** command:

add inclusive *byte-offset hex-pattern* <*hex mask*>

Adds a filter item to the byte filter list. If the byte filter item that is added produces a match with a NetBIOS packet, the filter list it belongs to will evaluate to Inclusive (True).

- Byte-offset specifies the number of bytes (in decimal) to offset into the packet being filtered. This starts at the NetBIOS header of the packet.
- Hex-pattern is a hexadecimal number used to compare with the bytes starting at the byte-offset of the NetBIOS header. Syntax rules for hex-pattern include no 0x in front, a maximum of 32 numbers, and an even number of hex digits.

- Hex-mask, if present, must be the same length as hex-pattern and is logically ANDed with the bytes in the packet starting at byte-offset before the result is compared for equality with hex-pattern. If the hex-mask argument is omitted, it is considered to be all binary 1s.

If the offset and pattern of a byte filter item represent bytes that do not exist in a NetBIOS packet (that is, if the packet is shorter than was intended when setting up a byte-filter list), then the filter item will not be applied to the packet and the packet will not be filtered. If a series of byte filter items is used to set up a single NetBIOS filter list, then a packet will not be tested for filtering if any of the byte filter items within the NetBIOS filter list represent bytes that do not exist in the NetBIOS packet.

Example: `add inclusive`

```
Byte Offset  [0] ?
Hex Pattern  [] ?
Hex Mask (<CR> for no mask)  [] ?
```

add exclusive *byte-offset hex-pattern* <*hex mask*>

Adds a filter item to the byte filter list. This command is identical to the add inclusive command, except that if the result of the comparison between the filter item and a NetBIOS packet results in a match, then the filter list evaluates to Exclusive (False). Datagram Broadcast Packets can be specified to be discarded by using this command with a byte offset of 4 and a byte pattern of 09.

- Byte-offset specifies the number of bytes (in decimal) to offset into the packet being filtered. This starts at the NetBIOS header of the packet.
- Hex-pattern is a hexadecimal number that is compared with the bytes starting at the byte-offset offset of the NetBIOS header. Syntax rules for hex-pattern include no 0x in front, a maximum of 32 numbers, and an even number of hex digits.
- Hex-mask, if present, must be the same length as hex-pattern and is logically ANDed with the bytes in the packet starting at byte-offset before the result is compared for equality with hex-pattern. If the hex-mask argument is omitted, it is considered to be all binary 1's.

If the offset and pattern of a byte filter item represent bytes that do not exist in a NetBIOS packet (that is, if the packet is shorter than was intended when setting up a byte-filter list), then the filter item will not be applied to the packet and the packet will not be filtered. If a series of byte filter items is used to set up a single NetBIOS filter list, then a packet will not be tested for filtering if any of the byte filter items within the NetBIOS filter list represent bytes that do not exist in the NetBIOS packet.

Example: `add exclusive`

```
Byte Offset  [0] ?
Hex Pattern  [] ?
Hex Mask  (<CR> for no mask)  [] ?
```

default include

Changes the default setting of the filter list to "inclusive." This command indicates that if no filter items of the filter list match the contents of the packet being considered for filtering, the filter list will be evaluated as Inclusive. This is the default setting.

default exclude

Changes the default setting of the filter list to “exclusive.” This command indicates that, if no filter items of the filter list match the contents of the packet being considered for filtering, the filter list will be evaluated as Exclusive.

delete *filter-item*

Deletes a filter item from the filter list.

Filter-item is a decimal number representing a filter item that was previously created by the add command.

list Displays information related to filter items in the specified filter list.

```
BYTE Filter List Name:     Engineering
BYTE Filter List Default:  Exclusive
Filter Item # Inc/Ex       Byte Offset    Pattern          Mask
1          Inclusive        14         0x123456         0xFFFF00
2          Exclusive         0         0x9876           0xFFFF
3          Exclusive        28         0x1000000        0xFF00FF00
```

move *filter-item1 filter-item2*

Reorders filter items within the filter list. The filter item whose number is specified by filter-item1 is moved and renumbered to be just after filter item2.

exit Exits to the previous command prompt level.

Update Name-Filter-List (Command Options)

The following section lists the command options available for the update name-filter-list command:

add inclusive *ASCII host-name* <*LAST-hex number*>

Adds a filter item to the host-name filter list. With this command, the host name fields of the NetBIOS packets are compared with the host-name given in this command. The following list shows how these comparisons are made:

- ADD_GROUP_NAME_QUERY: Source NetBIOS name field is examined
- ADD_NAME_QUERY: Source NetBIOS name field is examined
- DATAGRAM: Destination NetBIOS name field is examined
- NAME_QUERY: Destination NetBIOS name field is examined

If there is a match (taking into account wildcard designations in this command), then the filter list evaluates to Inclusive. If not, the next filter item of the filter list (if any) of the filter is applied to the packet. If the packet is not one of the four types supported by NetBIOS Name filtering, then the packet is bridged.

- Host-name is an ASCII string up to 16 characters long. A question mark (?) can be used in host-name to indicate a single character wildcard. An asterisk (*) can be used as the final character of host-name to indicate a wildcard for the remainder of the host-name. If host-name contains fewer than 15 characters, it is padded to the 15th character with ASCII spaces. Host-name can contain any character except the following:

  . / \ [ ] : | < > + = ; , <space>

  Note: Host-name is case sensitive.

- LAST-hex-number can be used if host-name contains fewer than 16 characters. It is a hexadecimal number (with no 0x in front of it) which

indicates the value to be used for the last character. If the LAST argument is not specified on a hostname less than 16 characters, then a “?” wildcard is supplied for the 16th character.

add inclusive HEX *hexstring*

Adds a filter item to the host-name filter list. This command is functionally the same as the add inclusive ASCII command. However, the representation of hostname is different. This command supplies the hostname as a series of hexadecimal numbers (with no 0x in front).

- Hexstring must consist of an even number of hexadecimal numbers. If you do not supply a full 32 hexadecimal numbers, ASCII blanks are padded to the 29th and 30th numbers and a wildcard is supplied as the 31st and 32nd (16th byte) numbers. A wildcard for a single byte can be specified by **??**.

add exclusive ASCII *host-name <LAST-hex-number>*

Adds a filter item to the host-name filter list. This command is identical to the add inclusive ASCII command, except that packets that are matched against this filter item produce an Exclusive result for the filter list.

- Host-name is an ASCII string up to 16 characters long. A question mark (?) can be used in host-name to indicate a single character wildcard. An asterisk (*) can be used as the final character of host-name to indicate a wildcard for the remainder of the host-name. If host-name contains fewer than 15 characters, it is padded to the 15th character with ASCII spaces. Host-name can contain any character except the following:

  . / \ [ ] : | < > + = ; , <space>

- LAST-hex-number can be used if host-name contains fewer than 16 characters. It is a hexadecimal number (with no 0x in front of it) that indicates the value to be used for the last character. If the LAST argument is not specified on a host-name less than 16 characters, then a **?** wildcard is supplied for the 16th character.

add exclusive HEX *hexstring*

Adds a filter item to the name filter list. This command is functionally the same as the add inclusive hex command, except that packets that are matched against this filter item produce an Exclusive result for the filter list.

- Hexstring must consist of an even number of hexadecimal numbers. If you do not supply a full 32 hexadecimal numbers, ASCII blanks are padded to the 29th and 30th numbers and a wildcard is supplied as the 31st and 32nd (16th byte) numbers. A wildcard for a single byte can be specified by **??**.

default include

Changes the default setting of the filter list to “inclusive.” This command indicates that, if no filter items of the filter list match the contents of the packet being considered for filtering, the filter list will evaluate to Inclusive. This is the default setting.

default exclude

Changes the default setting of the filter list to “exclusive.” This command indicates that, if no filter items of the filter list match the contents of the packet being considered for filtering, the filter list is evaluated as Exclusive.

delete *filter-item*
Deletes a filter item from the filter list.

- Filter-item is a decimal number representing a filter item that was previously created by the add command.

list
Displays information related to filter items in the specified filter-list.

```
NAME Filter List Name: nlist
NAME Filter List Default: Exclusive

Filter Item #   Type    Inc/Ex        Hostname       Last Char

      1         ASCII   Inclusive     EROS
      2         ASCII   Inclusive     ATHENA
      3         ASCII   Exclusive     FOOBAR
```

move *filter-item1 filter-item2*
Reorders filter items within the filter list. The filter item whose number is specified by filter-item1 is moved and renumbered to be just after filter-item2.

exit
Exits to the previous command prompt level.

Monitoring NetBIOS Filtering

This section describes the NetBIOS Filtering monitoring commands. These commands let you monitor and display NetBIOS Filter information as an added feature to ASRT bridging. monitoring commands are entered at the `NetBIOS >` monitoring prompt.

Changes you make at the `NetBIOS>` monitoring prompt affect both bridging and DLSw.

This chapter includes the following sections:

- "Accessing the ASRT and the DLSw NetBIOS Filtering monitoring Environments"
- "NetBIOS Filtering Monitoring Commands" on page 10-11

Accessing the ASRT and the DLSw NetBIOS Filtering monitoring Environments

To display the `NetBIOS>` monitoring prompt from the ASRT monitoring environment, enter the **netbios** command at the ASRT> prompt:

```
+ protocol asrt

ASRT> netbios
NetBIOS Support User monitoring

NetBIOS monitoring> set filters name or byte

NetBIOS filter>
```

To display the `NetBIOS>` monitoring prompt from the DLSw monitoring environment:

```
+ protocol dls
DLSw> netbios
NetBIOS Support User monitoring

NetBIOS Console> set filters name or byte
NetBIOS filtering

NetBIOS filter>
```

NetBIOS Filtering Monitoring Commands

Table 10-2 lists the NetBIOS filtering commands.

Table 10-2. NetBIOS Filtering Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
List	Displays all information concerning created filters.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

List

Use the **list** NetBIOS Filtering command to display all information concerning created filters.

Syntax:

list byte-filter-lists
filters
name-filter-lists

byte-filter-lists

Displays information related to filter items in the specified byte-filter-list.

Example: `list byte-filter-lists`

```
BYTE Filter-List Name:  Engineering
BYTE Filter-List Default:  Exclusive

Filter Item # Inc/Ex     Byte Offset  Pattern      Mask

1             Inclusive     14        0x123456    0xFFFF00
2             Exclusive      0        0x9876      0xFFFF
3             Exclusive     28        0x1000000   0xFF00FF00
```

Filter Item#

Specifies the filter item number of the filter item. Filter items are evaluated in numerical order when determining the Inclusive/Exclusive status of the filter list.

Inc/Ex Specifies the default status of the filter item.

Byte-offset

Specifies the number of bytes (in decimal) to offset into the packet being filtered. This starts at the NetBIOS header of the packet.

Pattern The hexadecimal number used to compare with the bytes starting at the byte-offset of the NetBIOS header. Syntax rules for hex-pattern include no 0x in front, a maximum of 32 numbers, and an even number of hex numbers.

Mask If present, must be the same length as hex-pattern and is logically ANDed with the bytes in the packet, starting at byte-offset, before the result is compared for equality with hex_pattern. If the hex-mask argument is omitted, it is considered to be all binary 1s.

filters Displays information related to all configured filters.

Example: `list filters`

```
NetBIOS Filtering: Enabled

    Port #      Direction      Filter List Handle(s)   Pkts Filtered

       1          Input        valencia                      0
       2          Output       raleigh                       0
```

name-filter-lists

Displays information related to filter items in the specified name-filter-list.

Example: `list name-filter-lists`

```
NAME Filter List Name: nlist
NAME Filter List Default: Exclusive


Filter Item #   Type    Inc/Ex     Hostname   Last Char

 1              ASCII   Inclusive  EROS       <0x03>
 2              ASCII   Inclusive  ATHENA
 3              ASCII   Exclusive  FOOBAR
```

Filter Item#

Specifies the filter item number of the filter item. Filter items are evaluated in numerical order when determining the Inclusive/Exclusive status of the filter list.

Inc/Ex Specifies the default status of the filter item.

Type “ASCII” indicates a host-name filter item added as ASCII characters. “Hex” indicates a host name filter item added as hexadecimal numbers

Host-name

ASCII string up to 16 characters long. A question mark (?) can be used in hostname to indicate a single-character wildcard. An asterisk (*) can be used as the final character of hostname to indicate a wildcard for the remainder of the hostname. If hostname contains fewer than 15 characters, it is padded to the 15th character with ASCII spaces. Hostname can contain any character but the following:

. / \ [ ] : | < > + = ; , <space>

Last char

Used if host-name contains fewer than 16 characters. It is a hexadecimal number (with no 0x in front of it) which indicates the value to be used for the last character. If the LAST argument is not specified on a hostname less than 16 characters, then a “?” wildcard is supplied for the 16th character.

Chapter 11. Configuring and Monitoring TCP/IP Host Services

This chapter describes how to configure the TCP/IP Host Services (TCP/IP Host) protocol and how to use the TCP/IP Host configuration commands. The chapter includes the following sections:

- "Basic Configuration Procedures"
- "Accessing the TCP/IP Host Configuration Environment" on page 11-2
- "TCP/IP Host Configuration Commands" on page 11-2
- "Accessing the TCP/IP Host Monitoring Environment" on page 11-5
- "TCP/IP Host Monitoring Commands" on page 11-5

See "TCP/IP Host Services (Bridge-Only Management)" on page 3-3 if you want to know more about why you would use TCP/IP host services.

Do not use this chapter if you are configuring the router for IP routing; instead, refer to Chapter 15, "Using IP" on page 15-1.

Note: To configure Host services, you cannot have any IP address configured on the interfaces. The router cannot be configured as a router for IP. The Host services are for bridging only.

Basic Configuration Procedures

The following sections describe the basic configuration procedures for enabling TCP/IP Host Services on your IBM 8210.

Setting the IP Address

To minimally configure TCP/IP Host services, assign the IBM 8210 an IP address by using the **set ip-host** command. This IP address is associated with the IBM 8210 as a whole, instead of being associated with a single interface.

Adding a Default Gateway

The IBM 8210 uses its default gateway to communicate with hosts and gateways that are not on the bridged network to which the IBM 8210 is directly connected. The IBM 8210 can dynamically learn its default gateway using either ICMP Router Discovery (see the **enable router-discovery** command in this chapter) or RIP (see the **enable rip-listening** command in this chapter). You can also statically specify one or more default gateways by using the **add default gateway** command. The IBM 8210 uses only one default gateway at a time; any additional default gateways are used for backup.

To save the assigned IP address and default gateway information, exit from the `TCP/IP-Host config>` prompt to the `Config>` and use the **restart** command. After restarting the IBM 8210, return to the `TCP/IP-Host config>` prompt.

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Enabling TCP/IP Host Services

After assigning and saving the IBM 8210 IP address and default gateway information, use the **enable services** command to enable TCP/IP Host Services.

Accessing the TCP/IP Host Configuration Environment

To access the TCP/IP Host configuration environment, enter the following command at the `Config>` prompt:

```
Config> protocol hst
TCP/IP-Host Services user configuration
TCP/IP-Host config>
```

TCP/IP Host Configuration Commands

This section describes the TCP/IP Host configuration commands. The TCP/IP Host configuration commands allow you to specify network parameters for the TCP/IP Host bridge. Restart the router to activate the configuration commands. Enter the TCP/IP Host configuration commands at the `TCP/IP-Host config>` prompt. Table 11-1 shows the commands.

Table 11-1. TCP/IP Host Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds a default-gateway.
Delete	Deletes a default-gateway.
Disable	Disables TCP/IP Host Services, router-discovery processes, and RIP listening.
Enable	Enables TCP/IP Host Services, router-discovery processes, and RIP listening.
List	Lists the current TCP/IP Host configuration.
Set	Sets the IBM 8210’s IP address.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add default gateways (that is, routers) to your configuration.

Default gateways are used when trying to send packets to IP destinations that are off the local connection. The routing table is then built up through redirect processing. An attempt is made to detect routers that disappear. If the IBM 8210 has booted over the network (via TFTP/BootP), then the default gateway is configured using the information from the booting process.

Syntax:

a**dd** default-gateway *def-gateway-IP-address*

Example: `add default-gateway`

```
Default-Gateway address [0.0.0.0]?  123.45.67.89
```

Delete

Use the **delete** command to delete default gateways from your IBM 8210 configuration. Enter the IP address of the default gateway you want to remove after the **delete** command.

Syntax:

de**lete** default-gateway *def-gateway-IP-address*

Example: `delete default-gateway`

```
Enter address to be deleted [0.0.0.0]?  123.45.67.89
```

Disable

Use the **disable** command to disable the following TCP/IP functions:

- TCP/IP Host Services
- Router-discovery processes
- RIP listening

Syntax:

di**sable** rip-listening
router-discovery
services

rip-listening
Disables the building of routing table entries that have been gathered by listening to the RIP protocol. By default, RIP-listening is disabled.

Example: `disable rip-listening`

router-discovery
Disables the ability to learn default gateways by receiving ICMP Router Discovery messages. By default, router discovery is enabled.

Example: `disable router-discovery`

services Disables the TCP/IP Host Services protocol entirely. If IP routing is not enabled, TCP/IP Host Services is enabled by default.

Example: `disable services`

Enable

Use the **enable** command to enable the following TCP/IP functions:

- TCP/IP Host Services
- Router discovery processes
- RIP listening

Syntax:

en**able** rip-listening
router-discovery
services

rip-listening
Enables the building of routing table entries that have been gathered by the bridge “listening” to the RIP protocol. RIP-listening is disabled by default.

Example: `enable rip-listening`

router-discovery
Enables the learning of default gateways through reception of ICMP Router Discovery messages. By default, router discovery is enabled.

Example: `enable router-discovery`

services Enables the TCP/IP Host Services protocol. If IP routing is not enabled, TCP/IP Host Services is enabled by default.

Example: `enable services`

List

Use the **list** command to display information about the current TCP/IP Host configuration.

Syntax:

list all

Example: `list all`

```
IP-Host IP address : 128.185.142.1
Address mask : 255.255.255.0

Default Gateway IP-address(es)
128.185.142.47

TCP/IP-Host Services Enabled.

RIP-LISTENING Disabled.

Router Discovery Enabled.
```

IP-Host IP address	Displays the current IP-Host IP address.
Address mask	Displays the current IP-Host IP subnet address mask.
Default Gateway IP-address(es)	Displays the current default gateway IP address.
TCP/IP Host Services	Displays whether TCP/IP Host Services is enabled or disabled.
RIP-LISTENING	Displays whether RIP-LISTENING is enabled or disabled.
Router Discovery	Displays whether Router Discovery is enabled or disabled.

Set

Use the **set** command to set the IBM 8210’s IP address. You must assign the IBM 8210 an IP address before enabling TCP/IP Host Services.

Note: If the IP address is not already configured, it is set (by default) using boot information. This process applies only if the IBM 8210 is a network host operating as an IP host.

Syntax:

set ip-host address *IP-host-address*

Example: `set ip 123.45.67.89`

```
Address mask [255.255.0.0]?
IP-Host Address set.
```

Monitoring TCP/IP Host Services

This section describes how to monitor the TCP/IP Host Services on the IBM 8210.

Accessing the TCP/IP Host Monitoring Environment

To access the TCP/IP Host monitoring environment, enter the following command at the + (GWCON) prompt:

```
+ protocol hst
TCP/IP-Host>
```

TCP/IP Host Monitoring Commands

This section describes the TCP/IP Host monitoring commands. These commands allow you to view parameters and enter information requests from the active terminal. Enter these commands at the `TCP/IP-Host>` prompt. Table 11-2 shows the commands.

Table 11-2. TCP/IP Host Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Dump	Displays the current IP routing table. One line is printed for each destination.
Interface	Displays the IBM 8210’s IP address.
Ping	Continuously pings a given destination, printing a line for each response received.
Traceroute	Displays the hop-by-hop route to a given destination.
Routers	Displays the list of all IP routers known to the IBM 8210.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Dump

Use the **dump** command to display the current IP routing table. One line is printed for each destination. Many of the entries that are displayed are the result of ICMP redirects.

Syntax:

dump

Example:

```
TCP/IP Host> dump
Type   Dest net         Mask      Cost     Age       Next hop(s)

Stat   0.0.0.0          00000000  0        51        128.185.142.47
 Dir*  128.185.142.0    FFFFFF00  1        50        BDG/0

Default gateway in use.
Type Cost     Age       Next hop
Stat 0        51        128.185.142.47

Routing table size: 768 nets (52224 bytes), 2 nets known
                      0 nets hidden, 0 nets deleted, 0 nets inactive
                      0 routes used internally, 766 routes free
TCP/IP Host>
```

Type	Route type which indicates how the route was derived: RIP - the route was learned through the RIP protocol. Stat - a statically configured route. Dir - a directly connected network or subnet.
Dest net	Displays the IP address of the destination network/subnet.
Mask	Displays the IP address mask.
Cost	Displays the Route Cost.
Age	For RIP routes diplays the time, in seconds, since the route was refreshed. For other types of routes displays the time, in seconds, since the route was installed.
Next Hop	Displays the IP address of the next router on the path toward the destination host. Also displayed is the interface type used by the sending router to forward the packet.
Default gateway	Displays the IP address of the default gateway along with the route type, cost, age, and next hop information associated with that entry.
Routing table size	Displays the current size (in networks and bytes) of the current table. Also identifies the number of networks (nets) known to the host.

Interface

Use the **interface** command to display the IBM 8210's IP address. When TCP/IP Host Services are running over the bridge, a single address is displayed on the terminal as Bridge/0.

Syntax:

interface

Example:

```
TCP/IP Host> interface
Interface  IP Address(es)   Mask(s)
  BDG/0    128.185.142.16   255.255.255.0
TCP/IP Host>
```

Interface	Displays the type of interface. For TCP/IP Host Services, this is always BDG/0, indicating the bridge.
IP Address	Displays the IP address of the TCP/IP Host Services interface.
Mask	Displays the IP address subnet mask.

Ping

Use the **ping** command to make the router send ICMP Echo Requests to a given destination once a second ("pinging") and watch for a response. This command can be used to isolate trouble in an internetwork environment.

This process is done continuously, incrementing the ICMP sequence number with each additional packet. Matching received ICMP Echo responses are reported with their sequence number and the round trip time. The granularity (time resolution) of the round trip time calculation is platform-specific, and usually is around 20 milliseconds.

To stop the pinging process, type any character at the terminal. At that time, a summary of packet loss, round trip time, and number of unreachable ICMP destinations will be displayed.

When a multicast address is given as destination, there may be multiple responses printed for each packet sent, one for each group member. Each returned response is displayed with the source address of the responder.

The size of the ping (number of data bytes in the ICMP message, excluding the ICMP header), TTL value, and rate of pinging are all user-configurable. The default values are a size of 56 bytes, a TTL of 64, and a rate of 1 ping per second.

Syntax:

p**ing** *destination source size ttl rate*

Example:

```
TCP/IP Host> ping
Destination IP address [0.0.0.0]? 128.185.142.11
Source IP address [128.185.142.16]?
Ping data size in bytes [56]?
Ping TTL [64]?
Ping rate in seconds [1]?
PING 128.185.142.16 -> 128.185.142.11: 56 data bytes, ttl=64, ... every 1 sec.
56 data bytes from 128.185.142.11: icmp_seq=0. ttl=254. time=0. ms
56 data bytes from 128.185.142.11: icmp_seq=1. ttl=254. time=0. ms
56 data bytes from 128.185.142.11: icmp_seq=2. ttl=254. time=0. ms
56 data bytes from 128.185.142.11: icmp_seq=3. ttl=254. time=0. ms
56 data bytes from 128.185.142.11: icmp_seq=4. ttl=254. time=0. ms
56 data bytes from 128.185.142.11: icmp_seq=5. ttl=254. time=0. ms

----128.185.142.11 PING Statistics----
6 packets transmitted, 6 packets received, 0% packet loss
round-trip min/avg/max = 0/0/0 ms
TCP/IP Host>
```

Traceroute

Use the **traceroute** command to display the entire path to a given destination, hop by hop. For each successive hop, the traceroute command sends out three probes and prints the IP address of the responder along with the round trip time associated with the response. If a particular probe receives no response, an asterisk (*) is printed. Each line in the display relates to this set of three probes, with the left-most number indicating the distance from the router executing the command (in router hops).

The traceroute is complete when the destination is reached, an ICMP Destination Unreachable message is received, or the path length reaches 32 router hops.

Syntax:

traceroute *destination source size probes wait ttl*

Example:

```
TCP/IP Host> traceroute
Destination IP address [0.0.0.0]? 128.185.144.239
Source IP address [128.185.142.16]?
Data size in bytes [56]?
Number of probes per hop [3]?
Wait time between retries in seconds [3]?
Maximum TTL [32]?
TRACEROUTE 128.185.142.16 -> 128.185.144.239: 56 data bytes
 1 128.185.142.11 16 ms 0 ms 0 ms
 2 128.185.143.33 16 ms 0 ms 0 ms
 3 128.185.144.239 16 ms 0 ms 0 ms
TCP/IP Host>
```

In the display:

TRACEROUTE	Displays the destination area address and the size of the packet being sent to that address.
1	The first trace showing the destination's NSAP and the round trip time it took the packet to reach the destination and return. The packet is traced three times.
Destination unreachable	Indicates that no route to the destination is available.
1 * * * 2 * * *	Indicates that the router is expecting some form of response from the destination, but the destination is not responding.

When a probe receives an unexpected result (see the previous output example), several indicators can be printed. These indicators are explained in the following table.

!N	Indicates that an ICMP Destination Unreachable (net unreachable) has been received.
!H	Indicates that an ICMP Destination Unreachable (host unreachable) has been received.
!P	Indicates that an ICMP Destination Unreachable (protocol unreachable) has been received.
!	Indicates that the destination has been reached, but the reply sent by the destination has been received with a TTL of 1. This usually indicates an error in the destination, prevalent in some versions of UNIX, whereby the destination is inserting the probe's TTL in its replies. This unfortunately leads to a number of lines consisting solely of asterisks before the destination is finally reached.

Routers

Use the **routers** command to display the list of all IP routers that are known to the IBM 8210. Routers can be learned through:

- Static configuration (using the **add default-gateway** command explained on page "Add" on page 11-2).
- Received ICMP redirects
- ICMP Router Discovery messages (if configured)
- RIP updates (if configured)

Each router is listed with its origin, its priority (used when selecting the default route), and its lifetime (the number of seconds before the router will be declared invalid unless it is heard from again).

Syntax:

routers

Example: `routers`

Chapter 12. Using MAC Filtering

This chapter describes how to use medium access control (MAC) for specifying packet filters to be applied to packets during processing. It includes the following sections:

- "MAC Filtering Parameters" on page 12-2

Filters are a set of rules applied to a packet to determine how the packet should be handled during bridging. MAC filtering affects only bridged traffic.

Note: MAC Filtering is allowed on tunnel traffic.

During the filtering process, packets are processed, filtered, or tagged during bridging. The actions are:

- **Processed** – Packets are permitted to pass unaffected through the bridge.
- **Filtered** – Packets are not permitted to pass through the bridge.
- **Tagged** – Packets are allowed to pass through the bridge, but are marked with a number in the range 1 through 64 based on a configurable parameter.

A MAC filter consists of the following three objects:

1. Filter-item – which is a single rule that is applied to the address field or an arbitrary window of data within a packet. The result of applying the rule is either a true (successful match) or false (no match) condition.
2. Filter-list – which contains a list of one or more filter-items.
3. Filter – which contains a set of filter-lists.

MAC Filtering and DLSw Traffic

You can filter incoming LLC traffic for the DLSw network by implementing MAC Filtering.

To set up a filter for LLC, use the *Bridge Net* number as the interface number for the filter. Determine the Bridge Net number by adding two to the number of interfaces configured for your router. Enter the **list devices** command at the `Config>` prompt, or enter **configuration** at the `+` prompt to see a list of interfaces.

In the following example, the Bridge Net number is 7.

```
Ifc 0 Ethernet                    CSR  81600, CSR2  80C00, vector 94
Ifc 1 WAN X.25                    CSR  81620, CSR2  80D00, vector 93
Ifc 2 WAN X.25                    CSR  81640, CSR2  80E00, vector 92
Ifc 3 WAN PPP                     CSR 381620, CSR2 380D00, vector 125
Ifc 4 WAN Frame Relay             CSR 381640, CSR2 380E00, vector 124
Ifc 5 Token Ring                  CSR 600000, vector 95
```

When you set up a filter for the Bridge Net, for example, the router does not drop frames that match exclusive filters. Instead, it forwards those frames to the bridge.

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MAC Filtering Parameters

You can specify some or all of the following parameters to create a filter:

- Source MAC address or destination MAC address
- Data to be matched within the packet
- Mask to be applied to the packet's fields to be filtered
- Interface number
- Input/Output designation
- Include/Exclude/Tag designation
- Tag value (if the tag designation is given)

Sliding-Window Filter Parameters

The following parameters are used to construct a sliding window filter-item:

- Base offset of the window data - this is either MAC or INFO.

  The base offset (MAC or INFO) specifies whether the location of the data to be matched in the packet is specified via an offset from the beginning of the MAC header or via an offset from the beginning of the information field in the packet.
- Offset of the data from base
- Window data - a hex-string
- Window mask - a hex-mask
- Tag - a tag-value

Each sliding window filter-item specifies a sequence of data (up to 32 bytes in length) to match against data in the packet

The window mask is ANDed with the packet data before the comparison with the window data is made.

Filter-Item Parameters

The following parameters are used to construct an address-filter-item:

- Address Type: SOURCE or DESTINATION
- Tag: a *tag-value*
- Address Mask: a *hex-mask*

Each filter-item specifies an address type (either SOURCE or DESTINATION) to match against the type in the packet.

The address mask is a string of numbers entered in hex, which is used in comparing the packet's addresses. The mask is applied to the SOURCE or DESTINATION MAC address of the packet before comparing it against the specified MAC address.

The address mask must be of equal length to the MAC address and specifies the bytes that are to be logically ANDed with the bytes in the MAC address before the equality comparison to the specified MAC address is made. If no mask is specified, it is assumed to be all 1s.

Filter-List Parameters

The following parameters are used to construct a filter-list:

- Name: an *ASCII-string*
- Filter-item list: *filter-item 1 . . . filter-item n*
- Action: INCLUDE, EXCLUDE, TAG(*n*)

A filter-list is built from one or more filter-items. Each filter-list is given a unique name.

Applying a filter-list to a packet consists of comparing each filter-item in the order in which the filter-items were added to the list. If any filter-item in the list returns a TRUE condition then the filter-list will return its designated action.

Filter Parameters

The following parameters are used to construct a filter:

- Filter-list names: *ASCII-string 1 . . . ASCII-string n*
- Interface number: an *IFC-number*
- Port direction: INPUT or OUTPUT
- Default action: INCLUDE, EXCLUDE, or TAG
- Default tag: a *tag-value*

A filter is constructed by associating a group of filter-list names with an interface number and assigning an INPUT or OUTPUT designation. The application of a filter to a packet means that each of the associated filter-lists should be applied to packets being received (INPUT) or sent (OUTPUT) on the specified numbered interface.

When a filter evaluates a packet to an INCLUDE condition, the packet is forwarded. When a filter evaluates a packet to an EXCLUDE condition, the packet is dropped. When a filter evaluates to a TAG condition, the packet being considered is forwarded with a tag.

An additional parameter of each filter is the default action, which is the result of non-match for all of its filter-lists. This default action is INCLUDE. It can be set to INCLUDE, EXCLUDE, or TAG. In addition, if the default action is TAG, a tag value is also given.

Using MAC Filtering Tags

The following list includes some uses of MAC filtering tags

- MAC Address filtering is handled jointly by bandwidth reservation and the MAC Filtering feature (MCF) using tags. A user with bandwidth reservation is able to categorize bridge traffic, for example, by assigning a tag to it.
- The tagging process is done by creating a filter-item in the MAC Filtering configuration console and then assigning a tag to it. This tag is then used to set up a bandwidth class for all packets associated with this tag. Tag values must currently be in the range 1 to 64.
- Once a tagged filter has been created in the MAC Filtering configuration process, the Bandwidth Reservation (BRS) **tag** configuration command is used to assign a BRS tag name (TAG1, TAG2, TAG3, TAG4, or TAG5) to the MAC filter tag number. The BRS tag name is then used on the BRS **assign**

configuration command to assign the corresponding MAC filter to a bandwidth traffic class and priority.

- Up to 5 tagged MAC addresses can be set from 1 to 5. TAG1 will be searched for first, then TAG2, all the way to TAG5.

:

Tags can also refer to “groups” in IP Tunnel. IP Tunnel end-points can belong to any number of groups, with packets assigned to a particular group through the tagging feature of MAC address filtering.

Chapter 13. Configuring and Monitoring MAC Filtering

This chapter describes how to access the MAC Filtering configuration and monitoring prompts and how to use the available commands. It includes the following sections:

- "Accessing the MAC Filtering Monitoring Prompt" on page 13-9
- "MAC Filtering Monitoring Commands" on page 13-9

Accessing the MAC Filtering Configuration Prompt

Use the **feature** command from the CONFIG process to access the MAC filtering configuration commands. The **feature** command lets you access configuration commands for specific features outside the protocol and network interface configuration processes.

Enter a question mark after the **feature** command to obtain a listing of the features available for your software release. For example:

```
   Config> feature ?
MCF
 Feature name or number [MCF]?
```

To access the MAC filtering configuration prompt, enter the **feature** command followed by the *feature number* (3) or *short name* (MCF). For example:

```
Config> feature mcf
MAC Filtering user configuration
Filter config>
```

Once you access the MAC filtering configuration prompt, you can begin entering specific configuration commands. To return to the CONFIG prompt at any time, enter the **exit** command at the MAC filtering configuration prompt.

MAC Filtering Configuration Commands

This section summarizes the MAC filtering configuration commands. Enter these commands at the `Filter config>` prompt.

Use the following commands to configure the MAC filtering feature.

Table 13-1 (Page 1 of 2). MAC Filtering Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Attach	Adds a filter list to a filter.
Create	Creates a filter list or an INPUT or OUTPUT filter.
Default	Sets the default action for the specified filter to EXCLUDE, INCLUDE, or TAG.
Delete	Removes all information associated with a filter list. Also deletes a filter that was created using the create filter command.
Detach	Removes a filter list from a filter.

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Table 13-1 (Page 2 of 2). MAC Filtering Configuration Command Summary	
Command	Function
Disable	Disables MAC Filtering entirely or disables a particular filter.
Enable	Enables MAC Filtering entirely or enables a particular filter.
List	Lists a summary of all the filter lists and filters configured by the user. Also generates a list of attached filter lists for this filter and all subsequent information for the filter.
Move	Reorders the filter lists attached to a specified filter.
Reinit	Reinitializes the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.
Set-Cache	Changes the cache size for a filter.
Update	Adds or deletes information from a specific filter list. Brings you to a menu of appropriate subcommands.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Attach

Use the **attach** command to add a filter-list to a filter.

A filter is constructed by associating a group of filter-lists with an interface number. A filter-list is built from one or more filter-items.

Syntax:

att**ach** *filter-list-name filter-number*

Create

Use the **create** command to create a filter-list or an INPUT or OUTPUT filter.

Syntax:

c**reate** list *filter-list-name*

filter [input or output] *interface-number*

list *filter-list-name*

Creates a filter-list. Lists are named by a unique string (Filter-list-name) of up to 16 characters of the user’s choice. This name is used to identify a filter-list that is being built. This name is also used with other commands associated with the filter-list.

filter [input or output] *interface-number*

Creates a filter and places it on the network associated with the INPUT or OUTPUT direction on the interface given by an interface number. By default this filter is created with no attached filter-lists, has a default action of INCLUDE and is ENABLED.

Default

Use the **default** command to set the default action for the filter with a specified filter number to exclude, include, or tag.

Syntax:

def**ault** exclude *filter-number*

include *filter-number*

tag *tag-number filter-number*

exclude *filter-number*
Sets the default action for the filter with a specified filter number to exclude.

include *filter-number*
Sets the default action for the filter with a specified filter number to include.

tag *tag-number filter-number*
Sets the default action for the filter with the specified filter number to TAG and sets the associated tag value to tag number.

Delete

Use the **delete** command to remove all information associated with a filter-list and to free an assigned string as a name for a new filter-list. If filter-list is attached to a filter that has already been created by the user, then this command will display an error message on the console without deleting anything. In addition all filter-items belonging to this list are also deleted

This command also deletes a filter that was created using the **create filter** command.

Syntax:

del**ete** list *filter-list*

filter *filter-number*

list *filter-list*
Removes all information associated with a filter-list and frees an assigned string as a name for a new filter-list. The filter-list must be a string entered by a previous **create list** command.

If the filter-list is attached to a filter that has already been created by the user, then this command will display an error message on the console without deleting anything. All filter-items belonging to this list are also deleted when this command is used.

filter *filter-number*
Deletes a filter that was created using the **create filter** command.

Detach

Use the **detach** command to delete a filter-list name (filter-list parameter) from a filter (filter-number parameter).

Syntax:

tsize-17.

det**ach** *filter-list-name filter-number*

Disable

Use the **disable** command to disable MAC Filtering entirely or to disable a particular filter.

Syntax:

di**sable** all

filter *filter-number*

all Disables MAC Filtering entirely. Filters are still set as ENABLED, however, if they were enabled previously.

filter *filter-number*
Disables a particular filter. The filter-number parameter corresponds to the numbers displayed in the **list filters** command.

Enable

Use the **enable** command to enable MAC Filtering entirely or to enable a particular filter.

Syntax:

en**able** all

filter *filter-number*

all Enables MAC Filtering entirely, although filters themselves may still be set to DISABLED.

filter *filter-number*
Enables a particular filter. The filter-number parameter corresponds to the numbers displayed in the **list filters** command.

List

Use the **list** command to list a summary of all the filter-lists and filters configured by the user. A list of all the filter-lists attached to a filter is not given. Other information displayed includes:

- A list containing the state of the filtering system (ENABLE, DISABLE)
- The set of configured filter-list records
- Each of the configured filter records.

In addition, the following information is displayed for each filter:

- Filter number
- Interface number
- Filter direction (INPUT, OUTPUT)
- Filter state (ENABLE, DISABLE)

- Filter default action (TAG, INCLUDE, EXCLUDE).

This command also generates a list of attached filter-lists for this filter and all subsequent information for the filter.

Syntax:

list all

filter *filter-number*

all Displays a summary of all the configured filter-lists and filters.

filter *filter-number*
Generates a list of attached filter-lists for the specified filter and all subsequent information for the filter.

Move

Use the **move** command to reorder the filter-lists attached to a specified filter (given by filter-number parameter). The list given by Filter-list-name1 is moved immediately before the list given by Filter-list-name2.

Syntax:

move *filter-list-name1 filter-list-name2 filter-number*

Reinit

Use the **reinit** command to reinitialize the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.

Syntax:

reinit

Set-Cache

Use the **set-cache** command to change the default cache size (16) to a number in the range 4 to 32768.

Syntax:

set-cache *cache-size filter-number*

Update

Use the **update** command to add information to or delete information from a specific filter-list. Using this command with the desired filter-list-name brings you to the `Filter filter-list-name Config>` prompt for that specific filter-list. From this new prompt you can then change information in the specified list.

The new prompt level is used to add or delete filter-items from filter-lists. The order in which the filter-items are specified for a given filter-list is important as it determines the order in which the filter-items are applied to a packet.

Syntax:

update *filter-list-name*

Update Subcommands

This section summarizes the MAC filtering configuration subcommands. Enter these subcommands at the `Filter filter-list-name config>` prompt.

Table 13-2. Update Subcommands Summary

Subcommand	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds source or destination MAC address filters or a window filter. Adds filter-items to a filter-list.
Delete	Removes filter-items from a filter-list.
List	Lists a summary of all the filter-lists and filters configured by the user. Also generates a list of attached filter-lists for this filter and all subsequent information for the filter.
Move	Reorders the filter-lists attached to a specified filter.
Set-Action	Sets a filter-item to evaluate the INCLUDE, EXCLUDE or TAG (with a tag-number option) condition.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Use the following subcommands to update a filter-list.

Add

Use the **add** subcommand to add filter-items to a filter-list. This subcommand specifically lets you add a hexadecimal number to compare against the source or destination MAC address, or a sequence of window data with a mask to compare against a packet data.

The order in which the filter-items are added to a given filter-list is important because it determines the order in which the filter-items are applied to a packet.

Each use of the **add** subcommand creates a filter-item within the filter-list. The first filter-item created is assigned filter-item-number 1, the next one is assigned number 2, and so on. After you enter a successful **add** subcommand, the router displays the number of the filter-item just added.

The first match that occurs stops the application of filter-items, and the filter-list evaluates to INCLUDE, EXCLUDE, or TAG, depending on the designated action of the filter-list. If none of the filter-items of a filter-list produces a match, then the default action (INCLUDE, EXCLUDE or TAG) of the filter is returned.

Syntax: a**dd** source *hex-MAC-addr hex-Mask*

destination *hex-MAC-addr hex-Mask*

window MAC *offset-value hex-data hex-mask*

window INFO *offset-value hex-data hex-mask*

source *hex-MAC-addr hex-Mask*

Adds a hexadecimal number to compare against the source MAC address. ***hex-MAC-addr*** must be an even number of hex digits with a maximum of 16 digits and should be entered without a 0x in front.

The hex-mask parameter must be the same length as hex-MAC-address and is logically ANDed with the designated MAC address in the packet. The default hex-mask argument is to be all binary 1s.

The hex-MAC-addr parameter can be specified in canonical or noncanonical bit order. A canonical bit order is specified as just a hex number (for example, 000003001234). It may also be represented as a series of hex digits with a hyphen (-) between every two digits (for example, 00-00-03-00-12-34).

A noncanonical bit order is specified as a series of hex digits with a colon (:) between every two digits (for example, 00:00:C9:09:66:49). MAC addresses of filter-items will always be displayed using either a hyphen (-) or a colon (:) to distinguish canonical from noncanonical representations.

destination *hex-MAC-addr hex-Mask*

Acts identically to the add source subcommand, with the exception that the match is made against the destination rather than the source MAC address of the packet.

window MAC *offset-value hex-data hex-mask*

Adds a sliding window filter-item using the specified offset (computed from the beginning of the frame) that matches the hex data with the mask against packet data.

window INFO *offset-value hex-data hex-mask*

Similar to the **add window mac** command, except that the offset is computed with respect to the beginning of the information field.

Delete

Use the **delete** subcommand to remove filter-items from a filter-list. You delete filter-items by specifying the filter-item-number assigned to the item when it was added.

When the **delete** subcommand is used, any gap created in the number sequence is filled in. For example, if filter-items 1, 2, 3, and 4 exist and filter-item 3 is deleted, then filter-item 4 will be renumbered to 3.

Syntax:

de**lete** *filter-item-number*

List

Use the **list** subcommand to print out a listing of all the filter-item records. The following information about each MAC-Address filter-item is displayed:

- MAC address and address mask in canonical or noncanonical form.
- filter-item numbers
- address type (source or destination)
- filter-list action

Syntax:

list canonical

noncanonical

mac-address canonical

mac-address noncanonical

window

canonical

Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in canonical form, and the address mask in canonical form. It also gives the filter-list action.

mac-address canonical

Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in canonical form, and the address mask in canonical form. In addition the filter-list action is given.

noncanonical

Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in noncanonical form, and the address mask in noncanonical form. It also gives the filter-list action.

mac-address noncanonical

Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in noncanonical form, and the address mask in noncanonical form. It also gives the filter-list action.

window Prints out a listing of all the sliding window filter-item records within a filter-list, giving the item numbers, base, offset, data, and mask. It also gives the filter-list action.

Move

The **move** subcommand reorders filter-items within the filter-list. The filter-item whose number is specified by *filter-item-name1* is moved and renumbered to be just before *filter-item-name2*.

Syntax:

move *filter-item-name1 filter-item-name2*

Set-Action

The **set-action** subcommand lets you set a filter-item to evaluate the INCLUDE, EXCLUDE, or TAG (with a tag-number option) condition. If one of the filter-items of the filter-list matches the contents of the packet being considered for filtering, the filter-list will evaluate to the specified condition. The default setting is INCLUDE.

Syntax:

set-action [INCLUDE or EXCLUDE or TAG] *tag-number*

Accessing the MAC Filtering Monitoring Prompt

Use the **feature** command from the GWCON process to access the MAC filtering monitoring commands. The **feature** command lets you access monitoring commands for specific router features outside of the protocol and network interface monitoring processes.

Enter a question mark after the **feature** command to obtain a listing of the features available for your software release. For example:

```
     + feature ?
MCF
```

To access the MAC filtering monitoring prompt, enter the **feature** command followed by the feature number (3) or short name (MCF). For example:

```
     + feature mcf
     MAC Filtering user monitoring
     Filter>
```

Once you access the MAC filtering monitoring prompt, you can begin entering specific monitoring commands. To return to the GWCON prompt at any time, enter the **exit** command at the MAC Filtering monitoring prompt.

MAC Filtering Monitoring Commands

This section summarizes the MAC filtering monitoring commands. Enter these commands at the `Filter>` prompt.

Table 13-3. MAC Filtering Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Clear	Clears the "per filter" statistics listed in the list filter command.
Disable	Disables MAC Filtering globally or on a "per filter" basis.
Enable	Enables MAC Filtering globally or on a "per filter" basis.
List	Lists a summary of statistics and settings for each filter currently running in the router.
Reinit	Reinitializes the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Use the following commands to monitor the MAC filtering feature.

Clear

Use the **clear** command to clear filter statistics.

Syntax:

clear all

filter *filter-number*

all Clears the statistics listed by the **list all** command.

filter *filter-number*
Clears the statistics listed by the **list filter** command.

Disable

Use the **disable** command to disable MAC filtering globally. This command does not individually disable each filter.

The command also disables a filter as specified by filter-number. This filter is disabled without modifying configuration records. If no argument is given, MAC filtering is globally disabled.

Syntax:

disable all

filter *filter-number*

all Disables MAC filtering globally. This command does not individually disable each filter.

filter *filter-number*
Disables the filter that is specified by the filter number. This filter is disabled without modifying configuration records. If no filter number is given, MAC filtering is globally disabled.

Enable

Use the **enable** command to enable MAC filtering globally. This command does not individually enable each filter.

The command also enables a filter as specified by filter-number. This filter is enabled without modifying configuration records. If no argument is given, MAC filtering is globally enabled.

Syntax:

enable all

filter *filter-number*

all Enables MAC filtering globally. This command does not individually enable each filter.

filter *filter-number*
Enables the filter that is specified by the filter number. This filter is enabled without modifying configuration records. If no filter number is given, MAC filtering is globally enabled.

List

Use the **list** command to list a summary of statistics and settings for each filter currently running in the router. The following information is displayed for each filter when the **list all** command is used:

- Default action
- Cache size
- Default tag
- State (enabled/disabled)

- Number of packets which have been filtered as INCLUDE, EXCLUDE or TAG.

In addition, the following information is also displayed by the **list filter** command for a specified filter:

- All information displayed by the list all command
- All the filter-lists currently running in this filter including:
  - List name
  - List action
  - List tag
  - Number of packets which have been filtered by each filter-list.

Syntax:

list all

filter *filter-number*

all Lists statistics and settings for each filter currently running in the router.

filter *filter-number*
Generates statistics and settings for each filter plus all the filter-lists currently running in this filter.

Reinit

Use the **reinit** command to reinitialize the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.

Syntax:

reinit

Configuring and Monitoring Router Protocols

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Chapter 14. Overview of Routing over ATM

Note: See the glossary for definitions of the abbreviations and terms used in this chapter. This chapter describes the routing over native ATM.

Overview of Routing

The routing overview presented in this section is short because the relationships between LAN Emulation (LE), Classical IP (CIP), and the supported routing protocols are simple. The server supports IP and IPX routing as illustrated in Figures Figure 14-1 and Figure 14-2.

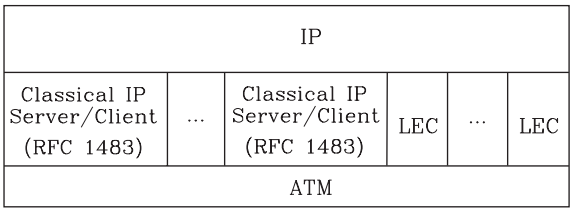

Figure 14-1. IP Routing

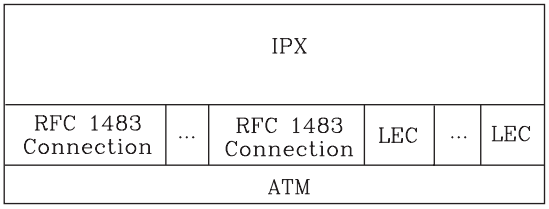

Figure 14-2. IPX Routing

IP routing is supported between arbitrary combinations of Classical IP (CIP) and LAN emulation (LE) subnets, whereas IPX routing is supported over emulated LAN interfaces and RFC 1483 [1]

connections to other routers. These protocols treat emulated interfaces implemented by LAN emulation (LE) clients just like real Ethernet and Token-Ring interfaces. When an LE client is created, it is assigned a unique interface number.

All other routing protocols, for example, Appletalk 2 and DECnet, are supported only in LAN Emulation Mode.

Overview of RFC 1483 Support

RFC 1483 (Multiprotocol Encapsulation over ATM Adaptation Layer 5) provides the details about the encapsulation of bridged and router frames. Routing of IP and IPX traffic is supported. The software also provides the full range of bridging capabilities, allowing bridged traffic to be transmitted natively over ATM.

[1] J. Heinanen, “Multiprotocol Encapsulation over ATM Adaptation Layer 5,” RFC 1483, Telecom Finland, July, 1993.

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RFC 1483 specifies LLC/SNAP encapsulation for carrying multiprotocol traffic over ATM. A LLC value of 0xAA-AA-03 is specified to indicate the presence of a SNAP header. The OUI portion of the SNAP header is 0x00-00-00 for routed protocols, and 0x00-80-C2 for bridged protocols.

Overview of RFC 1483 Support for Routing

Classical IP uses the LLC/SNAP format for routed protocols defined in RFC 1483. The server also supports connections to IPX routers that use LLC/SNAP encapsulation. This IPX support is modeled after the Classical IP approach.

RFC 1483 Support for IPX Routing

IPX routers use routing information protocol (RIP) and service advertising protocol (SAP) to propagate routing and device information tables. On LANs or emulated LANs, these protocols use broadcast frames to propagate information to interested parties. The server will also propagate the routing and device information to and from all RFC 1483 connections with other IPX routers.

Like other routers that support RFC 1483 LLC/SNAP encapsulation on ATM, the router can be interconnected in full or partial meshes using manually configured RFC 1483 connections.

In a *fully meshed* network, every router has a direct connection to every other router. In a *partially meshed* network, not every router has a direct connection to every other router; however, there exists enough connectivity for any router to reach any other router, directly or through another router. In the partially meshed network, some routers must perform intermediate routing. An intermediate router provides connectivity between routers that are not directly connected to one another.

Both permanent virtual circuits (PVCs) and configured switched virtual circuits (SVCs) are supported. However, virtual channel connections (VCCs) to IPX routers must be dedicated to IPX; they cannot be shared with other protocols, such as IP.

As with Classical IP, Quality of Service characteristics can be specified by configuring VCC traffic parameters such as Peak and Sustained Rates, and multiple circuits can be configured on a single ATM interface.

The server supports a single IPX network per ATM interface. This statement implies that there is a single ATM ARP client per interface for IPX, which must be explicitly configured. Therefore, all interconnected routers on the ATM interface must be part of the same IPX network.

IPX ATM addresses must be unique among all components using RFC 1483 encapsulation, including Classical IP components. The end system identifier (ESI) and the selector portions of IPX ATM addresses are configured in the same manner as Classical IP ATM addresses. When the server does not initiate the SVC, then at least the selector should be explicitly specified in order to provide a fixed address that can be configured at the calling router.

IPX protocol addresses have two parts: a 4-byte network number and a 6-byte host number (or host ID). Network numbers must be unique within IPX routing domains, and host numbers must be unique within a given network. The server sets the IPX host number to the ESI component of the associated ATM address. Whenever you

do not explicitly configure the ESI, it defaults to the MAC address that is burned into the ATM interface hardware.

You can specify destination IPX host numbers during VCC configuration or they can be learned dynamically using InATMARP. You must manually configure the IPX host numbers of destination routers that do not support InATMARP. The server also periodically uses InATMARP to refresh its knowledge of the partner router's IPX host number.

Routers that are interconnected in a partial mesh and are providing intermediate routing between routers on the same ATM interface should disable IPX split-horizon on the ATM interface. Doing this ensures that RIP and SAP correctly inform the interconnected routers of all available routes and services. Routers that are interconnected in a full mesh need not disable split-horizon.

The server implementation of RFC 1483 support for IPX routing requires minimal configuration. The IPX network number and the IPX host number (IPX ATM ARP client) are the only information that is required. If you wish to open a connection to a remote IPX router, you must additionally configure the desired virtual channel connections (VCCs). Although the combination of RFC 1483 encapsulation and InATMARP has not yet been standardized, the combination is specified for IPX over Frame Relay in RFC 1490. [2]

Note: Though the implementation limits IPX to one address per ATM interface, a single physical ATM interface can still support multiple IPX addresses using the ATM Virtual Interface. You will still be limited to one IPX address per interface, but because you can add several ATM Virtual Interfaces on each physical interface, you can avoid the single address limitation.

Refer to *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide* for additional information about ATM Virtual Interfaces.

[2] T. Bradley, C. Brown, and A. Malis, "Multiprotocol Interconnect Over Frame Relay," RFC 1490, Wellfleet Communications Inc. and Ascom Timeplex Inc., July 1993.

Chapter 15. Using IP

This chapter describes how to configure the Internet Protocol (IP). It includes the following sections:

- "Basic Configuration Procedures"
- "Configuring the BOOTP/DHCP Forwarding Process" on page 15-12
- "Configuring the Redundant Default IP Gateway" on page 15-13
- "IP Multicast Support" on page 15-13

Basic Configuration Procedures

This section outlines the initial steps required to get the IP protocol up and running. Details about making further configuration changes are covered in other sections of this chapter. Details about individual configuration commands are covered in the command section of this chapter. The following list outlines the initial configuration tasks to bring up IP on the router. After completing these tasks, you must restart the router for the new configuration to take effect.

1. Access the IP configuration environment. (See "Accessing the IP Configuration Environment" on page 16-1.)
2. Assign IP addresses to network interfaces. (See "Assigning IP Addresses to Network Interfaces.")
3. Enable dynamic routing. (See "Enabling Dynamic Routing" on page 15-2.)
4. Add static routing information, if necessary. (See "Adding Static Routing Information" on page 15-4.)
5. Enable ARP subnet routing, if necessary. (See "Enabling ARP Subnet Routing" on page 15-7.)
6. Set up ARP parameters, if necessary. (See "Setting Up ARP Configuration" on page 15-6.)
7. Exit the IP configuration process.
8. Restart the router to activate the configuration changes.

The following sections discuss each configuration task in more detail.

Assigning IP Addresses to Network Interfaces

Use the IP configuration **add address** command to assign IP addresses to the network interfaces. The arguments for this command include the interface number (obtained from the `Config>` **list devices** command) and the IP address with its associated address mask.

In the following example, network interface 2 has been assigned the address 128.185.123.22 with the associated address mask 255.255.255.0 (using the third byte for subnetting).

```
IP Config> add address 2 128.185.123.22 255.255.255.0
```

Multiple IP addresses can be assigned to a single network interface.

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By default the IP addresses assigned to the network interfaces must each be in a different network or subnet. The **enable same-subnet** command removes the restriction.

IP allows you to use a serial line interface for IP traffic without assigning a real IP address to the line. However, you must still assign each serial line a pseudo IP address; this address is used by the router to refer to the interface but is never used externally. Use the **add address** command to assign the serial line an address of the form 0.0.0.*n*, where *n* is the interface number (again obtained from the `Config>` **list devices** command). This address format tells the router that the interface in question is an *unnumbered serial line*.

To enable IP on serial-line interface number 2 without assigning the interface an IP address, use the following command:

```
IP Config> add address 2 0.0.0.2
```

Setting the Internal IP Address

This is an IP address that is independent of the state of any interface and is set without reference to any interface. Some IP configurations require it. See the command **set internal-IP-address** on page 16-32 for more information.

Enabling Dynamic Routing

Use the following procedures to enable dynamic routing on the router. The router software supports OSPF, RIPv1, and RIPv2 for interior gateway protocols (IGPs) as well as BGP, which is an external gateway protocol.

All routing protocols can run simultaneously. However, most routers will probably run only a single routing protocol (one of the IGPs). The OSPF protocol is recommended because of its robustness and the additional IP features (such as equal-cost multipath and variable-length subnets) that it supports.

Setting the Routing Table Size

The routing table size determines the number of entries in the routing table from all sources, including dynamic routing protocols and static routes. The default size is 768 entries.

To change the size of the routing table, use the **set routing table-size** configuration command. Setting the routing table size too small results in routes being discarded. Setting it too large results in inefficient use of memory resources. After operation, use the console **dump** command to view the contents of the table and then adjust the size as necessary, allowing some room for expansion.

Enabling the OSPF Protocol

OSPF configuration is done via its own configuration console (entered via the `Config>` **protocol ospf** command). To enable OSPF, use the following command:

```
OSPF Config> enable OSPF
```

After enabling the OSPF protocol, you are prompted for size estimates for the OSPF link state database. This gives the router some idea how much memory must be reserved for OSPF. You must supply the following two values that will be used to estimate the size of the OSPF link state database:

- Total number of external routes imported into the OSPF routing domain.

- Total number of OSPF routers in the routing domain.

Enter these values at the following prompts (sample values have been provided):

```
OSPF Config> enable ospf
Estimated # external routes[0]? 200
Estimated # OSPF routers [50]? 60
Maximum LSA size [2048]?
```

Next, configure each IP interface that is to participate in OSPF routing. To configure an IP interface for OSPF, use the following command:

```
OSPF Config> set interface
```

You are prompted to enter a series of operating parameters. Each interface is assigned a cost as well as other OSPF operating parameters.

When running other IP routing protocols besides OSPF, you may want to enable the exchange of routes between OSPF and the other protocols. To do this, use the following command:

```
OSPF Config> enable AS-boundary-routing
```

For more information on the OSPF configuration process, see Chapter 17, “Using OSPF” on page 17-1.

Enabling the RIP Protocol

This section describes how to initially configure the RIP protocol. When configuring the RIP protocol, you can specify which set of routes the router will advertise and/or accept on each IP interface.

RIP is not supported on X.25 or on native ATM (RFC 1577) network interfaces. For these types of interfaces, use OSPF instead of RIP for an interior gateway protocol (IGP). RIP is supported on ATM LAN Emulation network interfaces.

First, enable the RIP protocol with the following command:

```
IP Config> enable RIP
```

When RIP is enabled, the following default behavior is established:

- The router includes all network and subnet routes in RIP updates sent out on each of its configured IP interfaces. It does not include default and static routes.
- The router processes all RIP updates received on each of its configured IP interfaces.
- RIP will not override default and static routes.

To change any of the default sending/receiving behaviors, use the following IP configuration commands, which are defined on a per-IP-interface basis.

```
IP Config> enable/disable sending net-routes
IP Config> enable/disable sending subnet-routes
IP Config> enable/disable sending static-routes
IP Config> enable/disable sending host-routes
IP Config> enable/disable sending default-routes
 IP Config> enable/disable receiving rip
IP Config> enable/disable receiving dynamic nets
IP Config> enable/disable receiving dynamic subnets
IP Config> enable/disable receiving host-routes
IP Config> enable/disable override default
IP Config> enable/disable override static-routes
IP Config> set originate-rip-default
```

Enabling the BGP Protocol

The BGP protocol is enabled from its own configuration prompt, `BGP Config>` For more information about configuring BGP, refer to the discussion on using and configuring BGP4 in *Protocol Configuration and Monitoring Reference Volume 2*.

Adding Static Routing Information

This procedure is necessary only for routing information you cannot obtain from any of the above dynamic routing protocols. Static routing information persists over power failures and is used for routes that never change or cannot be learned dynamically.

The destination of a static route is described by an IP address (*dest-addr*) and an IP address mask (*dest-mask*). The mask indicates the range of IP addresses to which the route applies; for example, a route with IP address 10.0.0.0 and mask 255.0.0.0 applies to IP addresses from 10.0.0.0 through 10.255.255.255. The route to the destination is described by the IP address of the next hop router (*next-hop*) and the cost of forwarding a packet on this route (*cost*).

To create, modify, or delete a static route, use the following commands:

```
    IP Config> add route dest-addr dest-mask
next-hop cost
    IP Config> change route dest-addr dest-mask next-hop
cost
    IP Config> delete route dest-addr dest-mask
```

These commands allow you to define up to four static routes per IP destination, allowing for alternative routes if one or more of the routes fail. These commands take effect immediately without the need to reboot the router.

Longest Match Rule

Because the destination of a route includes the IP address mask, it is possible for more than one route to match a particular IP address; for example, for the IP address 10.1.2.3, a route with IP address 10.0.0.0 and mask 255.0.0.0 and a route with IP address 10.1.0.0 and mask 255.255.0.0 both match. To determine which route to use, the longest match rule is applied. The route with the largest mask is used (in this case the route with IP address 10.1.0.0 and mask 255.255.0.0).

Default, Network, Subnet and Host Routes

Routes can be classified as *default*, *network*, *subnet*, or *host*, according to their destination IP address and mask.

A default route has an IP address/mask of 0.0.0.0/0.0.0.0. This route matches all destination IP addresses, but because of the longest match rule, it is used only if

there is no other matching route. The following command creates a static default route:

```
IP Config> add route
IP destination [ ]? 0.0.0.0
Address mask [255.0.0.0]? 0.0.0.0
Via gateway 1 at [ ]? 192.9.1.4
Cost [1]? 5
Via gateway 2 at [ ]?
IP Config>
```

The static default route may also be set by the **set default network-gateway** command; however, this command does not take effect immediately, and it allows you to define only one default static route. The following example creates the same static default route as the above **add route** command:

```
IP Config> set default network-gateway
Default gateway [ ]? 192.9.1.4
gateway's cost [1]? 5
IP Config>
```

A *network route* has a mask that depends on the value of the route's destination IP address as specified by the IP address classes defined in RFC-791:

IP Address Class	IP Address Range	Network Mask
A	0.0.0.0 - 127.255.255.255	255.0.0.0
B	128.0.0.0 - 191.255.255.255	255.255.0.0
C	192.0.0.0 - 223.255.255.255	255.255.255.0

The **add route**, **change route**, and **delete route** commands use the network mask that corresponds to the destination IP address as the default mask value. The following command creates a static *network route*:

```
IP Config> add route 172.16.0.0
Address mask [255.255.0.0]?
Via gateway 1 at [ ]? 192.9.1.4
Cost [1]? 5
Via gateway 2 at [ ]?
IP Config>
```

A static network route may also be set by the **set default subnet-gateway** command; however, this command does not take effect immediately, and it allows you to define only one static route per destination. The following example creates the same static network route as the above **add route** command:

```
IP Config> set default subnet-gateway
For which subnetted network [ ]? 172.16.0.0
Default gateway [ ]? 192.9.1.4
gateway's cost [1]? 5
IP Config>
```

A *subnet route* has a mask that is larger than the network mask for the route's destination IP address. The following command creates a static subnet route:

```
IP Config> add route 172.16.1.0
Address mask [255.255.0.0]? 255.255.255.0
Via gateway 1 at [ ]? 192.9.1.4
Cost [1]? 5
Via gateway 2 at [ ]?
IP Config>
```

A *host route* is a route to a specific IP address; it has a mask of 255.255.255.255. The following command creates a static host route:

```
IP Config> add route 172.16.1.2
Address mask [255.255.0.0]? 255.255.255.255
Via gateway 1 at [ ]? 192.9.1.4
Cost [1]? 5
Via gateway 2 at [ ]?
IP Config>
```

Interaction Between Static Routing and Dynamic Routing

Routes dynamically learned through the OSPF and RIP protocols can override static routes. For the RIP protocol, you can disable this override behavior. See the RIP section of this chapter concerning the **enable/disable override static-routes** commands.

You can configure both OSPF and RIP to advertise configured static routes over interfaces where these dynamic protocols are enabled.

To configure RIP to advertise static routes, enter the following command at the `IP Config>` prompt:

```
IP Config> enable sending static-routes ip-interface-address
```

To configure OSPF to advertise static routes, enter the following command at the `OSPF Config>` prompt:

```
OSPF Config> enable as boundary
Import static routes? yes
```

Nexthop Awareness

Nexthop Awareness allows the router to sense whether a neighboring router is up or down. When this option is enabled, the router makes a more accurate determination of whether a static route that uses the neighboring router as its next hop will function. It also allows the router to determine over which network interface a static route's next hop can be reached when that next hop is in an IP subnet that is defined on multiple network interfaces.

To enable Nexthop Awareness on a particular IP interface, enter the following command at the IP configuration prompt:

```
IP Config> enable nexthop-awareness ip-interface-address
```

To disable Nexthop Awareness on a particular IP interface, enter the following command at the IP configuration prompt:

```
IP Config> disable nexthop-awareness ip-interface-address
```

Nexthop Awareness is supported only on frame relay networks on which the neighboring routers support inverse ARP.

Setting Up ARP Configuration

The Address Resolution Protocol (ARP) is used to map protocol addresses to hardware addresses before a packet is forwarded by the router. ARP is always active on the router, so you do not need to do any additional configuration to enable it with its default characteristics. However, if you need to alter any ARP configuration parameters (such as **enable auto-refresh** or **set refresh-timer**, which changes the default refresh timer), or if you need to add, change, or delete permanent address mappings, see Chapter 23, "Using ARP" on page 23-1.

If LAN Emulation is configured on an interface, the defaults apply. You can effectively use the ARP protocol without any changes. If RFC 1577 (Classical IP and ARP over ATM) is used, additional configuration for ARP Clients and ARP Servers is required for each IP address configured on that ATM interface (as described in “ARP Over ATM Configuration Commands” on page 24-5).

Enabling ARP Subnet Routing

If there are hosts on attached subnetted networks that do not support IP subnetting, use Address Resolution Protocol (ARP) subnet routing (described in RFC 1027). When the router is configured for ARP subnet routing, it will reply by proxy to ARP requests for destination (that is, off the LAN if the router is itself the best route to the destination, and the destination is in the same natural network as the source). For correct operation, all routers attached to a LAN containing subnetting-ignorant hosts should be configured for ARP subnet routing.

To enable ARP subnet routing, use the following command:

```
IP Config> enable arp-subnet-routing
```

Enabling ARP Network Routing

Some IP hosts ARP for all destinations, whether or not the destination is in the same natural network as the source. For these hosts, ARP subnet routing is not enough, and the router can be configured to reply by proxy to any ARP request as long as the destination is reachable through the router and the destination is not on the same local network segment as the source.

To enable ARP network routing, use the following command:

```
IP Config> enable arp-network-routing
```

IP Filtering

Filtering allows you to specify certain criteria that the router uses to control packet forwarding. The following two main types of filtering are provided to help you achieve your security and administrative goals:

- Access control
- Route filtering

Access Control

Access control allows the IP router to control the processing of individual packets based on source and destination IP addresses, IP protocol number, and by destination port number for the TCP and UDP protocols. This can control access to particular sets of IP hosts and services.

You can define access controls by configuring access control lists. One global list and two lists per interface can be specified. The global list applies to the router as a whole. Interface lists, also known as packet filters, are assigned names and apply only to the designated interface. For each interface, one list applies to incoming packets, and the other applies to outgoing packets. The lists are applied independently of each other. A packet might *pass* an incoming interface list, and be *dropped* by the global list.

Figure 15-1 on page 15-8 illustrates the series of access control lists through which a packet must pass before being forwarded.

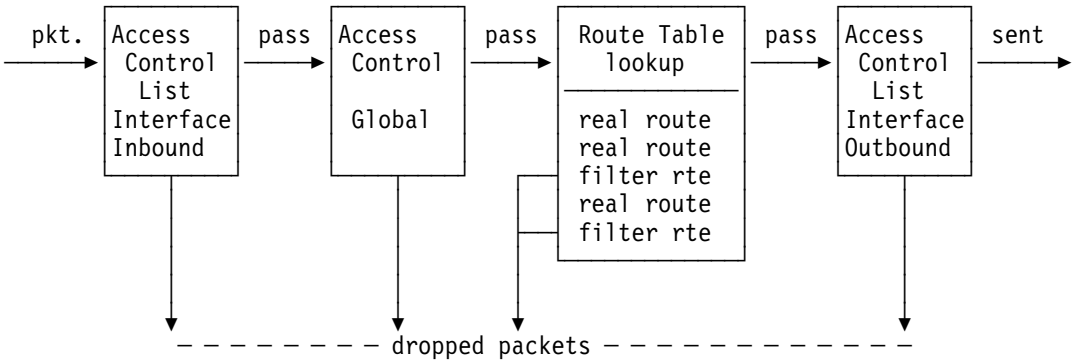

Figure 15-1. Access Control Lists in the Packet Forwarding Path

Access Control Rules

Each access control list consists of one or more access control rules that set the filtering criteria. Some access control rules define the global filters that affect all the interfaces on the router and others define the interface-specific access control lists (also called packet filters). The global access control rules are configured using the **add access** command at the `IP Config>` prompt. The packet filters are set using two commands at the `IP Config>` prompt: the **add packet-filter** command to define the filter and the **update packet-filter** command to configure it.

As IP packets flow through the router, IP headers are compared to the access control rules. A packet matches a rule if every specified field in the rule matches a corresponding field in the packet's IP header. If a packet matches a rule, and the rule filter type is inclusive, the packet *passes*. If the rule filter type is exclusive, the packet is *dropped* and is not processed any further by the router. If no rules match after going through the entire list, the packet is also dropped.

When defining records in access control lists, it is important to remember the following information:

- The order of records in a list is important. Configuration commands are provided to change the order of records in a list.
- For every list that includes at least one access control rule, an inclusive rule must exist for any packets to pass the list. One method of allowing all packets that do not match any of the specified rules in a list to pass is to include the following wildcard rule as the last rule in the list:

```
add access-control inclusive 0.0.0.0  0.0.0.0
```

Enabling Access Control

IP Access Control (including global and interface access control) is enabled with the **set access-control on** command and disabled with the **set access-control off** command. You can use the **enable packet-filter** and the **disable packet-filter** commands to enable and disable specific packet filters when IP Access Control is enabled.

If IP access control is enabled, you must be careful with packets that the router originates and receives. Be sure not to filter out the RIP or OSPF packets being sent or received by the router. The easiest way to do this is to add a wildcard inclusive rule as the last in the access control list. Alternatively, you can add specific rules for RIP and OSPF, perhaps with restrictive addresses and masks.

Note that some OSPF packets are sent to the Class D multicast addresses 224.0.0.5 and 224.0.0.6, which is important if address checking is being done for routing protocols. See the **add** command for more information on access control.

Defining the Global Access Control List

The global access control list is defined when rules are added at the `IP Config>` prompt:

```
IP Config>  add access-control...
```

Global access control rules can be listed, moved, or deleted using the **list**, **move**, or **delete** commands. See these commands for further information.

Defining Packet Filters

To define packet filters, which are interface-specific, use the **add packet-filter** command at the `IP Config>` prompt. The router prompts you for the filter name, direction (input or output), and the interface number to which it applies.

```
Packet-filter name [ ]? test
Filter incoming or outgoing traffic? [IN]? in
Which interface is this filter for [0]? 1
```

You can use the **list packet-filter** command to list all interface-specific access control lists configured in the router.

Setting Up Access Control Rules for Packet Filters

You must define access control rules for each defined list (packet filter). Otherwise, defined packet filters will have no effect on incoming or outgoing traffic. Use the **update packet-filter** command at the `IP Config>` prompt to define access control rules. The router first prompts you for the name of the packet filter that you want to update. The `IP Config>` prompt then changes to `Packet-filter 'name' Config>` where ‘name’ is the list name that you provide.

```
IP Config>  update packet-filter
Packet-filter name [ ]?  test
Packet-filter 'test' Config>
```

From this prompt, you can issue **add**, **list**, **move**, and **delete** commands. These commands are similar to those used to modify the global access control list.

Parameters for Access Control Rules

Access control rules consist of multiple parameters. Some parameters can be specified in all access control rules, while others can be specified only in the rules for packet filters. The following parameters can be specified in all access control rules:

- Type (inclusive, exclusive)
- IP source address and mask
- IP destination address and mask
- IP protocol number range
- TCP/UDP port number range

The following parameter is for packet filters only:

- Packet filter name

Type

The type of an access control rule defines what it does to packets that match it. An *exclusive* (E) rule discards packets. An *inclusive* (I) rule allows packets to be processed further by the router.

IP Source and Destination Addresses

Each rule has an IP address and mask pair for both the IP source and destination addresses. When an IP packet is compared to an access control rule, the IP address in the packet is ANDed with the mask in the rule, and the result compared with the address in the rule. For example, a source address of 26.0.0.0 with a mask of 255.0.0.0 in an access control rule will match any IP source address with 26 in the first byte. A destination address of 192.67.67.20 and a mask of 255.255.255.255 will match only IP destination host address 192.67.67.20. An address of 0.0.0.0 with mask 0.0.0.0 is a wildcard that matches any IP address.

IP Protocol Number

Each record can also have an IP protocol number range. This range is compared to the protocol byte in the IP header; a protocol value within the specified range (inclusive) will match. If you specify a range of 0 to 255, any protocol will match. Commonly used protocol numbers are 1 (ICMP), 6 (TCP), 17 (UDP), and 89 (OSPF).

TCP/UDP Port Number

TCP/UDP port number ranges can also be specified in an access control rule. This range is compared to the port number field in the TCP or UDP header of the IP packet; a port number value within the specified range (inclusive) will match. This field is ignored for IP packets that are not TCP or UDP packets. If you specify a range of 0 to 65535, any port number will match. Commonly used port numbers are 21 (FTP), 23 (Telnet), 25 (SMTP), 513 (rlogin) and 520 (RIP). See RFC 1700 (Assigned Numbers) for a list of IP protocol and port numbers.

Examples

The following example allows any host to send packets to the SMTP TCP socket on 192.67.67.20.

```
add access-control inclusive 0.0.0.0 0.0.0.0 192.67.67.20 255.255.255.255 6 6 25 25
```

The next example prevents any host on subnet 1 of Class B network 150.150.0.0 from sending packets to hosts on subnet 2 of Class B network 150.150.0.0 (assuming a 1-byte subnet mask).

```
add access-control exclusive 150.150.1.0 255.255.255.0 150.150.2.0 255.255.255.0 0 255 0 65535
```

This command allows the router to send and receive all RIP packets.

```
add access-control inclusive 0.0.0.0 0.0.0.0 0.0.0.0 0.0.0.0 17 17 520 520
```

Route Filtering

Route filtering impacts packet forwarding by influencing the content of the routing table. In general, route filtering is more efficient but less flexible than access control. Filtering based on packet fields other than the destination IP address can only be done using access control, described above.

The following methods are used in this router to influence the content of the routing table.

- Filter routes
- RIP input filters
- Route table filtering

Defining Filter Routes

You can designate an IP destination to be inserted in the routing table as a *filter route.* IP packets will not be forwarded to these destinations, and routing information concerning them will not be advertised. Filter routes are ***not*** recommended when OSPF is used in your network; OSPF-learned internal routes will override filtered routes in the routing table.

To configure a filter route, enter the following command at the `IP Config>` prompt:

```
IP Config>  add filter  dest-IP-address  address-mask
```

Filter routes will be listed as an entry with the type *fltr* when the **dump** command is used to view the IP routing table.

Note: If a more specific route is available, packets will be forwarded. For example, if a filter route is defined for network 9.0.0.0 (mask 255.0.0.0), but a route is learned for a subnet of the network (for example 9.1.0.0, mask 255.255.0.0), then packets will be forwarded to subnet 9.1.0.0 but not to other subnets of that network.

Defining RIP Input Filters

When RIP is used as the dynamic routing protocol, you can configure certain interfaces to ignore routes in RIP updates.

The following command results in ignoring all RIP updates received on an interface:

```
IP Config>  disable receiving rip  ip-interface-address
```

The following commands result in ignoring certain types of routes received on an interface:

```
IP Config> disable receiving dynamic nets ip-interface-address
IP Config> disable receiving dynamic subnets ip-interface-address
IP Config> disable receiving dynamic host ip-interface-address
```

When the latter group of commands are used, you can allow specific routes to be accepted using the following command:

```
IP Config> add accept-rip-route ip-network/subnet/host
```

Defining Route Table Filtering

When route table filtering is enabled and route filters are defined, checking is performed before adding routes to the IP routing table. If the route to be added matches on an inclusive route filter, it will be added to the IP route table. If it matches on an exclusive route filter, it will not be added to the IP route table. Direct and static routes will never be filtered.

This function can be used to prevent routes from being added to the IP route table in situations where the network administrator does not want all routes advertised by routing protocols to be available. This function could be used in a service provider environment to prevent customers from having access to each other's networks.

Configuring the BOOTP/DHCP Forwarding Process

BOOTP (documented in RFC 951 and RFC 1542) is a bootstrap protocol used by a diskless workstation to learn its IP address, the location of its boot file, and the boot server name. Dynamic Host Configuration Protocol (DHCP), documented in RFC 1541, is used to allocate reusable network addresses and host-specific configuration parameters from a server.

The following terms are useful when discussing the BOOTP/DHCP forwarding process:

- *Client* - the workstation requiring BOOTP/DHCP services.
- *Servers* - the boot host (with UNIX daemon bootpd, DOS version available from FTP software, or OS/2) or other BOOTP/DHCP server that is providing these services. This router does not provide server support.
- *BOOTP relay agent* or *BOOTP forwarder* - a device that forwards requests/replies exchanged by the Client and Server. This router supports the relay agent function.

The following steps outline an example of the BOOTP forwarding process. (DHCP exchanges proceed in a similar way):

1. The Client copies its Ethernet address (or appropriate MAC address) into a BOOTP packet and broadcasts it onto the local LAN. BOOTP is running on top of UDP.
2. The local BOOTP relay agent receives the packet and checks to see if the packet is well formatted and that the maximum number of application hops has not expired. It also checks to see if the client has been trying long enough.

   Note: If multiple hops are required before reaching the BOOTP agent, the packet is routed normally via IP. All other routers would not examine the packet to determine whether it is a BOOTP packet.
3. The Local BOOTP agent forwards a separate BOOTP request to each of its configured servers. The BOOTP request is the same as the one that was initially sent by the client except that it has a new IP header with the relay agent's IP address copied into the body of the BOOTP request.
4. The server receives the request and looks up the client's hardware (for example, Ethernet) address in its database. If found, it formats a BOOTP reply containing the client's IP address, the location of its boot file, and the boot server name. The reply is then sent to the BOOTP relay agent.
5. The BOOTP relay agent receives the reply and makes an entry in its ARP table for the client and then forwards the reply to the client.
6. The client then continues to boot using TFTP, using the information in the BOOTP reply packet.

Enabling/Disabling BOOTP Forwarding

To enable or disable BOOTP forwarding on the router, enter the following command at the IP configuration prompt. (Enable BOOTP Forwarding to allow the router to forward BOOTP and/or DHCP requests and replies between Clients and Servers on different segments of your network.)

```
IP Config> enable/disable bootp
```

When enabling BOOTP, you are prompted for the following values:

- Maximum number of application hops you want the BOOTP request to go. This is the maximum number of BOOTP relay agents that can forward the packet. This is ***not*** the maximum number of IP hops to the Server. A typical value for this parameter is 1.
- Number of seconds you want the Client to retry before the BOOTP request is forwarded. *This parameter is not commonly used.* A typical value for this parameter is 0.

After accepting a BOOTP request, the router forwards the BOOTP request to each BOOTP server. If there are multiple servers configured for BOOTP, the router replicates the packet.

Configuring a BOOTP/DHCP Server

To add a BOOTP or DHCP server to the router's configuration, enter the following command at the IP configuration prompt:

```
IP Config> add bootp-server server-IP-address
```

Multiple servers can be configured. In addition, if only the network number of the server is known or if multiple servers reside on the same network segment, a broadcast address can be configured for the server.

Configuring the Redundant Default IP Gateway

This section outlines the steps used to configure redundant default IP gateways on ELANs. Configuration of a redundant gateway allows end stations with manually configured default gateways to continue passing traffic to other subnets after their primary gateway goes down.

To configure a device with a primary gateway or backup gateway:

1. Determine the IP address end stations use as the default gateway.
2. Determine a MAC address not used by any interfaces on the ELAN. To determine which MAC addresses are used, see "Database List" in the "Monitoring LAN Emulation Services" chapter of *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*.
3. Select a device to have the primary gateway. This device must have a LEC interface on the ELAN of the end station.
4. Select a device or set of devices to have the backup gateway. This device or set of devices must have a LEC interface on the ELAN of the end station.
5. Config a redundant gateway on each device using the "Add" option for IP.

IP Multicast Support

IP multicast is an extension of LAN multicasting to a TCP/IP Internet. It is the ability of an IP host to send a single datagram (called IP multicast datagram) that will be delivered to multiple destinations. IP multicast datagrams are identified as those packets whose destinations are class D IP addresses (that is, whose first byte lies in the range 224 to 239). Each class D address defines a multicast group.

The extensions required of an IP host to participate in IP multicasting are specified in RFC 1112 (Host Extensions for IP Multicasting.) That document defines a protocol, the Internet Group Management Protocol (IGMP), that enables hosts to dynamically join and leave multicast groups. This router implements the IGMP protocol functions that enable it to keep track of IP group membership on its local physical and on its emulated LANs by sending IGMP Host Membership Queries and receiving IGMP Host Membership Reports.

A router must also be able to route IP multicast datagrams between the source and (multiple) destination hosts. This router supports the Multicast Open Shortest Path First (MOSPF) protocol as defined by RFC 1584 (Multicast Extensions to OSPF), and the Distance Vector Multicast Routing Protocol (DVMRP).

A MOSPF router distributes group location information throughout the routing domain by flooding a new type of link state advertisement, the group-membership-LSA (type 6). This in turn enables the MOSPF routers to most efficiently forward a multicast datagram to its multiple destinations: each router calculates the path of the multicast datagram as a tree whose root is the datagram source, and whose terminal branches are LANs containing group members. For more information, see “Multicast OSPF” on page 17-3.

DVMRP is a multicast routing protocol derived from the Routing Information Protocol (RIP). This router provides support for DVMRP so that you can exchange multicast routing information with other routing entities that do not support MOSPF. This router’s DVMRP implementation also allows tunneling of DVMRP information over an MOSPF-capable network and over a non-multicast-capable IP network.

This router also allows you to “enroll” the router itself as a member of one or more multicast groups. As a member of a multicast group, the router will respond to “pings” and SNMP queries addressed to the group address (one command could be used to query multiple routers).

Additionally, the device’s IP multicasting support is used to establish and manage DLSw groups, which reduces the amount of configuration needed for DLSw. For additional information, refer to Chapter 6, “Using DLSw” on page 6-1.

Configuring the Router for IP Multicast

To enable the router to track IP multicast group memberships and forward multicast datagrams, you must enable MOSPF.

Enabling MOSPF

To enable MOSPF, you must first enable OSPF (see “Enabling the OSPF Protocol” on page 15-2) and then do the following:

1. Enable multicast forwarding by entering the following command at the `OSPF Config>` prompt:

   ```
   OSPF Config> enable multicast-routing
   ```

2. Set the following parameters when configuring each OSPF interface through the `OSPF Config>` **set interface** command:

   ```
   Forward multicast datagrams (Yes or No)?
   Forward as datalink unicasts (Yes or No)?
   IGMP polling interval (in seconds) [60]?
   IGMP timeout (in seconds) [180]?
   ```

For more details on these configuration commands, see “Multicast OSPF” on page 17-3.

The following OSPF monitoring commands are used to obtain information about IP multicast groups and MOSPF routing:

```
OSPF> advertisement ls-type link-state-id
      (by entering type 6 in the ls-type field, this
       command displays the contents of the group-membership
       link-state-advertisement sent out by the router)

OSPF> interface interface-ip-address
       (a number of output fields are specific to multicasting
        and provide statistics on IGMP and multicast packets)

OSPF> Mcache
       (displays list of currently active multicast cache
        entries

OSPF> Mgroups
      (displays group membership of the router's attached
       interfaces as reported via IGMP)

OSPF> Mstat
      (displays various multicast packet statistics)
```

For more information on these commands, refer to “Multicast OSPF” on page 17-3.

Enrolling the Router in IP Multicast Groups

If the router itself is to join one or more multicast groups, the following join/leave commands are used:

- **join multicast-group-address**
- **leave multicast-group-address**

These **join** and **leave** commands are accessible from the `OSPF Config` prompt and the `OSPF` monitoring prompt.

Note that these commands are not necessary for the router to perform its IP multicast forwarding or IGMP group tracking functions; they are used to add the router to groups so that it can respond to “pings” and SNMP queries addressed to these groups.

Chapter 16. Configuring and Monitoring IP

This chapter describes the IP configuring and monitoring commands. It includes the following sections:

- "Accessing the IP Configuration Environment"
- "IP Configuration Commands"
- "Accessing the IP Monitoring Environment" on page 16-38
- "IP Monitoring Commands" on page 16-38

Accessing the IP Configuration Environment

To access the IP configuration environment, enter the following command at the `Config>` prompt:

```
Config> Protocol IP
Internet protocol user configuration
IP Config>
```

IP Configuration Commands

This section describes the IP configuration commands. These commands allow you to modify the IP protocol behavior to meet your specific requirements. Some amount of configuration is necessary to produce a fully functional IP router. Enter IP configuration commands at the `IP config>` prompt.

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Table 16-1. IP Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds to the IP configuration information. Interface addresses can be added, along with access controls, filters, and packet-filters.
Change	Modifies information that was originally entered with the **add** command.
Delete	Deletes IP configuration information that had been entered with the **add** command.
Disable	Disables certain IP features that have been turned on by the **enable** command.
Enable	Enables IP features such as ARP subnet routing, UDP Forwarding, originate default, directed broadcasts, BOOTP, the various RIP flags controlling the sending and receiving of RIP information, and route-table-filtering.
List	Displays IP configuration items.
Move	Changes the order of access control records.
Set	Establishes IP configuration modes such as the use of access control and the format of broadcast addresses. Also sets IP parameters such as TTL (time-to-live) of packets originated by the router, the size of the IP routing table, and rip interface metric.
Update	Used to assign access control entries to packet filters.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add IP information to your configuration.

Syntax:

add
- accept-rip-route . . .
- access-control . . .
- address . . .
- bootp-server
- distributed-ip-gateway
- filter . . .
- packet-filter
- redundant-default-gateway
- route . . .
- route-table-filter

accept-rip-route *IP-network/subnet*

Allows an interface to accept a RIP route when input RIP filtering is enabled for an interface. You can print the list of networks/subnets that

have already been entered using the **list rip-routes-accept** command. You can enable the input filtering of RIP routes on a per-IP-interface basis. This is done separately for network-level routes (for example, a route to 10.0.0.0) for subnet-level routes (for example, a route to 128.185.0.0), and for host-level routes (for example 128.185.123.28). To enable input filtering of routes on an IP interface, use the **disable dynamic nets/subnets/host** commands.

IP network/subnet

Valid Values: any valid IP address

Default Value: none

Example: `add accept-rip-route 10.0.0.1`

or

Example: `add accept-rip-route`

```
Network number [0.0.0.0]? 10.0.0.0
```

access-control *type IP-source source-mask IP-dest dest-mask first-protocol last-protocol [first-port last-port]*

Adds an access control record to the end of the global access control list. This allows you to describe a class of packets to forward or drop, depending on the type of the record. The length and order of the IP access control list can affect the performance of the IP forwarder. Each record must be assigned the following: type, IP source, source-mask, IP destination, and destination-mask fields. The type must either be inclusive or exclusive. The *IP-source* and *IP-dest* fields are in the form of IP addresses in dotted decimal notation. Optionally, you can specify an IP protocol number range with the *first-protocol* and *last-protocol* fields, which are an inclusive range of IP protocols that match this entry. You can also specify a TCP or UDP port number or port number range that matches an entry, where “port number range” is an inclusive range of TCP and UDP ports that matches this entry. Specify TCP or UDP in the protocol fields, then specify the port number range in the first-port and last-port fields.

type Indicates whether packets are sent or dropped for a specific address or set of addresses.

Specify *Include* to cause the router to receive a packet and to forward it if it matches criteria in the remaining arguments.

Specify *Exclude* to cause the router to discard the packets.

Specify

IP-source

Valid Values: any valid IP address

Default Value: none

source-mask

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: none

IP-dest **Valid Values**: any valid IP address

Default Value: none

dest-mask

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: none

first-protocol

The lower boundary of a range of IP protocol numbers.

Some commonly used protocol numbers are:

1 for ICMP
6 for TCP
17 for UDP
89 for OSPF

Valid Values: 0 to 255

Default Value: 0

last-protocol

The upper boundary of a range of IP protocol numbers.

Some commonly used protocol numbers are:

1 for ICMP
6 for TCP
17 for UDP
89 for OSPF

Valid Values: 0 to 255

Default Value: 255

first-port The lower boundary of an IP TCP/UDP port number range.

Some commonly used port numbers are:

21 for FTP
23 for Telnet
25 for SMTP
513 for rlogin
520 for RIP

Valid Values: a port number in the range of 0 - 65535

Default Value: 0

last-port The upper boundary of an IP TCP/UDP port number range.

Some commonly used port numbers are:

21 for FTP
23 for Telnet
25 for SMTP
513 for rlogin

520 for RIP

Valid Values: a port number in the range 0 to 65535

Default Value: 65535

Example: `add access-control inclusive`

```
Internet source [0.0.0.0]?
Source mask [255.255.255.255]?
Internet destination [0.0.0.0]?
Destination mask [255.255.255.255]?
Enter starting protocol number ([CR] for all) [-1]?
IP config>
```

address *interface-number IP-address address-mask*

Assigns an IP address to one of the router's hardware network interfaces. A hardware network interface will not receive or transmit IP packets until it has at least one IP address. You must specify an IP address together with its subnet mask. For example, if the address is on a class B network, using the third byte for subnetting, the mask would be 255.255.255.0. Use the **list devices** command to obtain the appropriate command interface-number. Serial lines do not need addresses. Such lines are called unnumbered. However, you must still enable them for IP traffic using the **add address** command. The address then used is 0.0.0.*n*, where *n* is the *interface-number*. You must specify an IP address together with its subnet mask. For example, if the address is on a class B network, using the third byte for subnetting, the mask would be 255.255.255.0. Use the **List Devices** option to obtain the appropriate option interface-number.

interface-number

Valid Values: any defined interface number

Default Value: none

ip-address

Valid Values:

The class A range is 1.0.0.1 through 126.255.255.254
The class B range is 128.0.0.1 through 191.255.255.254
The class C range is 192.0.0.1 through 223.255.255.254
For unnumbered serial line interfaces, 0.0.0.n, where *n* is the interface number

Default Value: none

address mask

Valid Values: 0.0.0.0 - 255.255.255.255

Default Value: none

Example: `add address 0 128.185.123.22 255.255.255.0`

bootp-server *server-IP-address*

Adds a BOOTP/DHCP server to the list of servers to which the router wll forward BOOTP/DHCP requests. See "Configuring the BOOTP/DHCP Forwarding Process" on page 15-12 for more information.

server-IP-address

Valid Values: any valid Bootp server IP address

Default Value: none

Example: `add bootp-server 128.185.123.22`

distributed-ip-gateway *interface-number gateway-IP-address address-mask MAC-address primary-gateway*

Adds a Distributed Gateway IP address to your configuration.

interface-number

Specifies the net number of LEC interfaces on the ELAN.

Valid Values: net numbers of LEC interfaces

Default Value: none

gateway-IP-address

Specifies the Default Gateway of the end station.

Valid Values: IP addresses used as default gateways

Default Value: 0.0.0.0

address-mask

Specifies the mask of the IP address.

Valid Values: any valid IP net mask

Default Value: 0.0.0.0

MAC-address

Valid Values: any valid MAC address not used by other interfaces on the ELAN

Default Value: 00.00.00.00.00.00

primary-gateway

Specifies whether the gateway is used as the primary or as the backup gateway.

This query asks whether the gateway on this device is the primary gateway active during the normal operation of the network, or the backup gateway that is active when the LEC interface containing the primary gateway is not operational. Answering **Yes** configures a primary gateway. There should be only one primary gateway per ELAN.

Valid Values Yes or No

Default Value: No

Example: `add distributed-ip-gateway`

```
Which net is this distirbuted gateway for [0]? 1
IP address of gateway [0.0.0.0]? 9.67.205.1
Address mask [255.255.0.0]? 255.255.240.0
MAC address [00.00.00.00.00.00.]? 00.00.00.00.00.BA
Is this the primary gateway [No]? Yes or No
```

filter *dest-IP-address address-mask*

Designates an IP destination to be filtered. IP packets will not be forwarded to filtered destinations, nor will routing information be disseminated concerning such destinations. Packets to filtered destinations are simply discarded. You must specify a filtered destination as an IP address with its subnet mask. For example, to filter a subnet of a class B network, using the third byte for subnetting, the mask would be 255.255.255.0. Using the filter mechanism is more efficient than IP access controls, although not as flexible. Filters also affect the operation of the IP routing protocols, unlike access controls. Filtered

networks/subnets are overridden if learned using the OSPF routing protocol.

The effect of this command is immediate; you do not have to reboot the router for it to take effect.

dest-IP-address

Valid Values: any valid IP address

Default Value: none

address mask.

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: 0.0.0.0

Example: `add filter 127.0.0.0 255.0.0.0`

packet-filter *filter-name type interface-number*

Defines a packet filter record within the router configuration.

filter-name

Valid Values: any 16-character name.

You can include dashes (-) and underscores (_) in the name.

Default Value: none

type *IN* filters incoming traffic.

OUT filters outgoing traffic.

interface-number

Valid Values: any defined interface

Default Value: none

Example: `add packet-filter`

```
Packet-filter name [ ]? filt-1-0
Filter incoming or outgoing traffic? [IN]?
Which interface is this filter for [0]? 1
```

redundant-default-gateway *interface-number gateway-IP-address address-mask MAC-address primary-gateway*

Adds a Redundant Default Gateway IP address to your configuration.

interface-number

Specifies the net number of LEC interfaces on the ELAN.

Valid Values: net numbers of LEC interfaces

Default Value: none

gateway-IP-address

Specifies the Default Gateway of the end station.

Valid Values: IP addresses used as default gateways

Default Value: 0.0.0.0

address-mask

Specifies the mask of the IP address.

Valid Values: any valid IP net mask

Default Value: 0.0.0.0

MAC-address

Valid Values: any valid MAC address not used by other interfaces on the ELAN

Default Value: 00.00.00.00.00.00

primary-gateway

Specifies whether the gateway is used as the primary or as the backup gateway.

This query asks whether the gateway on this device is the primary gateway active during the normal operation of the network, or the backup gateway that is active when the LEC interface containing the primary gateway is not operational. Answering **Yes** configures a primary gateway. There should be only one primary gateway per ELAN.

Valid Values Yes or No

Default Value: No

Example: `add redundant-default-gateway`

```
Which net is this redundant gateway for [0]? 1
IP address of gateway [0.0.0.0]? 9.67.205.1
Address mask [255.255.0.0]? 255.255.240.0
MAC address [00.00.00.00.00.00.]? 00.00.00.00.00.BA
Is this the primary gateway [No]? Yes or No
```

route *dest-addr dest-mask next-hop1 cost1 [next-hop2 cost2 [next-hop3 cost3 [next-hop4 cost4]]]*

Adds 1 to 4 static routes to the device's IP configuration. When dynamic routing information is not available for a particular destination, static routes are used.

The destination is specified by an IP address (*dest-addr*) together with an address mask (*dest-mask*). If the destination IP address is a network address, then the dest-mask must be a network mask. If the destination IP address is a subnet address, then the dest-mask must be a subnet mask. Finally, if the destination IP address is a host address, then the dest-mask must be a host mask (which means that the only valid value is 255.255.255.255). The dest-mask must be accurate; if it is not, the static route will not be accepted.

The route to the destination is specified by the IP address of the next hop *(next-hop)*, and the cost *(cost)* of routing the packet to the destination. The next hop must be on the same (sub)net as one of the router's directly connected interfaces. Static routes are always overridden by routes learned through OSPF. By default, static routes are also overridden by routes learned through RIP; however, you can change that with the **enable/disable override static-routes** command. The effect of this command is immediate; you do not have to reboot the router for it to take effect.

dest-addr

Valid Values: any valid IP address

Default Value: none

dest-mask

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: none

next-hop1, next-hop2, next-hop3, next-hop4

Valid Values: any valid IP address

Default Value: none

cost1, cost2, cost3, cost4

Valid Values: an integer in the range 0 to 255

Default Value: 1

Example:

```
IP config>add route
IP destination []? 1.1.0.0
Address mask [255.0.0.0]? 255.255.0.0
Via gateway 1 at []? 10.1.1.1
Cost [1]? 1
Via gateway 2 at []?
IP config>add route 1.1.0.0 255.255.0.0
Via gateway 2 at []? 20.1.1.1
Cost [1]? 2
Via gateway 3 at []? 30.1.1.1
Cost [1]? 3
Via gateway 4 at []?
IP config>add route 2.2.0.0 255.255.0.0 10.2.2.2 1 20.2.2.2 2
IP config>list routes

route to 1.1.0.0        ,255.255.0.0     via 10.1.1.1        cost 1
                                         via 20.1.1.1        cost 2
                                         via 30.1.1.1        cost 3
route to 2.2.0.0        ,255.255.0.0     via 10.2.2.2        cost 1
                                         via 20.2.2.2        cost 2

IP config>
```

route-table-filter *destination mask [both | exact | more-specific] [exclusive | inclusive]*

Adds a route table filter for the specified routes. When **route-table-filtering** is enabled, the route-table-filter will be matched against routes added to the IP route table. The order in which route-table-filters is unimportant. Rather, the route-table-filter with the most specific match is chosen. If no match is found, the route is added to the route table. When **exact** is specified, the route destination and mask must be exactly the same as the route-table-filter destination and mask for a match to occur. When **more-specific** is specified, the route destination and mask must part of the range subsumed by the route-table-filter destination and mask. Specifying **both** is the superset of both and more-specific (that is, a match will occur in both the case of an exact match and a more-specific match). If the route-table-filter indicates **include**, the route will be added to the IP route table. If the route-table-filter indicates **exclude**, the route will not be added to the IP route table. Static and direct routes are never excluded from the IP route table.

destination mask

Valid Values: any valid IP mask

Default Value: both exclude

Change

Use the **change** command to change an IP configuration item previously installed by the **add** command. In general, you must specify the item you want to change, just as you specified the item with the **add** command.

Syntax:

change access-control . . .

address . . .

route . . .

access-control *record-number type IP-source source-mask IP-dest dest-mask* **[***first-protocol last-protocol***] [***first-port last-port***]**

Modifies an existing global access-control record. Use the **list access-control** command to view all existing records and obtain the record number.

Example: `change access-control 2`

```
Enter type [E]? i
Internet source [1.1.1.1]?
Source mask [255.255.255.255]?
Internet destination [2.2.2.2]?
Destination mask [255.255.255.255]?
Enter starting protocol number [6]?
Enter ending protocol number [6]?
Enter starting port number [23]?
Enter ending port number [23]?
```

address ***o*ld-address new-address new-mask**

Modifies one of the router's IP interface addresses. You must specify each new address together with the new address' subnet mask. This command can also be used to change an existing address' subnet mask.

For non-serial line interfaces:

- The class A range is 1.0.0.1 through 126.255.255.254
- The class B range is 128.0.0.1 through 191.255.255.254
- The class C range is 192.0.0.1 through 223.255.255.254

For serial line interfaces:

- 0.0.0.n, where n is the hardware interface number.

Use these address guidelines to:

1. Enter the *old-address*.
2. Enter the *new-address*.
3. Enter the new *new-mask*.

Example: `change address 192.9.1.1 128.185.123.22 255.255.255.0`

route *dest-addr dest-mask new-next-hop1 new-cost1 [new-next-hop2 new-cost2 [new-next-hop3 new-cost3 [new-next-hop4 new-cost4]]]*

Modifies either the next hops or the costs associated with the configured static routes to the specified destination. The effect of this command is immediate; you do not have to reboot the router for it to take effect.

dest-addr

Valid Values: any valid IP address

Default Value: none

dest-mask

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: none

new-next-hop

Valid Values: any valid IP address

Default Value: none

new-cost

Valid Values: an integer in the range 0 to 255

Default Value: 1

Example:

```
IP config>list routes

route to 1.1.0.0        ,255.255.0.0     via 10.1.1.1        cost 1
                                         via 20.1.1.1        cost 2
                                         via 30.1.1.1        cost 3
route to 2.2.0.0        ,255.255.0.0     via 10.2.2.2        cost 1
                                         via 20.2.2.2        cost 2

IP config>change route
IP destination []? 1.1.0.0
Address mask [255.0.0.0]? 255.255.0.0
Via gateway 1 at [.10.1.1.1]? 10.10.10.1
Cost [1]? 10
Via gateway 2 at [20.1.1.1]? 20.20.20.1
Cost [2]? 20
Via gateway 3 at [30.1.1.1]? 30.30.30.1
Cost [3]? 30
Via gateway 4 at []? 40.40.40.1
Cost [1]? 40
IP config>change route 2.2.0.0 255.255.0.0 10.10.10.2 10
IP config>list routes

route to 1.1.0.0        ,255.255.0.0     via 10.10.10.1      cost 10
                                         via 20.20.20.1      cost 20
                                         via 30.30.30.1      cost 30
                                         via 40.40.40.1      cost 40
route to 2.2.0.0        ,255.255.0.0     via 10.10.10.2      cost 10
```

Delete

Use the **delete** command to delete an IP configuration item previously installed by the **add** command. In general, you must specify the item you want to delete, just as you specified the item with the **add** command.

Syntax:

de**lete**

accept-rip-route . . .

access-control . . .

address . . .

bootp-server

distributed-ip-gateway

default network/subnet-gateway . . .

filter . . .

packet-filter

redundant-default-gateway

route . . .

route-table-filter

accept-rip-route *net-number*

Removes a route from the list of networks that the RIP protocol always accepts.

Valid Values: Any IP address contained in the list of accepted networks.

Default Value: none

Example: `delete accept-rip-route 10.0.0.0`

access-control *rule-number*

Deletes one of the access control rules from the global access control list.

Example: `delete access-control 2`

address *ip-interface-address*

Deletes one of the router's IP interface addresses.

Valid Values: any valid IP address

Default Value: none

Example: `delete address 128.185.123.22`

bootp-server *server-IP-address*

Removes a BOOTP server from an IP configuration.

Valid Values: anyconfigured BOOTP server IP address

Default Value: 0.0.0.0

Example: `delete bootp-server 128.185.123.22`

default network/subnet-gateway *[ip-network-address]*

Deletes either the default gateway or the default subnet gateway for the specified subnetted network.

Valid Values: any valid IP address

Default Value: 0.0.0.0

Example: `delete default subnet-gateway 128.185.0.0`

distributed *interface-number*

Deletes the distributed IP Gateway from a LEC interface.

interface-number

Valid Values: Interface numbers of LECs with a distributed IP Gateway.

Default Value: none

Example:

```
Enter the Net number of distributed Gateway to delete:? 1
Gateway deleted.
```

filter *dest-addr dest-mask*

Deletes one of the router's filtered networks. The effect of this command is immediate; you do not have to reboot the router for it to take effect.

dest-addr

Valid Values: any valid IP address

Default Value: 0.0.0.0

dest-mask

Valid Values: 0.0.0.0 - 255.255.255.255

Default Value: none

Example: **delete filter 127.0.0.0**

```
Address mask [0.0.0.0]? 255.0.0.0
```

packet-filter *filter-name*

Deletes a specified packet-filter from the router's configuration.

Valid Values: any 16-character name.

You can include dashes (-) and underscores (_) in the name.

Default Value: none

Example:

```
IP config> delete packet-filter pf-in-0
All access controls defined for 'pf-in-0' will also be deleted.
Are you sure you want to delete(Yes or [No]): y
Deleted
IP config>
```

redundant *interface-number*

Deletes the Redundant IP Gateway from a LEC interface.

interface-number

Valid Values: Interface numbers of LECs with a Redundant Default IP Gateway.

Default Value: none

Example:

```
Enter the Net number of Redundant Gateway to delete:? 1
Gateway deleted.
```

route *dest-addr dest-mask [delete-next-hop1 [delete-next-hop2 [delete-next-hop3 [delete-next-hop4]]]]*

Deletes one of the device's configured static routes. The effect of this command is immediate; you do not have to reboot the router for it to take effect.

dest-addr

Valid Values: any valid IP address

Default Value: none

dest-mask

Valid Values: any valid IP mask

Default Value: none

delete-next-hop

Valid Values: yes or no

Default Value: no

Example:

```
IP config>list routes

route to 1.1.0.0        ,255.255.0.0     via 10.10.10.1      cost 10
                                         via 20.20.20.1      cost 20
                                         via 30.30.30.1      cost 30
                                         via 40.40.40.1      cost 40
route to 2.2.0.0        ,255.255.0.0     via 10.10.10.1      cost 10

IP config>delete route 1.1.0.0 255.255.0.0
Delete gateway 10.10.10.1? [No]:
Delete gateway 20.20.20.1? [No]: y
Delete gateway 30.30.30.1? [No]:
Delete gateway 40.40.40.1? [No]: y
IP config>delete route 2.2.0.0 255.255.0.0
IP config>delete route 1.1.0.0 255.255.0.0 n y
IP config>list routes

route to 1.1.0.0        ,255.255.0.0     via 10.10.10.1      cost 10

IP config>
```

route-table-filter *destination mask mask-definition[both | exact | more specific]*

Deletes a route filter from the route table filters added using **add route-table-filter.** See “route-table-filter” on page 16-9 for the command extension definitions.

destination

Valid Values: any valid IP mask

Default Value: none

mask **Valid Values**: any valid IP mask

Default Value: none

mask-definition

Valid Values: any valid IP mask

Default Value: none

Example: `delete route-table-filter`

```
IP config>delete route-table-filter
Route Filter IP address []? 7.0.0.0
Route Filter IP mask []? 255.0.0.0
Enter Match type (B, E, or M) [B]?
Enter Definition type (I or E) [E]?
Route filter deleted
IP config>
```

Disable

Use the **disable** command to disable IP features previously enabled by the **enable** command.

Syntax:

disable arp-net-routing

arp-subnet-routing

bootp-forwarding

classless

directed-broadcast

echo-reply

icmp-redirect . . .

nexthop-awareness . . .

override default/static-routes . . .

packet-filter

per-packet-multipath

receiving rip . . .

| receiving dynamic all/hosts/nets/subnets . . .

rip

rip2

route-table-filtering

same-subnet

sending default/net/subnet/poisoned/host/static/...

| sending rip1-routes-only

source-routing

tftp-server

udp-forwarding . . .

arp-net-routing
Turns off ARP network routing. When this is enabled, the router replies by proxy to all ARP requests for remote destinations that are best reached through the router. This is the default and the generally recommended setting.

Example: `disable arp-net-routing`

arp-subnet-routing
Turns off the IP feature called ARP subnet routing or proxy ARP, which, when enabled, deals with hosts that have no IP subnetting support. This is the default and the generally recommended setting.

Example: `disable arp-subnet-routing`

bootp-forwarding
Turns off the BOOTP/DHCP relay function.

Example: `disable bootp-forwarding`

classless Disables support for routing protocols that do not support Classless Inter-Domain Routing (CIDR). Natural network routes (for example, Class A, B, or C routes) will not be automatically generated for advertisement in protocols that do not advertise the network mask (for example, RIPv1).

Example: `disable classless`

directed-broadcast
Disables the forwarding of IP packets whose destination is a non-local (for example, remote LAN) broadcast address. The source host originates the packet as a unicast where it is then forwarded as a unicast to a destination subnet and “exploded” into a broadcast. You can use these packets to locate network servers.

Note: Forwarding and exploding cannot be disabled separately.

Example: `disable directed-broadcast`

echo-reply

Disables the router's ICMP Echo Reply function. Thus a ping sent to any of the router's interfaces will not generate a reply. The router defaults to echo-reply enabled.

Example: `disable echo-reply`

icmp-redirect *ip-interface-address*

Disables the router from sending ICMP Redirect messages on the specified IP interface. If you enter nothing at the prompt for the IP interface address, the router will be disabled from sending ICMP Redirect messages on all IP interfaces.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example:

```
IP Config> disable icmp-redirect
Interface address (NULL for all) []? 192.9.200.44
IP Config>
```

override default/static-routes *ip-interface-address*

Prevents a default route received by RIP on interface *ip-interface-address* from replacing a default route already installed in the IP routing table. The **disable override static-routes** command prevents RIP routes received on interface *ip-interface-address* from overriding any of the router's static routes.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `disable override default 128.185.123.22`

nexthop awareness *ip-interface-address*

Disables nexthop awareness on an IP interface.

ip-interface-address

Valid Values: any valid IP address

Default Value: disabled

Example:

```
IP config>disable nexthop-awareness 1.1.1.1
IP config>disable nexthop-awareness
Interface address []? 2.2.2.2
IP config>
```

packet-filter *filter-name*

Disables specified interface-specific access control list (packet-filters).

filter-name

Valid Values: Any 16-character name. You can include dashes (-) and underscores (_) in the name.

Default Value: None

Example: `disable packet-filter pf-in-0`

per-packet-multipath

If per-packet-multipath is disabled, the router will choose the first available path to a destination. The default for this feature is disabled.

Example: `disable per-packet-multipath`

receiving rip *ip-interface-address*
Prevents RIP from processing any RIP updates received on interface *ip-interface-address.*

ip-interface-address
Valid Values: any valid IP address

Default Value: none

Example: `disable receiving rip 128.185.123.22`

receiving dynamic all/hosts/nets/subnets *ip-interface-address*
The **disable receiving dynamic nets** command ensures that for RIP updates received on the interface *ip-interface-address*, the router accept only those network level routes entered by the **add accept-rip-route** command. The **disable receiving dynamic subnets** command produces the analogous behavior for subnet routes. The **disable receiving dynamic host** produces the analogous behavior for host routes.

ip-interface-address
Valid Values: any valid IP address

Default Value: none

Example: `disable receiving dynamic nets 128.185.123.22`

rip Turns off the RIP protocol.

Example: `disable rip`

rip2 Disables RIP2 mode on an interface.

ip-interface-address
Valid Values: any valid IP address of an interface that has RIP2 enabled.

Default Value: none

Example: `disable rip2 128.185.123.22`

route-table-filtering
Disables application of route-table-filters when routes are added to the routing table.

Example: `disable route-table-filtering`

same-subnet
Disables the same subnet option. When the router is rebooted, it will not allow multiple IP interfaces to the same subnet to be installed. This is the default.

Example: `disable same-subnet`

sending rip-routes-only *ip-interface-address*
To stop advertising only RIP routes in the RIP2 multicast packets.

ip-interface-address
Valid Values: any valid IP address of an interface that has RIP2 enabled.

Default Value: none

Example: `disable sending rip1-routes-only 128.185.123.22`

sending all/default/host/net/poisoned/static/subnet *ip-interface-address*

Prevents the router from advertising the specified type of route in RIP updates sent out using the interface ip-interface-address. The other flags that control the RIP routes sent out an interface are **host-routes**, **static-routes**, **net-routes**, and **subnet-routes**. You can turn these off individually. A route is advertised if it is specified by any of the enabled flags.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `disable sending net-routes 128.185.123.22`

source-routing

Prevents the router from forwarding source-routed packets (that is, IP packets that include a source-route option). This option defaults to source-routing enabled.

Example: `disable source-routing`

tftp-server

Prevents the router from accepting TFTP GET or PUT requests from the network. This prevents the inadvertent overlaying of configuration files or load images from another device. You will still be able to perform GETs or PUTs from a directly attached terminal or a telnet session with the device.

Example: `disable tftp-server`

udp-forwarding *port-number*

Disables UDP forwarding for packets received by the router with the specified UDP destination port number.

Default: UDP forwarding is disabled for all port numbers.

port-number

Valid Values: an integer in the range 0 to 65535

Default Value: 0

Example: `disable udp-forwarding 36`

Enable

Use the **enable** command to activate IP features, capabilities, and information added to your IP configuration.

Syntax:

enable arp-net-routing
arp-subnet-routing
bootp-forwarding
classless
directed-broadcast
echo-reply
icmp-redirect

nexthop awareness

override default ...

override static-routes ...

packet-filter

per-packet-multipath

receiving rip ...

| receiving dynamic all ...

| receiving dynamic hosts...

receiving dynamic nets ...

receiving dynamic subnets ...

rip

rip2

route-table-filtering

same-subnet

| sending all-routes ...

sending default-routes ...

| sending host-routes ...

sending net-routes ...

sending poisoned-reverse-routes

| sending rip1-routes-only

sending static-routes ...

sending subnet-routes ...

source-routing

tftp-server

udp-forwarding ...

arp-net-routing

Turns on ARP network routing. When enabled, the router replies by proxy to all ARP requests for remote destinations that are best reached through the router. Use this command when there are hosts on the LAN that ARP for all destinations, instead of (as is proper) only local destinations.

Example: `enable arp-net-routing`

arp-subnet-routing

Turns on the router's ARP subnet routing (sometimes also called Proxy ARP) function. This function is used when there are hosts unaware of subnetting attached to directly connected IP subnets. The directly connected subnet having subnet-incapable hosts must use ARP for this feature to be useful.

The way ARP subnet routing works is as follows. When a subnet-incapable host wants to send an IP packet to a destination on a remote subnet, it does not realize that it should send the packet to a

router. The subnet-incapable host therefore simply broadcasts an ARP request. This ARP request is received by the router. The router responds as the destination (hence the name proxy) if both arp-subnet-routing is enabled and if the next hop to the destination is over a different interface than the interface receiving the ARP request.

If there are no hosts on your LAN that are “subnet-incapable,” do not enable ARP-subnet routing. If ARP subnet routing is needed on a LAN, it should be enabled on all routers on that LAN.

Example: `enable arp-subnet-routing`

bootp-forwarding

Turns on BOOTP/DHCP packet forwarding. In order to use BOOTP forwarding, you must also add one or more BOOTP servers with the **add bootp-server** command.

Example: `enable bootp-forwarding`

```
Maximum number of forwarding hops [4]?
Minimum seconds before forwarding [0]?
```

Maximum number of forwarding hops

Maximum number of allowable BOOTP agents that can forward a BOOTP request from the client to the Server (this is not the maximum number of IP hops to the server).

Default: 4

Minimum seconds before forwarding

This parameter is generally not used. Use this parameter when there is a redundant path between the client and the server, and you want to use the secondary path or paths as a standby.

Default Value: 0

classless Indicates the router will be operating in a classless IP addressing environment. The Nways family of routers fully supports CIDR addressing as described in RFC 1817 without this option enabled. Enabling this option prevents automatic generation of the natural network routes (for example, Class A, B, or C network routes) corresponding to routes added to the IP route table. If you are not running RIPv1 you do not require the natural network route.

Example: `enable classless`

directed-broadcast

Enables the forwarding of IP packets whose destination is a network-directed or subnet-directed broadcast address. The packet is originated by the source host as a unicast where it is then forwarded as a unicast to a destination subnet and “exploded” into a broadcast. These packets can be used to locate network servers. This command enables both the forwarding and exploding of directed broadcasts. The IP packet forwarder never forwards link level broadcasts/multicasts, unless they correspond to Class D IP addresses. (See the OSPF **enable multicast-routing** command.) The default setting for this feature is enabled.

Note: Forwarding and exploding cannot be implemented separately. Also, the router will not forward all-subnets IP broadcasts.

Example: `enable directed-broadcast`

echo-reply

Enables the building and sending of an ICMP Echo Reply in response to an ICMP Echo Request.

Example: `enable echo-reply`

icmp-redirect *ip-interface-address*

Enables the router to send ICMP Redirect messages on the specified IP interface. If you enter nothing at the prompt for the IP interface address, the device will be enabled to send ICMP Redirect messages on all IP interfaces.

ip-interface-address

Valid Values: any valid IP address, or nothing for all IP interfaces

Default Value: none

Example:

```
IP Config> enable icmp-redirect
Interface address (NULL for all) []? 192.9.200.44
IP Config>
```

nexthop awareness *ip-interface-address*

Enables nexthop awareness on an IP interface.

ip-interface-address

Valid Values: any valid IP address

Default Value: disabled

Example:

```
IP config>enable nexthop-awareness 1.1.1.1
IP config>enable nexthop-awareness
Interface address []? 2.2.2.2
IP config>
```

override default *ip-interface-address*

Enables received RIP information to override any default route installed in the IP routing table. This command is invoked on a per-IP-interface basis. When the **enable override default** command is invoked, default RIP routes received on interface ip-interface-address overwrites the router's current default route, providing the cost of the new default is cheaper.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable override default 128.185.123.22`

override static-routes *ip-interface-address*

Enables received RIP information to override some of the router's statically configured routing information. This command is invoked on a per-IP-interface basis. When the **enable override static-routes** command is invoked, RIP routing information received on interface ip-interface-address overwrite statically configured network/subnet routes providing the cost of the RIP information is cheaper.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable override static-routes 128.185.123.22`

packet-filter *filter-name*

Enables specified interface-specific access control list (packet-filters).

filter-name

Valid Values: any 16-character name. You can include dashes (-) and underscores (_) in the name.

Default Value: none

Example: `enable packet-filter pf-in-0`

per-packet-multipath

If per-packet-multipath is enabled, and there are multiple equal-cost paths to a destination, then the router chooses the path for forwarding each packet in a round-robin fashion. The default for this feature is disabled.

Example: `enable per-packet-multipath`

receiving rip *ip-interface-address*

Enables the processing of RIP updates that are received on a particular interface. This command has an analogous disable command. (See the **disable receiving** command.) This command is enabled by default.

If you invoke the **disable receiving rip** command, no RIP updates will be accepted on interface *ip-interface-address* address.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable receiving rip 128.185.123.22`

receiving dynamic nets *ip-interface-address*

Modifies the processing of RIP updates that are received on a particular interface. This command has an analogous disable command. (See the **disable receiving** command.) This command is enabled by default.

If you invoke the **disable receiving dynamic nets** command, for RIP updates received on interface *ip-interface-address*, the router will not accept any network-level routes unless they have been specified in an **add accept-rip-route** command.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable receiving dynamic nets 128.185.123.22`

receiving dynamic subnets *ip-interface-address*

Modifies the processing of RIP updates that are received on a particular interface. This command has an analogous disable command. (See the **disable receiving** command.) This command is enabled by default.

If you invoke the **disable receiving dynamic subnets** command, for RIP updates received on interface *ip-interface-address*, the router will not accept any subnet-level routes unless they have been specified in an **add accept-rip-route** command.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: **`enable receiving dynamic subnets 128.185.123.22`**

rip Enables the router's RIP protocol processing.

When RIP is enabled, the following default behavior is established:

- The router includes all network and subnet routes in RIP updates sent out on each of its configured IP interfaces.
- The router processes all RIP updates received on each of its configured IP interfaces.

To change any of the default sending/receiving behaviors, use the IP configuration commands, which are defined on a per-IP-interface basis.

Example: **`enable rip`**

rip2

Enables RIP2 on an interface. RIP2 advertisement packets will be multicast broadcast on address `224.0.0.9`. When RIP2 is enabled on an interface, you will be asked whether or not to set the authentication key. If you answer `N (No)` there will be no authentication on the RIP2 packet advertisement. If you answer `Y (Yes)` you will be asked to enter an authentication key. This authentication key will need to be entered twice for validation. The authentication key will be included in the RIP2 advertisement packets that originate from that particular interface.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: **`enable rip2 128.185.123.22`**

```
IP config>enable rip2 153.2.2.25 yes clear-password clear-password
RIP2 is enabled on this interface.
RIP2 Authentication is enabled on this interface.
```

route-table-filtering

Applies route table filters to any route added to the routing table. Route table filters are applied based on a most-specific match of the destination and network mask. Route table filters are never applied to direct routes or static routes.

Example: **`enable route-table-filtering`**

same-subnet

Enables the same subnet option. When the device is rebooted, it will allow multiple IP interfaces to the same subnet to be installed. Multiple IP interfaces to the same subnet are useful under only one of the following conditions:

- OSPF Point-to-Multipoint is configured on the IP interfaces.

- Nexthop Awareness is enabled on the IP interfaces, and static routes are defined for the routes that go through the IP interfaces.

By default, this option is disabled.

Example: `enable same-subnet`

sending default-routes *ip-interface-address*

Determines the contents of RIP updates that are sent out a particular interface. This command has an analogous disable command. (See the **disable sending** command.) The effect of the **enable sending** command is additive. Each separate enable sending command specifies that a certain set of routes should be advertised from a particular interface. A route is included in a RIP update only if it has been included by at least one of the enable sending commands. The **enable sending default-routes** command specifies that the default route (if one exists) should be included in RIP updates sent out interface ip-interface-address.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable sending default-routes 128.185.123.22`

Note: Some settings of the **enable sending ...** commands are redundant. For example, if you invoke **enable sending net-routes**, **enable sending subnet-routes**, and **enable sending host-routes** for a particular interface, there is no need to also specify **enable sending static-routes** (because each static route is a network-level, subnet, or host route). By default, when you first enable RIP, sending net-routes, sending subnet-routes, and sending host-routes are enabled for each interface, while sending static-routes and sending default are disabled.

sending net-routes *ip-interface-address*

Determines the contents of RIP updates that are sent out a particular interface. This command has an analogous disable command. (See the **disable sending** command.)

The effect of the **enable sending** command is additive. Each separate **enable sending** command specifies that a certain set of routes should be advertised from a particular interface. A route is included in an RIP update only if it has been included by at least one of the **enable sending** commands. The **enable sending network-routes** command specifies that all network-level routes should be included in RIP updates sent out interface ip-interface-address. A network-level route is a route to a single class A, B, or C IP network.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable sending net-routes 128.185.123.22`

sending poisoned-reverse-routes *ip-interface-address*

A technique used by RIP to improve convergence time when routes change (for complete details on the technique, refer to rfc 1058). Use of

this technique increases the size of RIP update messages. You may find it more acceptable to minimize routing overhead by accepting somewhat slower convergence. The **disable sending poisoned-reverse-routes** command specifies that poisoned reverse routes should not be included in RIP updates sent out on an interface specified by the **enable ip-interface-address** command.

Default: Enabled

ip-interface-address

Valid Values: any valid IP address

Default Value: none

sending rip-routes-only *ip-interface-address*

To advertise only RIP routes in the RIP2 multicast packets.

ip-interface-address

Valid Values: any valid IP address of an interface that has RIP2 enabled.

Default Value: none

Example: `enable sending rip-routes-only 128.185.123.22`

sending subnet-routes *ip-interface-address*

Determines the contents of RIP updates that are sent out a particular interface. This command has an analogous disable command. (See the **disable sending** command.) The effect of the **enable sending** command is additive. Each separate **enable sending** command specifies that a certain set of routes should be advertised out a particular interface. A route is included in an RIP update only if it has been included by at least one of the enable sending commands. The **enable sending subnet-routes** command specifies that all subnet routes should be included in RIP updates sent out interface ip-interface-address. However, a subnet route is included only if ip-interface-address connects directly to a subnet of the same IP subnetted network.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable sending subnet-routes 128.185.123.22`

sending static-routes *ip-interface-address*

Determines the contents of RIP updates that are sent out a particular interface. This command has an analogous disable command. (See the **disable sending** command.) The effect of the **enable sending** command is additive. Each separate **enable sending** command specifies that a certain set of routes should be advertised out a particular interface. A route is included in an RIP update only if it has been included by at least one of the enable sending commands. The **enable sending static-routes** command specifies that all statically configured and directly connected routes should be included in RIP updates sent out interface ip-interface-address.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

Example: `enable sending static-routes 128.185.123.22`

sending host-routes *ip-interface-address*

Determines the contents of RIP updates that are sent out a particular interface. This command has an analogous **disable ...** command. (See the **disable sending** command.) The effect of the **enable sending** command is additive. Each separate **enable sending** command specifies that a certain set of routes should be advertised out a particular interface. A route is included in an RIP update only if it has been included by at least one of the **enable sending** commands. The **enable sending host-routes** command specifies that all host routes should be included in RIP updates sent out interface ip-interface-address.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

source-routing

Allows the router to forward IP packets containing an IP source route option.

Example: `enable source-routing`

tftp-server

Allows the router to accept TFTP GET or PUT requests from the network for configuration files or image loads.

Example: `enable tftp-server`

udp-forwarding *port-number*

Enables UDP forwarding for packets received by the router with the specified UDP destination port number.

Default: UDP forwarding is disabled for all port numbers.

port-number

Valid Values: an integer in the range 0 to 65535

Default Value: 0

Example: `enable udp-forwarding 36`

List

Use the **list** command to display various pieces of the IP configuration data, depending on the particular subcommand invoked.

Syntax:

list all

access-controls

addresses

bootp

distributed-ip-gateway

filters

icmp redirect

nexthop-awareness

packet-filter

parameters

protocols

redundant-default-gateway

rip-routes-accept

routes

route-table-filtering

sizes

tags

all Displays the entire IP configuration.

Example: `list all`

access-controls
Displays the configured access control mode (enabled or disabled) and the list of configured global access control records. Each record is listed with its record number. This record number can be used to reorder the list with the IP **move access-control** command.

Example: `list access control`

bootp Indicates whether BOOTP forwarding is enabled or disabled as well as the configured list of BOOTP servers.

Example: `list bootp`

distributed-ip-gateway
Displays the distributed IP Gateway for each interface configured.

Example: `list distributed`

```
Distributed IP Gateways for each interface:
   inf 4  11.1.1.6     255.0.0.0     00.00.00.00.00.BA  primary
   inf 8  33.3.3.6     255.0.0.0     00.00.00.00.00.AB  backup
```

icmp-redirect
Lists whether the sending of ICMP redirect messages is enabled or disabled on each IP interface.

nexthop-awareness
Lists the setting of nexthop awareness on all IP interfaces.

Example:

```
IP config>list nexthop-awareness
Nexthop awareness for each IP interface address:
   intf  0   1.1.1.1          255.0.0.0        nexthop awareness enabled
   intf  1   2.2.2.2          255.0.0.0        nexthop awareness disabled
IP config>
```

packet-filter *filter-name*
Lists information about packet filters. If you specify a name, the command lists access control information configured for the filter. If you do not specify a filter name, the command lists configured packet-filters.

Example: `list packet-filter pf-in-0`

```
Name              Direction     Interface
pf-in-0           In            0

Access Control is: enabled
List of access control records:

                                                  Beg  End Beg End
    Ty Source      Mask      Destination  Mask     Pro  Pro Prt Prt
1   E  128.185.0.0 FFFF0000  0.0.0.0      00000000 0   255  0  65535
2   I  0.0.0.0     00000000  0.0.0.0      00000000 0   255  0  65535
```

parameters

Lists the various global IP parameters including the same subnet.

Example: `list parameters`

```
IP config>list parameters
ARP-SUBNET-ROUTING   : enabled
ARP-NET-ROUTING      : enabled
CLASSLESS            : disabled
DIRECTED-BROADCAST   : enabled
ECHO-REPLY           : enabled
PER-PACKET-MULTIPATH : disabled
REASSEMBLY-SIZE      : 12000 bytes
ROUTING TABLE-SIZE   : 768 entries (49152 bytes)
(Routing) CACHE-SIZE : 64 entries
SAME-SUBNET          : disabled
SOURCE-ROUTING       : enabled
TTL                  : 64
```

protocols

Displays the configured state of the IP routing protocols (OSPF, RIP, BGP) along with other general configuration settings.

Example: `list protocols`

redundant-default-gateway

Displays the Redundant Default IP Gateway for each interface configured.

Example: `list redundant`

```
Redundant Default IP Gateways for each interface:
   inf 4  11.1.1.6     255.0.0.0     00.00.00.00.00.BA  primary
   inf 8  33.3.3.6     255.0.0.0     00.00.00.00.00.AB  backup
```

rip-routes-accept

Displays the set of routes that the RIP routing protocol always accepts. See the IP configuration commands **enable/disable receiving dynamic nets/subnets/hosts** for more information.

Example: `list rip-routes-accept`

route-table-filtering

Displays the list of route filters added to the routing filter.

Example: `list route-table-filtering`

```
IP config>list route-table-filtering

Route Filtering Disabled

Destination     Mask           Match Type
10.1.1.0        255.255.255.0   BOTH  E
50.50.0.0       255.255.0.0     BOTH  I
10.1.1.1        255.255.255.255 EXACT I
50.0.0.0        255.0.0.0       BOTH  E

MORE-Match more-specific routes   EXACT-Match route exactly
BOTH-Match exact and more-specific routes  E-Exclude  I-Include
IP config>
```

routes Displays the list of static routes that have been configured.

Example: `list routes`

```
IP config>list routes

route to 1.1.0.0        ,255.255.0.0     via 10.1.1.1        cost 1
                                         via 20.1.1.1        cost 2
                                         via 30.1.1.1        cost 3
route to 2.2.0.0        ,255.255.0.0     via 10.2.2.2        cost 10
route to 3.3.0.0        ,255.255.0.0     via 10.3.3.3        cost 100
                                         via 20.3.3.3        cost 200
```

sizes Displays the routing table size, reassembly buffer size, and the route cache size.

Example: `list sizes`

tags Displays the per-interface tags that will be associated with received RIP information. These tags can be used to group routes together for later readvertisement via BGP where a tag will be treated as if it were a route's source autonomous system (AS). (Refer to the information on originate, send, and receive policies in *Protocol Configuration and Monitoring Reference Volume 2*.) Tags are also propagated by the OSPF routing protocol.

Example: `list tags`

Move

Use the **move** command to change the order of records in the global access control list. This command places record number from# immediately after record number to#. After you move the records, they are immediately renumbered to reflect the new order.

The router applies the access control records in a list in the order that they were created. For each packet received on an interface, the router applies each access control record in order until it finds a match. The first record that matches the packet determines whether it will be discarded, or forwarded to its destination.

This makes the order of the access control records very important. If they are in the wrong order, certain packets may slip through, or be blocked, in a manner contrary to your intentions.

Let us say, for example, that access control record 1 enforces the rule: *all packets from network 10.0.0.0 shall be blocked on this interface.* Contrary to this, access control record 2 states: *Packets from subnet 10.5.5.0 in network 10.0.0.0, which are destined for address 1.2.3.4, shall be allowed to pass.* Assigned in this order, these records will block all traffic from 10.0.0.0, even though record 2 explicitly allows certain types of packets to pass.

In this example, record 1 makes record 2 moot. Record 1 guarantees that the router discards all packets from 10.0.0.0, despite the intent of record 2, which is that certain packets be forwarded. The key to fixing this type of problem is in the order of the access control records. This way, packets in subnet 10.5.5.0 and destined for address 1.2.3.4 will pass through the interface; the router discards all other packets from 10.0.0.0 as intended.

Syntax:

m**ove** a**ccess-control** *from# to#*

Example: `move 5 2`

Set

Use the **set** command to set certain values, routes, and formats within your IP configuration.

Syntax:

set access-control...
broadcast-address...
cache-size
default network-gateway...
default subnet-gateway...
internal-ip-address
originate-rip-default
reassembly-size
rip-in-metric
rip-out-metric
router-id
routing table-size
tag . . .
ttl

access-control *on* **or** *off*

Allows you to configure the router to enable or disable IP access control. Setting access-control *on* enables the global access control list as well as the interface–specific lists. Setting it *off* disables all lists but does not delete them

Example: `set access-control on`

broadcast-address *ip-interface-address style fill-pattern*

Specifies the IP broadcast format that the router uses when broadcasting packets out on a particular interface. IP broadcasts are most commonly used by the router when sending RIP update packets.

The style parameter can take either the value local wire or the value network. Local-wire broadcast addresses are either all ones (255.255.255.255) or all zeros (0.0.0.0). Network style broadcasts begin with the network and subnet portion of the ip-interface-address.

You can set the fill-pattern parameter to either 1 or 0. This indicates whether the rest of the broadcast address (that is, other than the network and subnet portions, if any) should be set to all ones or all zeros.

When receiving the router recognizes all forms of the IP broadcast address.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

style **Valid Values**: *local-wire* or *network*

Default Value: local-wire

fill-pattern

Valid Values: *0* or *1*

Default Value: 1

The example below configures a broadcast address of 255.255.255.255. The second example produces a broadcast address of 192.9.1.0, assuming that the network 192.9.1.0 is not subnetted.

Example: `set broadcast-address 192.9.1.11 local-wire 1 set broadcast-address 192.9.1.11 network 0`

cache-size *entries*

Configures the maximum number of entries for the IP routing cache. This cache stores information about the specific IP addresses to which the router has recently forwarded packets. The cache reduces the processing time needed to forward multiple packets to the same destination.

In contrast with this cache, the IP routing *table* stores information about all accessible networks but does not contain specific IP destination addresses. Use the **set routing table-size** command to configure the size of the IP routing table.

Valid Values: 64 to 10000

Default Value: 64

Example: `set cache-size 64`

default network-gateway *next-hop cost*

Configures a route to the authoritative router (default gateway). You should assume that the router's default gateway has more complete routing information than the router itself.

The route is specified by the IP address of the next hop (next-hop) and the distance (cost) to the default gateway.

All packets having unknown destinations are forwarded to the authoritative router (default gateway).

nexthop **Valid Values**: any valid IP address

Default Value: 0.0.0.0 with a gateway cost of 1.

cost **Valid Values**: an integer in the range 0 to 255

Default Value: 1

Example: `set default network-gateway 192.9.1.10 10`

default subnet-gateway *subnetted-network next-hop cost*

Configures a route to a subnetted network's authoritative router (default subnet gateway). You can configure a separate default subnet gateway for each subnetted network.

The IP address of the next hop (next-hop) and the distance (cost) to the default subnet gateway specify the route.

All packets destined for unknown subnets of a known subnetted network are forwarded to the subnetted network's authoritative router (default subnet gateway).

subnetted network

Valid Values: any valid IP address

Default Value: 0.0.0.0

next-hop

Valid Values: any valid IP address

Default Value: 0.0.0.0

cost

Valid Values: an integer in the range 0 to 255

Default Value: 1

Example: `set default subnet-gateway 128.185.0.0` 128.185.123.22 6

internal-IP-address *ip-address*

Configures an IP address that is independent of the state of any interface. The internal address is always considered active. The primary reason for defining an internal address is to provide an address for a TCP connection that will not become inactive when an interface becomes inactive. This address is used for data link switching (DLSw), allowing alternate paths to be used to avoid disrupting DLSw connections when an interface becomes inactive. Because the internal address remains active and because OSPF maintains active IP routes to this destination, IP routing can switch DLSw traffic onto the alternate path without bringing down the TCP connection or disrupting the SNA sessions that are running on top of DLSw.

The internal IP address also provides some value when unnumbered interfaces are used. It is the first choice as a source address for packets originated by this router and transmitted over an unnumbered interface. The stability of this address makes it easier to keep track of such packets. The chance for confusion is further reduced when the same IP address is used for both the router ID and the internal address. Therefore the router ID will default to the internal address.

When an internal address is defined it will be advertised by OSPF as a host route into all areas directly attached to the router.

Valid Values: any valid IP address.

Default Value: none

Example: `set internal-ip-address 142.82.10.1`

originate-rip-default

Causes RIP to advertise this router as the default gateway. Use this command in the following environment:

- The IP routes in this router's routing table are determined by a number of protocols.
- RIP is one of those protocols.

- At most partial routing information is imported from the other protocols and advertised by RIP.

Traffic in the RIP network for destinations that are not known by RIP can follow the default path to this router. The more complete routing information in this node's route table can then be used to forward the traffic along an appropriate path towards its destination. You can configure the router to only originate the default when routes are known to this router that will not be advertised in the RIP network.

When you issue this command, you will be prompted to indicate whether the router should always originate a RIP default or to originate a RIP default only when the route from other protocols are available.

This default route will direct traffic bound for a non-RIP network to a boundary router. Originating a single default route means that the boundary router does not have to distribute the other network's routing information to the other nodes in its network.

from AS number

Valid Values: an integer in the range 0 to 65535

Default Value: none

to network number

Valid Values: any valid IP address

Default Value: none

default cost

Valid Values: an integer in the range 0 to 255

Default Value: 1

Example: `set originate-rip-default`

```
IP Config> set originate rip-default
Always originate default route? [No]:?
Originate default if BGP routes available? [No] yes
  From AS number [6]?
  To network number [0.0.0.0]?
Originate default if OSPF routes available? [No]
Originate default cost [1]?
```

- Answering "Yes" to the "Always originate" question means a default route is always originated.
- Answering "Yes" to the "BGP" question originates a default whenever there are BGP routes in the routing table.
- Answering "Yes" to the "if OSPF routes available" question causes the RIP default to be advertised when OSPF routes are in the routing table.
- When the router does decide to originate a RIP default, it uses the "original default cost" number.

reassembly-size *bytes*

Configures the size of the buffers that are used for the reassembly of fragmented IP packets.

Valid Values: 2048-65535

Default: 12000

Example: `set reassembly-size 12000`

rip-in-metric *ip-interface-address metric*

Allows the configuration of the metric to be added to RIP routes of an interface prior to installation in the routing table.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

metric **Valid Values**: an integer in the range 1 to 15

Default Value: 1

Example: `set rip-in-metric 128.185.120.209 1`

rip-out-metric *ip-interface-address metric*

Allows the configuration of the metric to be added to RIP routes advertised on an interface configured to advertise RIP or RIP2 routes.

ip-interface-address

Valid Values: any valid IP address

Default Value: none

metric **Valid Values**: an integer in the range 1 to 15

Default Value: 0

Example: `set rip-out-metric 128.185.120.209 0`

router-id *ip-address*

Sets the default IP address used by the router when sourcing various IP packets. This address is of particular importance in multicasting and OSPF.

The router ID must match one of the configured IP interface addresses of the router or the configured internal IP address. If not, it is ignored. When ignored, or just not configured, the default IP address of the router (and its OSPF router ID) is set to the internal IP address (if configured) or to the first IP address in the router's configuration.

Valid Values: any valid IP address

Default Value: none

Example: `set router-id 128.185.120.209`

routing table-size *number-of-entries*

Sets the size of the router's IP routing table. The default size is 768 entries. Setting the routing table size too small causes dynamic routing information to be discarded. Setting the routing table size too large wastes router memory resources. See "Sizes" on page 16-45 for additional information about table sizes.

Valid Values: an integer number of entries in the range 64 to 65535

Default Value: 768 entries

Example: `set routing table-size 1000`

tag Configures the per-interface tags associated with received RIP information. These tags can be used to group routes together for later readvertisement via BGP where a tag will be treated as if it were a route's source autonomous system (AS) number. (Refer to the information on originate, send, and receive policies in the chapter "Using

and Configuring BGP" in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*.) Tags are propagated also by the OSPF routing protocol.

Valid Values: an integer in the range 0 to 65535

Default Value: 0

Example: `set tag`

```
Interface address [0.0.0.0]? 1.1.1.1
Interface tag (AS number) [0]? 1
```

ttl Specifies the time-to-live for packets originated by the router.

Valid Values: a numeric in the range 1 to 255

Default Value: 64

Example: `set ttl 255`

Update

Use the **update packet-filter** command at the `IP config>` prompt to assign access control entries. The router prompts you for the name of the filter that you want to update. The `IP config>` prompt changes to incorporate the packet filter name you provide.

Syntax:

u**pdate** *packetfiltername*

packet filter name

Specifies the name of the packet filter you to be updated. You must have created that filter using the **add packet-filter** command and you must use the **set access-control** command to enable the filter.

Valid Values: any 16-character name.

You can include dashes (-) and underscores (_) in the name.

Default Value:none

```
IP Config> update packet-filter
Packet-filter name [ ]? pf-1-in
Packet-filter 'pf-1-in' Config>
```

You can access a list of sub-commands by typing **?** at the `Packet-filter 'name' Config>` prompt.

```
Packet-filter 'test' Config> ?
LIST
CHANGE
DELETE
ADD
MOVE
EXIT
```

Adding and Changing Access Controls to a Packet Filter

Use the **add access-control** command to add access controls to the specified packet filter. The router prompts you for the access control type (either Exclusive or Inclusive), and the source and destination addresses and masks of packets to which the filter will apply.

type Indicates what is done with packets that match the access control rule parameters.

E Exclusive; matching packets are discarded.

I Inclusive; matching packets are processed further by the router.

Default Value: Exclusive

source address

Valid Values: A valid IP address in dotted decimal notation.

Default Value: 0.0.0.0

source mask

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: 255.255.255.255

destination address

Valid Values: A valid IP address in dotted decimal notation.

Default Value: 0.0.0.0

destination mask

Valid Values: 0.0.0.0 to 255.255.255.255

Default Value: 255.255.255.255

first protocol

The lower boundary of a protocol number range.

The commonly used protocol numbers are:

1 for ICMP
6 for TCP
8 for EGP
17 for UDP
89 for OSPF.

See RFC 1340, “Assigned Numbers” for details on IP protocol numbers.

Valid Values: 0 to 255

Default Value: 0

last protocol

The upper boundary of a protocol number range.

The commonly used protocol numbers are:

1 for ICMP
6 for TCP
8 for EGP
17 for UDP
89 for OSPF.

See RFC 1340, “Assigned Numbers” for details on IP protocol numbers.

Valid Values: 0 to 255

Default Value:0

first port The lower boundary of a IP TCP/UDP port range.

Valid Values: a port number in the range 0 to 65535

Address Default Value: 0

Some commonly used port numbers are:

- 21 for FTP
- 23 for Telnet
- 25 for SMTP
- 513 for rlogin
- 520 for RIP

last port The upper boundary of a IP TCP/UDP port range.

Valid Values: a port number in the range 0 to 65535

Address Default Value: 0

Some commonly used port numbers are:

21 for FTP
23 for Telnet
25 for SMTP
513 for rlogin
520 for RIP

Example: This example of the **add access-control** command shows how to exclude all incoming packets originating from network 128.185.0.0 and received on interface 0.

```
Packet-filter 'pf-in-0' Config> add access-control
Enter type [E]?
Internet source [0.0.0.0]? 128.185.0.0
Source mask [255.255.255.255]? 255.255.0.0
Internet destination [0.0.0.0]?
Destination mask [255.255.255.255]? 0.0.0.0
Enter starting protocol number ([CR] for all) [-1]?
```

Use the **change access-control** command to change existing access controls using the index number of the access control that you want to change.

You can use the **list access-control** command to view the access controls configured for each packet filter.

```
Packet-filter 'pf-in-0' Config> list access-control
Access Control is: enabled
List of access control records:

                                                  Beg  End Beg End
    Ty Source      Mask      Destination  Mask    Pro  Pro Prt Prt
1   E  128.185.0.0 FFFF0000  0.0.0.0      00000000 0   255  0  65535
2   I  0.0.0.0     00000000  0.0.0.0      00000000 0   255  0  65535
```

You can change the order of a packet filter's access control records with the **move access-control** command as shown.

```
Packet-filter 'test' Config> move access-control
Enter index of control to move [1]?
Move record AFTER record number [0]? 2
About to move:

                                                Beg  End Beg End
    Ty Source      Mask      Destination  Mask    Pro  Pro Prt Prt
1   E  10.0.0.0    FFFF0000  0.0.0.0      00000000  0  255  0  65535
to be after:
2   I  10.5.5.0    FFFF0000  1.2.3.4      FF0000FF 0   255  0  65535
Are you sure this is what you want to do (Yes or [No]): y
```

Deleting Access Controls for a Filter

Use the **delete access-control** command to delete a record from a packet filter's access-control list.

```
Packet-filter 'test' Config> delete access-control
Enter index of access control to be deleted [1]? 4
```

The router responds by displaying the access-control record you have specified.

```
                                                Beg  End Beg End
    Ty Source      Mask      Destination  Mask    Pro  Pro Prt Prt
4   I  1.2.9.9     FF0000FF  0.0.0.0      00000000 0   255  0  65535
Are you sure this is the record you want to delete (Yes or [No]): y
Deleted
Packet-filter 'test' Config>
```

Exiting the Access Controls Process

Exit the access controls process by typing **exit** at the prompt. This returns you to the `IP config>` prompt.

```
Packet-filter 'test' Config> exit
IP config>
```

For the **disable** and **enable** commands, only the keyword **source-addr-verification** can be configured from the `Packet-filter '`*`filter-name`*`' Config>` prompt.

Accessing the IP Monitoring Environment

For information on how to access the IP monitoring environment, refer to "Getting Started (Introduction to the User Interface)" in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*.

IP Monitoring Commands

This section describes the IP monitoring commands. Table 16-2 lists the IP monitoring commands. The commands allow you to monitor the router's IP forwarding process.

Table 16-2 (Page 1 of 2). IP Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Access controls	List the current IP access control mode, together with the configured access control records.

Table 16-2 (Page 2 of 2). IP Monitoring Command Summary

Command	Function
Cache	Displays a table of all recent routed destinations.
Counters	Lists various IP statistics, including counts of routing errors and packets dropped.
Distributed IP Gateway	Lists whether a distributed gateway exists and if it is active or inactive.
Dump routing tables	Lists the contents of the IP routing table.
Interface addresses	Lists the router's IP interface addresses.
Packet-filter	Displays the access-control information defined for the specified packet-filter, or all filters.
Ping	Sends ICMP Echo Requests to another host and watches for a response. This command can be used to isolate trouble in an internetwork environment.
Redundant Default Gateway	Lists whether a redundant default gateway exists and if it is active or inactive.
Route	Lists whether a route exists for a specific IP destination, and if so, the routing table entry that corresponds to the route.
Route-table-filtering	Lists any defined route filters and indicates whether route-filtering is enabled or disabled.
Sizes	Displays the size of specific IP parameters.
Static routes	Displays the static routes that have been configured. This includes the default gateway.
Traceroute	Displays the complete path (hop-by-hop) to a particular destination.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

Access Controls

Use the **access controls** command to print the global access control mode in use together with a list of the configured access control records.

The access control mode is either disabled (meaning that no access control is being done and the access control records are being ignored) or enabled (meaning that access control is being done and the access control records are being recognized). When access control is enabled, access control records are scanned in order looking for the first match.

Exclusive (E) means that packets matching the access control record are being discarded. Inclusive (I) means that packets matching the access control record are being forwarded. When access control is enabled, packets failing to match any access control record are discarded. Pro (protocol) indicates the IP protocol number, and Port indicates the UDP or TCP destination port number.

Syntax: access

Example: `access`

```
Access Control currently enabled
Access Control run 13 times, 14 cache hits

List of access control records:
                                                          Beg End Beg  End
    Ty Source        Mask      Destination   Mask      Pro Pro Port Port   Use
1   E  10.5.22.0     FFFFFF00  0.0.0.0       00000000  0   255 0    65535  0
2   E  0.0.0.0       00000000  10.5.22.0     FFFFFF00  0   255 0    65535  0
3   I  0.0.0.0       00000000  0.0.0.0       00000000  0   255 0    65535  27
```

The IP access control system is based on a global list of *inclusive* and *exclusive* access control records. If access control is enabled, each IP packet being originated, forwarded, or received, is subject to the access control list.

The Use field (far right) specifies the number of times the access control system matched a particular record to an incoming packet, for example, the number of times that a particular record in the IP access controls system was invoked by the characteristics of an incoming or outgoing packet.

Cache

Use the **cache** command to display the IP routing cache, which contains recently routed destinations. If a destination is not in the cache, the router looks up the destination in the routing information table in order to make a forwarding decision.

Syntax:

cache

Example: **`cache`**

```
Destination     Usage           Next hop

128.185.128.225 1               128.185.138.180
```

Destination
IP destination host.

Usage Number of packets recently sent to the destination host.

Next hop IP address of the next router on the path toward the destination host. Also displayed is the network name of the interface used by the sending router to forward the packet.

Counters

Use the **counters** command to display the statistics related to the IP forwarding process. This includes a count of routing errors, along with the number of packets that have been dropped due to congestion.

Syntax:

counters

Example: **`counters`**

```
Routing errors
Count   Type
    0   Routing table overflow
 2539   Net unreachable
    0   Bad subnet number
    0   Bad net number
    0   Unhandled broadcast
58186   Unhandled multicast
    0   Unhandled directed broadcast
 4048   Attempted forward of LL broadcast

Packets discarded through filter  0
IP multicasts accepted:           60592
```

Routing table overflow
Lists the number of routes that have been discarded due to the routing table being full.

Net unreachable
Indicates the number of packets that could not be forwarded due to unknown destinations. This does not count the number of packets that have been forwarded to the authoritative router (default gateway).

Bad subnet number
Counts the number of packets or routes that have been received for illegal subnets (all ones or all zeros).

Bad net number
Counts the number of packets or routes that have been received for illegal IP destinations (for example, class E addresses).

Unhandled broadcasts
Counts the number of (non-local) IP broadcasts received (these are not forwarded).

Unhandled multicasts
Counts the number of IP multicasts that have been received, but whose addresses were not recognized by the router (these are discarded).

Unhandled directed broadcasts
Counts the number of directed (non-local) IP broadcasts received when forwarding of these packets is disabled.

Attempted forward of LL broadcast
Counts the number of packets that are received having non-local IP addresses but were sent to a link–level broadcast address. These are discarded.

Packets discarded through filter
Counts the number of received packets that have been addressed to filtered networks/subnets. These are discarded silently.

IP multicasts accepted
Counts the number of IP multicasts that have been received and successfully processed by the router.

IP packet overflows
Counts the number of packets that have been discarded due to congestion at the forwarder's input queue. These counts are sorted by the receiving interface.

Distributed IP Gateway

Use the **distributed ip gateway** command to display the distributed IP Gateways configured for each interface.

Syntax:

di**stributed ip gateway**

Example

```
Distributed IP Gateways for each interface:
   inf  3   22.2.2.6   255.0.0.0   00.00.00.00.00.AB   backup standby
   inf  4   11.1.1.6   255.0.0.0   00.00.00.00.00.BA   primary active
```

Note: Type can be “Primary” or “Backup.” Status can be “Active” or “Standby.”

Dump Routing Table

Use the **dump** command to display the IP routing table. A separate entry is printed for each reachable IP network/subnet. The IP default gateway in use (if any) is listed at the end of the display.

Syntax:

dump

Example: dump

```
Type   Dest net         Mask     Cost Age   Next hop(s)
SPE1   0.0.0.0          00000000  4    3    128.185.138.39  (2)

Sbnt   128.185.0.0      FFFF0000  1    0    None
SPF    128.185.123.0    FFFFFF00  3    3    128.185.138.39  (2)
SPF    128.185.124.0    FFFFFF00  3    3    128.185.138.39  (2)
SPF    192.26.100.0     FFFFFF00  3    3    128.185.131.10  (2)
RIP    197.3.2.0        FFFFFF00  10   30   128.185.131.10
RIP    192.9.3.0        FFFFFF00  4    30   128.185.138.21
Del    128.185.195.0    FFFFFF00  16   270  None


Default gateway in use.

Type Cost Age  Next hop
SPE1 4    3    128.185.138.39

Routing table size: 768 nets (36864 bytes), 36 nets known
```

Type (route type)

Indicates how the route was derived.

Sbnt - Indicates that the network is subnetted; such an entry is a place-holder only.

Dir - Indicates a directly connected network or subnet.

RIP - Indicates that the route was learned through the RIP protocol.

Del - Indicates that the route has been deleted.

Stat - Indicates a statically configured route.

BGP - Indicates routes learned through the BGP protocol.

BGPR - Indicates routes learned through the BGP protocol that are readvertised by OSPF and RIP.

Fltr - Indicates a routing filter.

SPF - Indicates that the route is an OSPF intra-area route.

SPIA - Indicates that it is an OSPF inter-area route.

SPE1, SPE2 - Indicates OSPF external routes (type 1 and 2 respectively)

Rnge - Indicates a route type that is an active OSPF area address range and is not used in forwarding packets.

Dest net IP destination network/subnet.

Mask IP address mask.

Cost Route Cost.

Age For RIP and BGP routes, the time that has elapsed since the routing table entry was last refreshed.

Next Hop IP address of the next router on the path toward the destination host. Also displayed is the interface type used by the sending router to forward the packet.

An asterisk (*) after the route type indicates that the route has a static or directly connected backup. A percent sign (%) after the route type indicates that RIP updates will always be accepted for this network/subnet.

A number in parentheses at the end of the column indicates the number of equal-cost routes to the destination. The first hops belonging to these routes can be displayed with the IP **route** command.

Interface Addresses

Hardware interfaces having no configured IP interface addresses will not be used by the IP forwarding process; they are listed as Not an IN net. There is one exception. Serial lines need not be assigned IP interface addresses in order to forward IP traffic. Such serial lines are called unnumbered. They show up as having address 0.0.0.0.

Syntax:

interface

```
interface
```

Interface Indicates the hardware type of the interface.

IP addresses
Indicates the IP address of the interface.

Mask Indicates the subnet mask of the interface.

Packet-filter

Use the **packet-filter** command to display information defined for a specific packet filter, or for all filters. Packet-filters are interface-specific lists of access control records.

Syntax: packet-filter [*name*]

Example: `packet-filter pf-in-0`

```
Name              Direction     Interface   #Access-Controls
pf-in-0           In            0           2

Access Control currently enabled
Access Control run 8 times, 7 cache hits

List of access control records:

                                                    Beg End  Beg  End
  Ty  Source       Mask     Destination  Mask      PPP PPP  Port Port  Use
0 I   0.0.0.0      00000000 192.67.67.20 00000000  6   6    25   25    0
1 E   150.150.1.0  FFFFFF00 150.150.2.0  00000000  0   255  0    655   0
2 I   0.0.0.0      00000000 0.0.0.0      00000000  89  89   0    655   27
```

Ping

Use the **ping** command to have the router send ICMP Echo Requests to a given destination (that is, “pinging”) and watch for a response. This command can be used to isolate trouble in an internetwork environment.

This process is done continuously, incrementing the ICMP sequence number with each additional packet. Each matching received ICMP Echo response is reported with its sequence number and the round-trip time. The granularity (time resolution) of the round–trip time calculation is usually around 20 milliseconds, depending on the platform.

To stop the PING process, type any character at the monitoring. At that time, a summary of packet loss, round-trip time, and number of unreachable ICMP destinations will be displayed.

When a multicast address is given as destination, there may be multiple responses printed for each packet sent, one for each group member. Each returned response is displayed with the source address of the responder.

The size of the ping (number of data bytes in the ICMP message, excluding the ICMP header), TTL value, and frequency of pinging are all user configurable. The source IP address is also configurable. If not specified, the router uses its local address on the outgoing interface to the specified destination. If you are validating connectivity from any of the router’s other interfaces to the destination, enter the IP address for that interface as the source address.

The default values are a size of 56 bytes, a TTL of 64 seconds, and a frequency of 1 ping per second. Only the destination value is required, all other values are optional.

Syntax: ping

ping *dest-addr [src-addr size ttl rate]*

Example: **`ping 128.185.142.06  128.185.142.11 56 60  1`**

```
PING 128.185.142.11 -> 128.185.142.06: 56 data bytes, ttl = 60 every 1 sec.
56 bytes from 128.185.142.06: icmp_seq=0 time=0 ms
56 bytes from 128.185.142.06: icmp_seq=1 time=0 ms
56 bytes from 128.185.142.06: icmp_seq=2 time=0 ms
56 bytes from 128.185.142.06: icmp_seq=3 time=0 ms
56 bytes from 128.185.142.06: icmp_seq=4 time=0 ms
56 bytes from 128.185.142.06: icmp_seq=5 time=0 ms

----128.185.142.06 PING Statistics----
6 packets transmitted, 6 packets received, 0% packet loss
round-trip (ms)  min/avg/max = 0/0/0 ms.
```

Redundant Default Gateway

Use the **redundant default gateway** command to display the redundant Default IP Gateways configured for each interface.

Syntax:

red**undant default gateway**

Example:

```
Redundant Default IP Gateways for each interface:
   inf  3   22.2.2.6   255.0.0.0   00.00.00.00.00.AB   backup standby
   inf  4   11.1.1.6   255.0.0.0   00.00.00.00.00.BA   primary active
```

Note: Type can be “Primary” or “Backup.” Status can be “Active” or “Standby.”

Route

Use the **route** command to display the route (if one exists) to a given IP destination. If a route exists, the IP addresses of the next hops are displayed, along with detailed information concerning the matching routing table entry. (See the IP **dump** command.)

Syntax:

route *ip-destination*

Example: **`route 133.1.167.2`**

Example: **`route 128.185.230.0`**

Example: **`route 128.185.232.0`**

Route-table-filtering

Use the **route-table-filtering** command to display whether or not route table filtering is enabled and list any defined route table filters.

Syntax:

route-table-filtering

Example: route-table-filtering

```
IP>route-table-filtering
Route Filters

Destination     Mask            Match Type
10.1.1.0        255.255.255.0   BOTH  E
10.1.1.1        255.255.255.255 EXACT I
50.0.0.0        255.0.0.0       BOTH  E
50.50.0.0       255.255.0.0     BOTH  I

IP>
```

Sizes

Use the **sizes** command to display the configured sizes of specific IP parameters.

Syntax:

sizes

Example: `sizes`

```
Routing table size:         768
Table entries used:         3
Reassembly size:            12000
Largest reassembled pkt:    0
Size of routing cache:      64
# of cache entries in use:  0
```

Routing table size The configured number of entries that the routing table will maintain.

Table entries used The number of entries used from the routing table. This number includes both active and inactive entries. The value displayed using the “dump” command as “xx nets known” is the number of active routing table entries. The configured routing table size should be large enough to maintain current active entries as well as other anticipated routing entries.

Reassembly buffer size The configured size of the reassembly buffer that is used to reassemble fragmented IP packets.

Largest reassembled pkt The largest IP packet that this router has had to reassemble.

Size of routing cache The configured size of the routing cache.

# of cache entries in use The number of entries currently being used from the cache.

Static Routes

Use the **static routes** command to display the list of configured static routes. Configured default gateways and default subnet gateways are also listed.

Each static route’s destination is specified by an address-mask pair. Default gateways appear as static routes to destination 0.0.0.0 with mask 0.0.0.0. Default subnet gateways also appear as static routes to the entire IP subnetted network.

The following example shows a configured default gateway, a configured default subnet gateway (assuming 128.185.0.0 is subnetted), and a static route to network 192.9.10.0.

Syntax:

static

```
IP>static routes
Net             Mask            Cost  Next hop
1.1.0.0         255.255.0.0     1     10.1.1.1        TKR/0
                                2     20.1.1.1        TKR/1
                                3     30.1.1.1        TKR/2
2.2.0.0         255.255.0.0     10    10.2.2.2        TKR/0
3.3.0.0         255.255.0.0     100   10.3.3.3        TKR/0
                                200   20.3.3.3        TKR/1

IP>
```

Net The destination address of the route.

Mask The destination mask of the route.

Cost The cost of using this route.

Next Hop The next router a packet would pass through using this route.

Traceroute

Use the **traceroute** command to display the entire path to a given destination, hop by hop. For each successive hop, **traceroute** sends out three probes, and prints the IP address of the responder, together with the round–trip time associated with the response. If a particular probe receives no response, an asterisk is displayed. Each line in the display relates to this set of three probes, with the left-most number indicating the distance from the router executing the command (in router hops).

The traceroute is done whenever the destination is reached, an ICMP Destination Unreachable is received, or the path length reaches 32 router hops.

When a probe receives an unexpected result, several indications can be displayed. “!N” indicates that an ICMP Destination Unreachable (net unreachable) has been received. “!H” indicates that an ICMP Destination Unreachable (host unreachable) has been received. “!P” indicates that an ICMP Destination Unreachable (protocol unreachable) has been received; because the probe is a UDP packet sent to a strange port, a port unreachable is expected. “!” indicates that the destination has been reached, but the reply sent by the destination has been received with a TTL of 1. This usually indicates an error in the destination, prevalent in some versions of UNIX, whereby the destination is inserting the probe’s TTL in its replies. This unfortunately leads to a number of lines consisting solely of asterisks before the destination is finally reached.

Syntax:

tr**aceroute** *interface-address*

Example: **`traceroute 128.185.142.239`**

```
TRACEROUTE 128.185.124.110: 56 data bytes
 1 128.185.142.7 16 ms 0 ms 0 ms
 2 128.185.123.22 16 ms 0 ms 16 ms
 3 * * *
 4 * * *
 5 128.185.124.110 16 ms ! 0 ms ! 0 ms !
```

TRACEROUTE
Displays the destination area address and the size of the packet being sent to that address.

1 The first trace showing the destination’s NSAP and the amount of time it took the packet to arrive at the destination. The packet is traced three times.

Destination unreachable
Indicates that no route to destination is available.

1 * * * 2 * * *
Indicates that the router is expecting some form of response from the destination, but the destination is not responding.

Chapter 17. Using OSPF

This chapter describes how to use the Open Shortest Path First (OSPF) Protocol, which is an Interior Gateway Protocol (IGP).

Included in this chapter are the following sections:

- "The OSPF Routing Protocol"
- "Configuring OSPF" on page 17-4
- "Accessing the OSPF Configuration Environment" on page 18-1
- "OSPF Configuration Commands" on page 18-1
- "Multicast Forwarding" on page 17-11

Routers that use a common routing protocol form an *autonomous system* (AS). This common routing protocol is called an Interior Gateway Protocol (IGP). IGPs dynamically detect network reachability and routing information within an AS and use this information to build the IP routing table. IGPs can also import external routing information into the AS. The router can simultaneously run OSPF and RIP. When it does, OSPF routes are preferred. In general, use of the OSPF protocol is recommended due to its robustness, responsiveness, and decreased bandwidth requirements.

The OSPF Routing Protocol

The router supports a complete implementation of the OSPF routing protocol, as specified in RFC 1583 (Version 2). OSPF is a link-state dynamic routing protocol that detects and learns the best routes to reachable destinations. OSPF can quickly perceive changes in the topology of an AS, and after a short convergence period, calculate new routes. The OSPF protocol does not encapsulate IP packets, but forwards them based on the destination address only.

OSPF is a link-state dynamic routing protocol that detects and learns the best routes to (reachable) destinations. OSPF can quickly perceive changes in the topology of an AS, and after a short convergence period, calculate new routes. The OSPF protocol does not encapsulate IP packets, but forwards them based on destination address only.

OSPF Routing Summary

When a router is initialized, it uses the Hello Protocol to send Hello packets to its neighbors, and they in turn send their packets to the router. On broadcast and point-to-point networks, the router dynamically detects its neighboring routers by sending the Hello packets to the multicast address *ALLSPFRouters (224.0.0.5);* on non-broadcast networks you must configure information to help the router discover its *neighbors*. On all multi-access networks (broadcast and non-broadcast), the Hello Protocol also elects a *designated router* for the network.

Note: For ATM networks, RFC 1577 will allow IP to use the network as a Non-Broadcast Multiple Access network. Thus, OSPF should be configured assuming non-broadcast. If you are using LAN Emulation, the network is treated as a broadcast network, and you should configure OSPF accordingly. If you are using both RFC 1577 and LAN Emulation on a single physical interface, configure OSPF non-broadcast on the RFC 1577 interfaces (IP addresses assigned to the real interface, for example,

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ATM/0), and configure OSPF broadcast on virtual or emulated interfaces (IP addresses assigned to emulated or virtual interfaces, for example, TKR/0).

The router then attempts to form adjacencies with its neighbors to synchronize their topological databases. Adjacencies control the distribution (sending and receiving) of the routing protocol packets as well as the distribution of the topological database updates. On a multi-access network, the designated router determines which routers become adjacent.

A router periodically advertises its status or link state to its adjacencies. *Link state advertisements* (LSAs) flood throughout an area, ensuring that all routers have exactly the same topological database. This database is a collection of the link state advertisements received from each router belonging to an area. From the information in this database, each router can calculate a shortest path tree with itself designated as the root. Then the shortest path tree generates the routing table.

OSPF is designed to provide services that are not available with RIP. OSPF includes the following features:

- *Least-Cost Routing.* Allows you to configure path costs based on any combination of network parameters. For example, bandwidth, delay, and dollar cost.
- *No limitations to the routing metric.* While RIP restricts the routing metric to 16 hops, OSPF has no restriction.
- *Multipath Routing.* Allows you to use multiple paths of equal cost that connect the same points. You can then use these paths for load distribution that results in more efficient use of network bandwidth.
- *Area Routing.* Decreases the resources (memory and network bandwidth) consumed by the protocol and provides an additional level of routing protection.
- *Variable-Length Subnet Masks.* Allows you to break an IP address into variable-size subnets, conserving IP address space.
- *Routing Authentication.* Provides additional routing security.

OSPF supports the following physical network types:

- *Point-to-Point.* Networks that use a communication line to join a single pair of routers. A 56-Kbps serial line that connects two routers is an example of a point-to-point network.
- *Broadcast.* Networks that support more than two attached routers and are capable of addressing a single physical message to all attached routers. A token-ring network is an example of a broadcast network. Emulated LANs over ATM treat the ATM network as a broadcast network.
- *Non-Broadcast Multi-Access (NBMA).* Networks that support more than two attached routers but have no broadcast capabilities. An X.25 Public Data Network is an example of a non-broadcast network. For OSPF to function correctly, this network requires extra configuration information about other OSPF routers attached to the non-broadcast network. Classical IP over ATM (RFC 1577) treats the ATM interface as a Non-Broadcast Multiple Access (NBMA) interface.
- *Point-to-Multipoint.* Networks that support more than two attached routers, have no broadcast capabilities, and are non-fully meshed. A frame relay network

without PVC between all the attached routers is an example of a Point-to-Multipoint network. Like non-broadcast networks, extra configuration information about other OSPF routers attached to the network is required.

Designated Router

Every broadcast or non-broadcast multi-access network has a designated router that performs two main functions for the routing protocol: it originates network link advertisements and it becomes adjacent to all other routers on the network.

When a designated router originates network link advertisements, it lists all the routers, including itself, currently attached to the network. The link ID for this advertisement is the IP interface address of the designated router. By using the subnet/network mask, the designated router obtains the IP network number.

The designated router becomes adjacent to all other routers and is tasked with synchronizing the link state databases on the broadcast network.

The OSPF Hello protocol elects the designated router after determining the router's priority from the *Rtr Pri* field of the Hello packet. When a router's interface first becomes functional, it checks to see if the network currently has a designated router. If it does, it accepts that designated router regardless of that router's priority, otherwise, it declares itself the designated router. If the router declares itself the designated router at the same time that another router does, the router with higher router priority (*Rtr Pri*) becomes the designated router. If both *Rtr Pris* are equal, the one with the higher router ID is elected.

Once the designated router is elected, it becomes the end-point for many adjacencies. On a broadcast network, this optimizes the flooding procedure by allowing the designated route to multicast its Link State Update packets to the address ALLSPFRouters (224.0.0.5) rather than sending separate packets over each adjacency.

Multicast OSPF

Multicasting is a LAN technique that allows copies of a single packet to pass to a selected subset of all possible destinations. Some hardware (Ethernet, for example) supports multicast by allowing a network interface to belong to one or more multicast groups. Refer to "IP Multicast Support" on page 15-13 for details about the router's support of IP multicasting.

The OSPF protocol supports IP multicast routing through multicast extensions to OSPF (MOSPF).

An MOSPF router distributes group location information throughout the routing domain by flooding a new type (type 6) of link state advertisement, the group-membership-LSA. This enables the MOSPF routers to efficiently forward a multicast datagram to its multiple destinations. Each router does this by calculating the path of the multicast datagram as a tree whose root is the datagram source and whose terminal branches are LANs containing group members.

While running MOSPF, multicast datagram forwarding works in the following ways:

- Although forwarding IP multicasts is not reliable, IP multicast datagrams are delivered with the same best effort as with the delivery of IP unicasts.

- Multicast datagrams travel the shortest path between the datagram source and any particular destination (OSPF link state cost). This occurs because a separate tree is built for each datagram source and destination group pair.
- A multicast datagram is forwarded as a data-link multicast at each hop. The ARP protocol is not used. For some network technologies, mapping between IP Class D addresses and data-link multicast occurs while, for others Class D IP addresses are mapped to the data-link broadcast address.
- When paths from the datagram source to two separate group members share an initial common segment, only a single datagram is forwarded until the paths go in separate directions. The path can split either at a router or at a network. If the path splits at a router, the router replicates the packet before it is sent. If the path splits at a network, it replicates through a data-link multicast.
- A network configuration could include both MOSPF routers and routers without multicast extensions. In this configuration, all routers interoperate in the routing of unicasts. This allows you to slowly introduce multicast capability into an internetwork.

  Some configurations of MOSPF and non-MOSPF routers might produce unexpected failures in multicast routing.
- The router can be configured to send SNMP traps to a multicast group address by adding a group address to a particular SNMP community name.

Configuring OSPF

The following sections present information on how to initially configure the OSPF protocol. This information outlines the tasks required to get the OSPF protocol up and running. Information on how to make further configuration changes is explained under “OSPF Configuration Commands” on page 18-1.

The following steps outline the tasks required to get the OSPF protocol up and running. The sections that follow explain each step in detail, including examples.

Before your router can run the OSPF protocol, you must:

1. Enable the OSPF protocol. In doing so, you must estimate the final size of the OSPF routing domain. (See “Enabling the OSPF Protocol” on page 17-5.)
2. Set the OSPF router ID. For network technologies that do not support data-link multicast or broadcast (for example, frame relay), the multicast datagram must be replicated by the router and forwarded as a data-link unicast. (See “Setting OSPF Router IDs” on page 17-5.)
3. Define OSPF areas attached to the router. If no OSPF areas are defined, a single backbone area is assumed. (See “Defining Backbone and Attached OSPF Areas” on page 17-6.)
4. Define the router’s OSPF network interfaces. Set the cost of sending a packet out on each interface, along with a collection of the OSPF operating parameters. (See “Setting OSPF Interfaces” on page 17-9.)
5. If you want to forward IP multicasts (IP Class D addresses), enable IP multicast routing capability. (See “Multicast Forwarding” on page 17-11.)
6. If the router interfaces to non-broadcast networks such as ATM using RFC 1577 (Classical IP and ARP over ATM), set additional interface parameters.

(See “Setting Non-Broadcast Network Interface Parameters” on page 17-12 and “Configuring Wide Area Subnetworks” on page 17-12.)

7. If you want the router to import routes learned from other routing protocols running on this router (BGP, RIP or statically configured routes), enable AS boundary routing. In addition, you must define whether routes are imported as Type 2 or Type 1 externals. (See “Enabling AS Boundary Routing” on page 17-13.)
8. If you want to boot via a neighboring router over an attached point-to-point or point-to-multipoint interface, you must configure the neighbor’s IP address. Do this by adding an OSPF neighbor for the point-to-point interface's destination.

Enabling the OSPF Protocol

When enabling the OSPF routing protocol, you must supply the following two values to estimate the final size of the OSPF routing domain:

- Total number of AS external routes that will be imported into the OSPF routing domain. A single destination might lead to multiple external routes when it is imported by separate AS boundary routers. For example, if the OSPF routing domain has two AS boundary routers, both importing routes to the same 100 destinations, set the number of AS external routes to 200.
- Total number of OSPF routers in the routing domain.

Configure these two values identically in all of your OSPF routers. Each router running the OSPF protocol has a database describing a map of the routing domain. This database is identical in all participating routers. From this database the IP routing table is built through the construction of a shortest-path tree, with the router itself as root. The routing domain refers to an AS running the OSPF protocol.

To enable the OSPF routing protocol, use the **enable** command as shown in the following example.

```
OSPF Config> enable ospf
Estimated # external routes[100]? 200
Estimated # OSPF routers [50]? 60
Maximum Size LSA [0]? 2048
```

Normally, 2048 bytes is large enough for any Link State Advertisement (LSA) generated by the router. However, routers with many OSPF dial links (for example, ISDN dial links) can require a larger LSA. Additionally, in these situations, the **packet-size** may also need to be increased in the general configuration.

Setting OSPF Router IDs

Every router in an OSPF routing domain must be assigned a unique 32-bit router ID. Choose the value used for the OSPF router ID as follows:

- If you use the IP configuration **set router ID** command, the value configured is used as an OSPF router ID.
- If you use the IP configuration **set internal address** command, the address configured is used as the OSPF router ID. It is recommended that the same value be used for the router ID and internal address, if defined.
- If neither the router ID nor the internal address are configured during IP configuration, the first OSPF interface address will be used as the OSPF router ID.

Defining Backbone and Attached OSPF Areas

Figure 17-1 on page 17-7 shows a sample diagram of the structure of an OSPF routing domain. One division is between IP subnetworks within the OSPF domain and IP subnetworks external to the OSPF domain. The subnetworks included within the OSPF domain are subdivided into regions called *areas*. OSPF areas are collections of contiguous IP subnetworks. The function of areas is to reduce the OSPF overhead required to find routes to destinations in a different area. Overhead is reduced both because less information is exchanged between routers and because fewer CPU cycles are required for a less complex route table calculation.

Every OSPF routing domain must have at least a *backbone area*. The backbone is always identified by area number 0.0.0.0. For small OSPF networks, the backbone is the only area required. For larger networks with multiple areas, the backbone provides a core that connects the areas. Unlike other areas, the backbone's subnets can be physically separate. In this case, logical connectivity of the backbone is maintained by configuring *virtual links* between backbone routers across intervening non-backbone transit areas.

Routers that attach to more than one area function as area *border routers*. All area border routers are part of the backbone, so a border router must either attach directly to a backbone IP subnet or be connected to another backbone router over a virtual link. In addition, there must be a collection of backbone subnetworks and virtual links that connects all of the backbone routers.

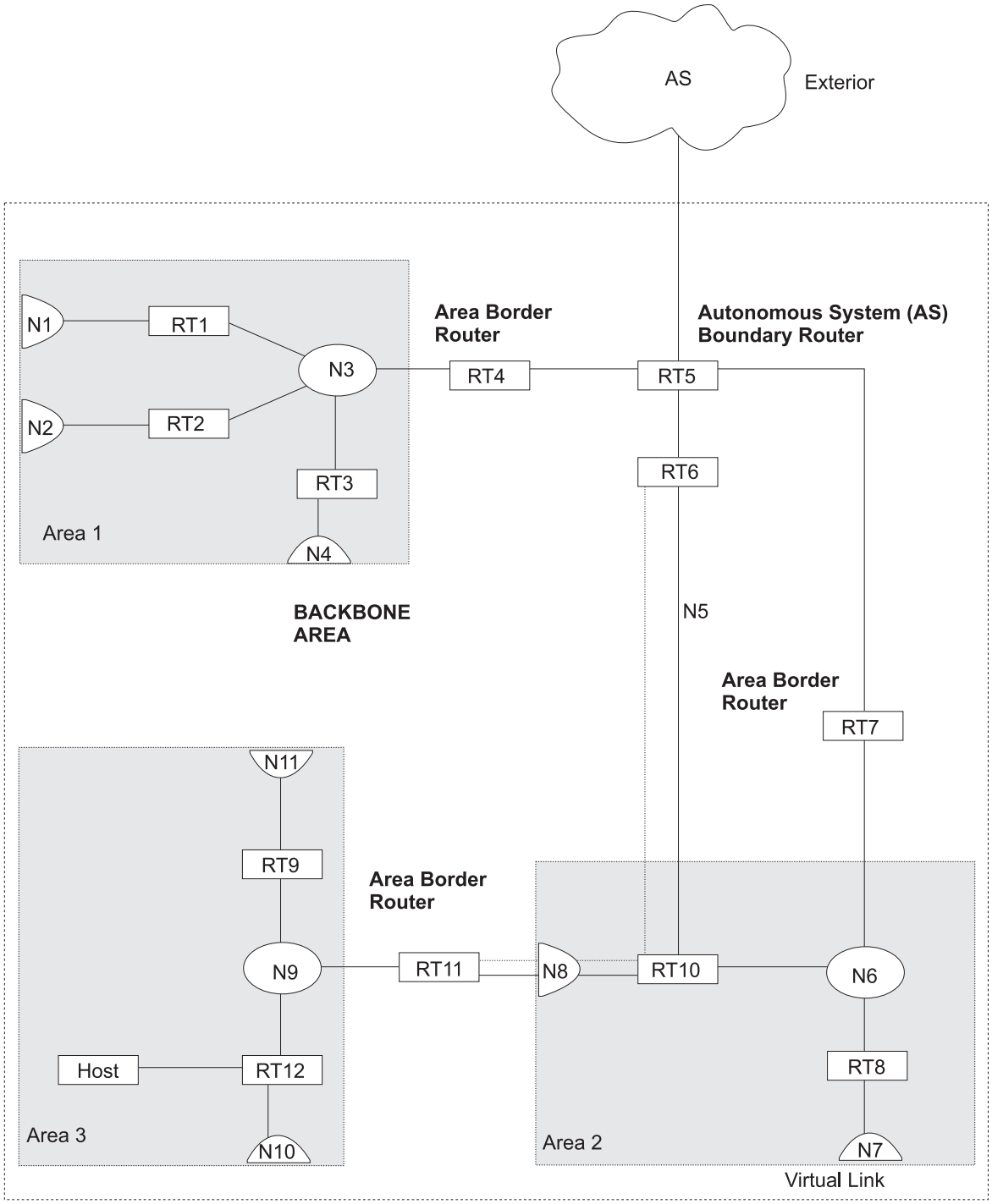

Figure 17-1. OSPF Areas

The information and algorithms used by OSPF to calculate routes vary according to whether the destination IP subnetwork is within the same area, in a different area within the same domain, or external to the OSPF domain. Every router maintains a complete map of all links within its area. All router to multi-access network, network to multi-access router, and router to router links are included in the map. A shortest path first algorithm is used to calculate the best routes to destinations within the area from this map. Routes between areas are calculated from summary advertisements originated by area border routers for IP subnetworks, IP subnetwork

ranges, and autonomous system external (ASE) boundary routers located in other areas of the OSPF domain. External routes are calculated from ASE advertisements that are originated by ASE boundary routers and flooded throughout the OSPF routing domain.

The backbone is responsible for distributing inter-area routing information. The backbone area consists of any of the following:

- Networks belonging to Area 0.0.0.0
- Routers attached to those networks
- Routers belonging to multiple areas
- Configured virtual links

Use the **set area** command to define areas to which a router attaches. If you do not use the **set area** command, the default is that all interfaces of the router attach to the backbone.

When area border routers are configured, options on the **set area** and **add range** commands can be used to control what OSPF route information crosses the area boundary.

One option is to use the **set area** command to define an area as a *stub*. OSPF ASE advertisements are never flooded into stub areas. In addition, the **set area** command has an option to suppress origination into the stub of summary advertisements for inter-area routes. Area border routers advertise default routes into stub areas. Traffic within the stub destined for unknown IP subnets is forwarded to the area border router. The border router uses its more complete routing information to forward the traffic on an appropriate path toward its destination. An area cannot be configured as a stub if it is used as a transit area for virtual links.

The other option is to use IP subnet address ranges to limit the number of summary advertisements that are used for inter-area advertisements of an area's subnets. A range is defined by an IP address and an address mask. Subnets are considered to fall within the range if the subnet IP address and the range IP address match after the range mask has been applied to both addresses.

When a range is added for an area at an area border router, the border router suppresses summary advertisements for subnets in the areas that are included in the range. The suppressed advertisements would have been originated into the other areas to which the border router attaches. Instead, the area border router may originate a single summary advertisement for the range or no advertisement at all, depending on the option chosen with the add range command.

Note that if the range is not advertised, there will be no inter-area routes for any destination that falls within the range. Also note that ranges cannot be used for areas that are used as transit areas by virtual links.

To set the parameters for an OSPF area, use the **set area** command and respond to the following prompts:

```
OSPF Config> set area
Area number [0.0.0.0]? 0.0.0.1
Authentication type [1]? 1
Is this a stub area?  [No]:
```

Define an area as a stub when:

1. There is no requirement for the area to handle transit backbone traffic.
2. It is acceptable for area routers to use an area-border-router-generated default for traffic destined outside the AS.
3. There is no requirement for area routers to be AS boundry routers (OSPF routers that advertise routes from external sources as AS external advertisements).

In this case, only the area border routers and backbone routers will have to calculate and maintain AS external routes.

Setting OSPF Interfaces

OSPF interfaces are a subset of the IP interfaces defined during IP configuration. The parameters configured for OSPF interfaces determine the topology of the OSPF domain, the routes that will be chosen through the domain, and the characteristics of the interaction between directly connected OSPF routers. The **set interface** command is used to define an OSPF interface and to specify some of its characteristics. Other characteristics of the interface were specified in response to the **add address** prompt during IP configuration.

OSPF Domain Topology

The definition of the topology of an OSPF domain depends on a definition of which routers are directly connected across some physical media or subnetwork technology and the area to which those connections are a part. The basic case is for all routers attached to a physical subnetwork to be directly connected, but it is possible to define multiple IP subnetworks over a single physical subnetwork. In that case, OSPF will consider routers to be directly connected only when they have OSPF interfaces attached to the same IP subnetwork. It is also possible to have cases where routers attached to the same subnetwork do not have a direct link layer connection.

For LAN media, directly connected OSPF routers are determined from the IP subnetwork and physical media associated with an OSPF interface. The IP address of the OSPF interface is specified in response to the **Interface IP address** prompt. This address must match the address of an IP interface that was defined with the **add address** command during IP configuration. The IP address, along with the subnetwork mask defined with the **add address** command determine the IP subnetwork to which the OSPF interface attaches. The *net index* associated with the IP interface by the add address command determines the physical subnetwork to which the OSPF interface attaches. The broadcast capability of LANs allows OSPF to use multicast Hello messages to discover other routers that have interfaces attached to the same IP subnetwork. Consequently, the interface parameters are all that are required for OSPF to determine which routers are directly connected across a LAN.

LANs can be used to connect an OSPF router with IP hosts. In this case, it is still necessary to define an OSPF interface to any IP subnetwork that is defined for the LAN. Otherwise, OSPF will not generate routes with those IP subnetworks as destinations. To prevent OSPF Hello traffic on these LANs without other attached routers, the network can be defined as a non-broadcast multi-access network. The router priority should also be set to zero because no designated router is required.

The requirements for configuring OSPF interfaces that attach to serial lines vary with the lower layer technology.

For point-to-point lines, only one other router is accessible over the interface, so the directly connected router can be determined without additional configuration. In fact, because there is no requirement to configure an IP subnetwork at all, unnumbered OSPF interfaces can be used for point-to-point lines. In this case, the same net index used as the IP address for the IP add address command is used as the IP address for the OSPF set interface command.

For subnetwork technologies like Frame Relay, ATM, and X.25 that support connections to multiple routers over a single serial line, the configuration of the OSPF interfaces is similar to that for a LAN, but because directly connected routers are not discovered dynamically for these subnetwork technologies, additional configuration is required to specify directly connected neighbors. For more information on the required configuration, see “Configuring Wide Area Subnetworks” on page 17-12.

Costs for OSPF Links

OSPF calculates routes by finding the least-cost path to a destination. The cost of each path is the sum of the costs for the different links in the path. The cost of a link to a directly connected router is specified at the **set interface** command for **Type of Service 0 cost**.

Correctly configuring the costs according to the desirability of using interfaces for data traffic is critical for obtaining the desired routes through an OSPF domain. The factors that make individual links more or less desirable may vary in different networks, but the most common goal is to choose routes with the least delay and the most capacity. In general, this policy can be achieved by making the cost of a link inversely proportional to the bandwidth of the media used for the physical subnetwork.

A recommended approach is to use a cost of one for the highest bandwidth technology. For example, use the value 1 as the cost for an interface running 155 Mbps ATM.

Table 17-1. Sample Costs for OSPF Links

Interface Bandwidth	Cost
155 Mbps ATM	1
Ethernet	10
16 Mbps Token-Ring	6
4 Mbps Token-Ring	25
serial line	Cost based on bandwidth
Emulated Token-Ring (See note.)	1
Emulated Ethernet (See note.)	1

Note: An Emulated Token Ring or Ethernet will run at the interface speed (for example, 155 Mbps), and should be configured with a cost of 1.

ATM can for attach to networks at a slower rate than the maximum line speed. For example, if the router has a port that is capable of 155 Mbps, and a router connects to it with 25 Mbps, that link will still be treated as a cost of 1. The OSPF weighting is on an interface basis.

The cost of an OSPF interface can be dynamically changed from the router's monitoring environment. This new cost is flooded quickly throughout the OSPF routing domain, and modifies the routing immediately.

When the router restarts/reloads, the cost of the interface reverts to the value that has been configured in SRAM.

Interactions Between Neighbor Routers

A number of the values configured with the **set interface** command are used to specify parameters that control the interaction of directly connected routers. They include:

- Retransmission interval
- Transmission delay
- Router priority
- Hello interval
- Dead router interval
- Demand Circuit
- Hello Suppression
- Poll Interval
- Authentication key

In most cases, the default values can be used.

Note: The Hello interval, the dead router interval, and the authentication key must have the same value for all OSPF routers that attach to the same IP subnetwork. If the values are not the same, routers will fail to form direct connections (adjacencies).

Multicast Forwarding

To enable the routing of IP multicast (class D) datagrams, use the **enable multicast-routing** command. When enabling multicast routing, you will also be prompted as to whether you want the router to forward multicasts between OSPF areas.

```
OSPF Config>enable multicast forwarding
Inter-area multicasting enabled?  [No]: yes
```

When the **enable multicast forwarding** command is first invoked, multicast is enabled on all OSPF interfaces with default parameters.

If you want to change the MOSPF parameters, use the **set interface** command. You will be queried for multicast parameters only if you have first enabled multicast forwarding.

On networks that lie on the edge of an Autonomous System, where multiple multicast routing protocols (or multiple instances of a single multicast routing protocol) may exist, you may need to configure forwarding as data-link unicasts to avoid unwanted datagram replication. In any case, for all routers attached to a common network, the interface parameters forward multicast datagrams and forward as data-link unicasts should be configured identically.

Setting Non-Broadcast Network Interface Parameters

If the router is connected to a non-broadcast, multi-access network, such as an ATM Network running RFC 1577, you have to configure the following parameters to help the router discover its OSPF neighbors. This configuration is necessary only if the router will be eligible to become designated router of the non-broadcast network.

First configure the OSPF poll interval with the following command:

```
OSPF Config> set non-broadcast
Interface IP address [0.0.0.0]? 128.185.138.19
Poll Interval [120]?
```

Then configure the IP addresses of all other OSPF routers that will be attached to the non-broadcast network. For each router configured, you must also specify its eligibility to become the designated router.

```
OSPF Config> add neighbor
Interface IP address [0.0.0.0]? 128.185.138.19
IP Address of Neighbor [0.0.0.0]? 128.185.138.21
Can that router become Designated Router [Yes]?
```

Setting non-broadcast can also be used to force a network without any other OSPF routers to be advertised. The router priority for the interface should be set to zero and no neighbors should be defined.

Configuring Wide Area Subnetworks

Frame Relay, Classical IP over ATM, and X.25 allow direct connections between multiple routers over a single serial line. Additional configuration beyond that achieved with the **set interface** command is required for OSPF interfaces that attach to this kind of network. Because OSPF protocol messages are sent directly to specific neighbors on these networks, configuration is used instead of dynamic discovery to determine neighbor relationships and router roles.

Note: The configurations described in this section do not apply to point-to-point networks.

OSPF can assume either of two patterns for the direct connections between routers across these subnetworks:

- Point-to-Multipoint
- Non-broadcast multi-access (NBMA)

The key factor that distinguishes these two patterns is whether or not there is a direct connection between all pairs of routers that attach to the subnetwork (*full mesh connectivity*) or whether some of the routers are only connected through multi-hop paths with other routers as intermediates (*partial mesh connectivity*).

Non-broadcast multi-access (NBMA) requires *full mesh connectivity* while point-to-multipoint requires only *partial mesh connectivity*.

Point-to-multipoint is the default choice because it works for both full mesh connectivity and partial mesh connectivity. But when full mesh connectivity is available, NBMA is a more efficient solution.

Configuring Point-to-Multipoint Subnetworks

Point-to-multipoint can be configured more easily than NBMA because there are no DRs, but neighbor relationships must be configured for all pairs of routers that will exchange data traffic directly across the point-to-multipoint subnet. Each pair of directly connected routers will exchange Hello messages, so one side can discover the other through these messages. The router configured to send the first Hello message, however, must have the IP address of its neighbor configured using the **add neighbor** command.

It is important to remember that OSPF will not calculate the correct routes if some of the routers attached to a subnetwork represent it as NBMA and others represent it as point-to-multipoint. Therefore, never use the **set non-broadcast** command for any interface to a point-to-multipoint network.

Configuring NBMA Subnetworks

For NBMA IP subnetworks, some subset of the attached OSPF routers are configured to be eligible to be the designated router (DR). Each router eligible to be the DR periodically sends Hello messages to all other routers eligible to be the DR. These messages are used in the protocol to elect a DR and a backup DR. Both the DR and the backup DR periodically exchange Hello messages with all other OSPF routers that are attached to the NBMA IP subnetwork. Also, the flow of OSPF route information across the NBMA IP subnetwork is only between each of the attached routers and the DR or backup DR.

Select NBMA by using the **set non-broadcast** command for interfaces that attach to an NBMA subnetwork. This command must be used for all interfaces that attach to the NBMA network.

The configuration required for an OSPF router that attaches to an NBMA subnetwork depends on whether or not that router is eligible to become the DR.

- For a router not eligible to become a DR, the **set interface** command must be used to set the router priority to 0.
- For a router eligible to become a DR, the **set interface** command must be used to set the router priority to a nonzero value and the **add neighbor** command must be used to identify all of the OSPF routers with interfaces attached to the NBMA subnetwork and to indicate which of them are eligible to become DR.

Note: In a star configuration, use the **add neighbor** command at the hub (neighbors at the remote site do not need to be configured). The **add neighbor** command takes effect immediately without restarting the router.

Enabling AS Boundary Routing

To import routes learned from other protocols (RIP and statically configured information) into the OSPF domain, enable AS boundary routing. You must do this even if the only route you want to import is the default route (destination 0.0.0.0).

When enabling AS boundary routing, you are asked which external routes you want to import. You can choose to import, or not to import, routes belonging to the following categories.

- BGP routes
- RIP routes

- Static routes
- Direct routes

For example, you could choose to import BGP and direct routes, but not RIP or static routes.

Independently of the above external categories, you can also configure whether or not to import subnet routes into the OSPF domain. This configuration item defaults to ENABLED (subnets are imported).

The metric type used in importing routes determines how the imported cost is viewed by the OSPF domain. When comparing two type 2 metrics, only the external cost is considered in picking the best route. When comparing two type 1 metrics, the external and internal costs of the route are combined before making the comparison. For example, you can set the router so that its default is originated only if a route to 10.0.0.0 is received from AS number 12. Setting the AS number to 0 means “from any AS.” Setting the network number to 0.0.0.0 means “any routes received.”

The syntax of the **enable** command is as follows:

```
OSPF Config>enable as boundary
Import BGP routes? [No]: yes
Import RIP routes? [No]:
Import static routes? [No]:
Import direct routes? [No]: yes
Import subnet routes? [No]:
Always originate default route? [No]: yes
Originate as type 1 or 2 [2]? 2
Default route cost [1]?
Default forwarding address [0.0.0.0]? 10.1.1.1
```

Configuring OSPF over ATM

The options for configuring OSPF over an ATM subnetwork depend on whether LAN Emulation or Classical IP over ATM is being used for the IP layer. In the case of LAN Emulation, OSPF is configured in the same way as for a real LAN. For Classical IP over ATM the OSPF configuration options are the same as for Wide Area Subnetworks. See “Configuring Wide Area Subnetworks” on page 17-12. Both NBMA and Point-to-Multipoint configurations are supported.

Configuring OSPF Over ATM (RFC 1577)

OSPF over ATM running RFC 1577 requires the following configuration steps:

1. Assign one or more IP addresses to the ATM interface using the `IP Config>` **add address** command. Each IP address corresponds to an attached Logical IP Subnet (LIS).
2. Use the `OSPF Config>` **set interface** command for each of the IP addresses configured on the ATM interface. Set the OSPF parameters including Designated-Router(DR) eligibility.
3. Use the `OSPF Config>` **set non-broadcast** command for each of the IP addresses configured on the ATM interface. This also needs to be set on all interfaces on every router that is connected to an ATM RFC 1577 LIS.
4. Use the `OSPF Config>` **add neighbor** command to define the other routers on the Logical IP Subnet (LIS) that you wish to share OSPF routing information with.

Note: All routers that are eligible to be Designated Routers (DRs) need to be configured with the neighbor information. Only one router in every LIS needs to be DR; however, if other routers are also configured to be DR-eligible, the LIS is more capable of recovering when an outage occurs.

Other Configuration Tasks

Setting Virtual Links

To maintain backbone connectivity, you must have all of your backbone routers interconnected either by permanent or virtual links. You can configure virtual links between any two area border routers that share a common non-backbone and non-stub area. Virtual links are considered to be separate router interfaces connecting to the backbone area. Therefore, you are asked to also specify many of the interface parameters when configuring a virtual link.

The following example illustrates the configuration of a virtual link. Virtual links must be configured in each of the link's two end-points. Note that you must enter OSPF router IDs in the same form as IP addresses.

```
OSPF Config> set virtual
Virtual endpt.  (Router ID) [0.0.0.0]? 128.185.138.21
Link's transit area [0.0.0.1]?
Retransmission Interval (in seconds) [10]?
Transmission Delay (in seconds) [5]?
Hello Interval (in seconds) [30]?
Dead Router Interval (in seconds) [180]?
Authentication Key []? 3-14159
```

No cost is configured for a virtual link because the cost is the OSPF intra-area cost between the virtual link end-points through the transit area.

Configuring for Routing Protocol Comparisons

If you use a routing protocol in addition to OSPF, or when you change your routing protocol to OSPF, you must set the Routing Protocol Comparison.

OSPF routing in an AS occurs on these three levels: intra-area, inter-area, and exterior.

Intra-area routing occurs when a packet's source and destination address reside in the same area. Information that is about other areas does not affect this type of routing.

Inter-area routing occurs when the packet's source and destination addresses reside in different areas of the same AS. OSPF does inter-area routing by dividing the path into three contiguous pieces: an intra-area path from source to an area border router; a backbone path between the source and destination areas; and then another intra-area path to the destination. You can visualize this high-level of routing as a star topology with the backbone as hub and each of the areas as a spoke.

Exterior routes are paths to networks that lie outside the AS. These routes originate either from routing protocols, such as Border Gateway Protocol (BGP), or from static routes entered by the network administrator. The exterior routing information provided by BGP does not interfere with the internal routing information provided by the OSPF protocol.

AS boundary routers can import exterior routes into the OSPF routing domain. OSPF represents these routes as AS external link advertisements.

OSPF imports external routes in separate levels. The first level, called type 1 routes, is used when the external metric is comparable to the OSPF metric (for example, they might both use delay in milliseconds). The second level, called external type 2 routes, assumes that the external cost is greater than the cost of any internal OSPF (link-state) path.

Imported external routes are tagged with 32 bits of information. In a router, this 32-bit field indicates the AS number from which the route was received. This enables more intelligent behavior when determining whether to re-advertise the external information to other autonomous systems.

OSPF has a 4-level routing hierarchy (see Figure 17-2). The **set comparison** command tells the router where the BGP/RIP/static routes fit in the OSPF hierarchy. The two lower levels consist of the OSPF internal routes. OSPF intra-area and inter-area routes take precedence over information obtained from any other sources, all of which are located on a single level.

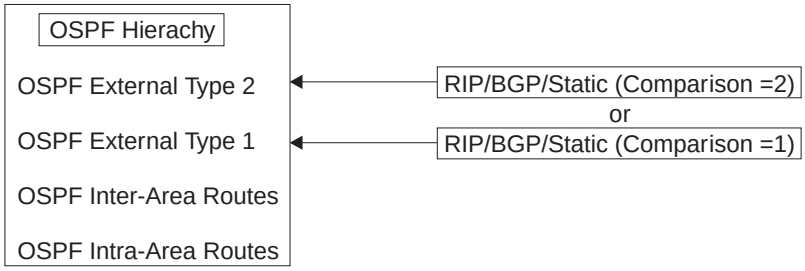

Figure 17-2. OSPF Routing Hierarchy

To put the BGP/RIP/static routes on the same level as OSPF external type 1 routes, set the comparison to 1. To put the BGP/RIP/static routes on the same level as OSPF external type 2 routes, set the comparison to 2. The default setting is 2.

For example, suppose the comparison is set to 2. In this case, when RIP routes are imported into the OSPF domain, they will be imported as type 2 externals. All OSPF external type 1 routes override received RIP routes, regardless of metric. However, if the RIP routes have a smaller cost, the RIP routes override OSPF external type 2 routes. The comparison values for all of your OSPF routers must match. If the comparison values set for the routers are inconsistent, your routing will not function correctly.

The syntax of the **set comparison** command is as follows:

```
OSPF Config> set comparison
Compare to type 1 or 2 externals [2]?
```

Demand Circuit

A demand circuit can be configured for any interface. There is no dependence on physical media or the model used by OSPF for the route calculation. When the demand circuit is configured and there are no compatibility problems:

- Only Link State Advertisements (LSAs) with real changes will be advertised over the interface. Normally, OSPF's reliable flooding algorithm causes LSAs to

be refreshed with a new instance every 30 minutes even if topology changes have occurred.

- The DoNotAge bit will be set for LSAs flooded over the interface. This is required since they will not be refreshed over the interface.

Request Hello Suppression

This is an additional parameter that you can use to configure an interface to request Hello suppression. This parameter will have value for point-to-point and point-to-multipoint interfaces. In addition, the subnetwork the interface attaches to must be able to notify OSPF that data cannot be delivered over a connection. Currently, ATM and ISDN dial-on-demand interfaces are the only interface types on which Hello suppression is supported.

Poll Interval

When Hello suppression is not active, the poll interval is used only with non-broadcast multi-access subnetworks and is set with the **set non-broadcast** command. You can configure this parameter after an interface has been configured as a demand circuit and Hello suppression has been requested. This parameter will be used by OSPF to try to reestablish a connection when a point-to-point line is down because there was a failure to transmit data but the network still appears to be operational.

Converting from RIP to OSPF

To convert your Autonomous System from RIP to OSPF, install OSPF one router at a time, leaving RIP running. Gradually, all your internal routes will shift from being learned via RIP to being learned by OSPF (OSPF routes have precedence over RIP routes). If you want to have your routes look exactly as they did under RIP (in order to check that the conversion is working correctly) use hop count as your OSPF metric. Do this by setting the cost of each OSPF interface to 1.

Remember that the size of your OSPF system must be estimated when the protocol is enabled. This size estimate should reflect the final size of the OSPF routing domain.

After installing OSPF on your routers, turn on AS boundary routing in all those routers that still need to learn routes via other protocols (BGP, RIP, and statically configured routes). The number of these AS boundary routers should be kept to a minimum.

Finally, you can disable the receiving of RIP information on all those routers that are not AS boundary routers.

Dynamically Changing Interface Costs

The cost of an OSPF interface can be dynamically changed from the router's console interface. This new cost flooded quickly throughout the OSPF routing domain, and modifies the routing immediately.

When the router restarts/reloads, the cost of the interface reverts to the value that has been configured in SRAM.

Chapter 18. Configuring and Monitoring OSPF

This chapter describes how to configure the Open Shortest Path First (OSPF) Protocol. OSPF is an Interior Gateway Protocol (IGP).

Accessing the OSPF Configuration Environment

To access the OSPF configuration environment, enter the following command at the `Config>` prompt:

```
Config> protocol ospf
Open SPF-based Routing Protocol configuration monitoring
OSPF Config>
```

OSPF Configuration Commands

Before you can use OSPF, you must configure it using the OSPF configuration commands. The following section summarizes and then explains the OSPF commands. Enter these commands at the `OSPF config>` prompt. Table 18-1 shows the commands.

Table 18-1. OSPF Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds to already existent OSPF information. You can add ranges to areas, and neighbors to non-broadcast networks.
Delete	Deletes OSPF information from SRAM.
Disable	Disables the entire OSPF protocol, AS boundary routing capability, demand circuit capability, or IP multicast routing.
Enable	Enables the entire OSPF protocol, AS boundary routing capability, demand circuit capability, or IP multicast routing.
Join	Configures the router to belong to one or more multicast groups.
Leave	Removes the router from membership in multicast groups.
List	Displays OSPF configuration.
Set	Establishes or changes the configuration information concerning OSPF areas, interfaces, non-broadcast networks, or virtual links. This command also allows you to set the way in which OSPF routes are compared with information gained from other routing protocols.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add more information to already existing OSPF information. With this command you can add ranges to areas as well as neighbors to non-broadcast networks.

Syntax:

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add range . . .
neighbor . .

range *area# IP-address IP-address-mask*

Adds ranges to OSPF areas. OSPF areas can be defined in terms of address ranges. External to the area, a single route is advertised for each address range. For example, if an OSPF area were to consist of all subnets of the class B network 128.185.0.0, it would be defined as consisting of a single address range. The address range would be specified as an address of 128.185.0.0 together with a mask of 255.255.0.0. Outside of the area, the entire subnetted network would be advertised as a single route to network 128.185.0.0.

Ranges can be defined to control which routes are advertised externally to an area. There are two choices:

- When OSPF is configured to advertise the range, a single inter-area route is advertised for the range if at least one component route of the range is active within the area.
- When OSPF is configured not to advertise the range, no inter-area routes are advertised for routes that fall within the range.

Ranges cannot be used for areas that serve as transit areas for virtual links. Also, when ranges are defined for an area, OSPF will not function correctly if the area is partitioned but is connected by the backbone.

Example:

```
add range 0.0.0.2 128.185.0.0 255.255.0.0
inhibit advertisement ? [No]
```

1. The *area number* has:

   Valid Values: Any valid area number

   Default Value: none

2. The *IP address* has:

   Valid Values: Any valid IP address.

   Default Value: none

3. The *IP address mask* has:

   Valid Values: Any valid IP address mask.

   Default Value: none

neighbor Configures neighbors adjacent to the router over this interface. In non-broadcast multi-access networks, neighbors need to be configured only on those routers that are eligible to become the designated router. In point-to-multipoint networks, at least one end of every logical connection must have a configured neighbor.

Example: add neighbor

```
Interface IP address [0.0.0.0]? 128.185.138.19
IP Address of Neighbor [0.0.0.0]? 128.185.138.21
Can that router become Designated Router on this net [Yes]?
```

1. The *Interface IP address* has:

   Valid Values: Any valid IP address.

Default Value: None

2. The *IP Address of Neighbor* has:

   Valid Values: Any valid IP address

   Default Value: None

3. Answer the question, `Can that router become designated router on this net?` For point-to-multipoint interfaces, this parameter is not applicable. For consistency, set it to "No."

   Valid Values: Yes or No

   Default Value: Yes

Delete

Use the delete command to delete OSPF information from SRAM.

Syntax:

delete range . . .
area . . .
interface . . .
neighbor . . .
non-broadcast . . .
virtual-link

range *area# IP-address*

Deletes ranges from OSPF areas.

Example: `delete range 0.0.0.2 128.185.0.0 255.255.0.0`

1. The *area number* of the range has:

   Valid Values: Any valid area address

   Default Value: none

2. The *IP Address of Range* has:

   Valid Values: Any valid IP address.

   Default Value: none

3. The *IP Address Mask of Range* has:

   Valid Values: Any valid IP address mask.

   Default Value: none

area *area#*

Deletes OSPF areas from the current OSPF configuration.

Example: `delete area 0.0.0.1`

The *area number* has:

Valid Values: Any valid area number.

Default Value: none

interface *interface-IP-address*

Deletes an interface from the current OSPF configuration.

Example: `delete interface 128.185.138.19`

The *interface IP address* has:

Valid Values: Any valid IP address.

Default Value: none

neighbor *interface-IP-address neighbor-IP-address*

Deletes configured neighbors from the current OSPF configuration.

Example: `delete neighbor`

```
Interface IP address [0.0.0.0]? 128.185.138.19
IP Address of Neighbor [0.0.0.0]? 128.185.138.21
```

1. The *interface IP address* has:

   Valid Values: Any valid IP address.

   Default Value: none

2. The *neighbor IP address* has:

   Valid Values: Any valid IP address.

   Default Value: none

non-broadcast *interface-IP-address*

Deletes non-broadcast network information from the current OSPF configuration.

Example: `delete non-broadcast 128.185.133.21`

1. The *interface IP address* has:

   Valid Values: Any valid IP address.

   Default Value: none

virtual-link

Deletes a virtual link that you have set using the **set virtual-link** command.

Example: `delete virtual-link`

```
Virtual endpoint (Router ID) [0.0.0.0]? 10.1.1.1
Link's transit area [0.0.0.1]? 0.0.0.2
```

1. The *virtual endpoint (router ID)* that defines the ID of the virtual neighbor has:

   Valid Values: Any valid IP address.

   Default Value: none

2. The *link's transit area* has:

   Valid Values: Any valid area address.

   Default Value: 0.0.0.1

Disable

Use the **disable** command to disable either the entire OSPF protocol or just the AS boundary routing capability.

Syntax:

di**sable**	as boundary routing demand-circuits multicast forwarding OSPF routing protocol

subnet

as boundary routing
Disables the AS boundary routing capability. When disabled, the router will not import external information into the OSPF domain.

Example: `disable as boundary routing`

demand-circuits
Disables the demand circuit capability. When disabled, the router will not indicate that it supports demand circuit processing in its router link's Link State Advertisement (LSA) and will not originate any LSAs with the DoNotAge bit set. If one router in the routing domain or OSPF stub area does not support demand circuits, none of the routers in the routing domain or OSPF stub area will originate DoNotAge LSAs.

Example: `disable demand-circuits`

multicast forwarding
Disables IP multicast routing on all interfaces. When disabled, the router will not forward IP multicast (Class D) datagrams.

Example: `disable multicast forwarding`

OSPF routing protocol
Disables the entire OSPF protocol.

Example: `disable OSPF routing protocol`

subnet For an interface to a point-to-point serial line, this option disables the advertisement of a stub route to the subnet that represents the serial line rather than the host route for the other router's address. You must supply this router's address for the interface to identify it.

Example:

```
OSPF Config> disable subnet
Interface IP address [0.0.0.0]? 8.24.3.1
```

The *interface IP address* has:

Valid Values: Any valid IP address.

Default Value: none

Enable

Use the **enable** command to enable either the entire OSPF protocol, the advertisement of a stub to route to a subnet, or just the AS boundary routing capability.

Syntax:

en**able**	as boundary routing demand-circuits multicast forwarding OSPF routing protocol send outage-only subnet

as boundary routing
Enables the AS boundary routing capability which allows you to import routes learned from other protocols (BGP, RIP, and statically configured

information) into the OSPF domain. For additional information on the use of the **enable** command, see “Configuring OSPF” on page 17-4.

Example: `enable as boundary routing`

```
Import RIP routes? [No]:
Import static routes? [No]:
Import direct routes? [No]: yes
Import subnet routes? [No]:
Always originate default route? [No]: yes
Originate as type 1 or 2 [2]? 2
Default route cost [1]?
Default forwarding address [0.0.0.0]? 10.1.1.1
```

1. The *Originate as type 1 or 2* indicates whether the OSPF-originated default will have an AS external metric type of 1 or 2. Type 1 metrics are considered in the same context as OSPF costs while type 2 metrics are considered higher than any OSPF metric.

   Valid Values: 1 or 2

   Default Value: 2

2. The *Default route cost* is the parameter that specifies the cost that OSPF associates with the default route to its area border router. The cost is used to determine the shortest path for the default route to its area border router.

   Valid Values: 0 to 16777215

   Default Value: 1

3. The *Default forwarding address* is the parameter that specifies the forwarding address that will be used in the imported default route.

   Valid Values: a valid IP address

   Default Value: none

multicast forwarding

Enables the forwarding of IP multicast (Class D) datagrams. When enabling multicast routing, you are also prompted whether you want to forward IP multicast datagrams between OSPF areas. To run MOSPF (OSPF with multicast extensions), a router currently running OSPF needs only to use this command. You do not need to reenter its configuration information.

Example: `enable multicast forwarding`

```
Inter-area multicasting enabled (Yes or No): yes
```

demand-circuits

Enables demand circuit processing for the router. The router will indicate that it supports demand circuit processing in its router link’s Link State Advertisement (LSA). The default is enabled so that demand circuits can be deployed without reconfiguring every router in the OSPF routing domain.

```
OSPF Config> enable demand-circuits
```

OSPF routing protocol

Enables the entire OSPF protocol. When enabling the OSPF routing protocol, you must supply the following two values that will be used to estimate the size of the OSPF link state database:

- Total number of AS external routes that will be imported into the OSPF routing domain. A single destination may lead to multiple

external routes when it is imported by separate AS boundary routers. For example, if the OSPF routing domain has two AS boundary routers, both importing routes to the same 100 destinations, the number of AS external routes should be set to 200.

Valid Values: 0 to 65535

Default Value: 100

- Total number of OSPF routers in the routing domain.

  Valid Values: 0 to 65535

  Default Value: 50

- Additionally, you can specify the maximum LSA size. This value may need to be increased if you have a large Nways router with many OSPF dial links (for example, ISDN primary) in the same OSPF area. Normally, 2048 is more than enough space for any single LSA.

  Valid Values: 2048 to 65535

  Default Value: 2048

  Example: `enable OSPF routing protocol`

```
Estimated # external routes[100]? 200
Estimated # OSPF routers [50]? 60
Maximum LSA Size [2048]?
```

subnet For an interface to a point-to-point serial line, this option enables the advertisement of a stub route to the subnet that represents the serial line rather than the host route for the other router's address. You must supply this router's address for the interface to identify it.

Example:

```
OSPF Config> enable subnet
Interface IP address [0.0.0.0]? 8.24.3.1
```

The *interface IP address* has:

Valid Values: Any valid IP address.

Default Value: none

Join

Use the **join** command to configure the router as a member of a multicast group. When the router is the member of a multicast group, it responds to PINGs and SNMP queries sent to the group address.

To request group membership in a more immediate way (a restart/reload is not required), issue the **join** command from OSPF monitoring. Also, from OSPF monitoring, the join command keeps track of the number of times a particular group is joined. IP multicast groups joined through OSPF monitoring are not retained across router restarts and reloads.

Syntax:

j**oin** *multicast-group-address*

Example: `join 224.185.0.0`

The *multicast group address* parameter specifies the IP class D group/multicast address.

Valid Values: Class D IP address from 224.0.0.1 to 239.255.255.255

Default Value: None

Leave

Use the **leave** command to remove a router's membership from a multicast group. This will prevent the router from responding to PINGs and SNMP queries sent to the group address.

To delete group membership in a more immediate way (a restart/reload is not required), issue the **leave** command from OSPF monitoring. Also, from OSPF monitoring, group membership is not deleted until the number of leaves executed equals the number of joins previously executed.

Syntax:

le**ave** *multicast-group-address*

Example: `leave 224.185.0.0`

The *multicast group address* parameter specifies the IP class D group/multicast address.

Valid Values: Class D IP address from 224.0.0.1 to 239.255.255.255

Default Value: none

List

Use the **list** command to display OSPF configuration information.

Syntax:

li**st** all
areas
interfaces
neighbors
non-broadcast
virtual-links

all Lists all OSPF-related configuration information.

Example: `list all`

```
        --Global configuration--
    OSPF Protocol:          Enabled
    # AS ext. routes:       300
    Estimated # routers:    100
    Maximum LSA Size:       2048
    External comparison:    Type 2

    AS boundary capability: Enabled
    Import external routes: BGP RIP STA DIR SUB
    Orig. default route:    No (0,0.0.0.0)
    Default route cost:     (1, Type 2)
    Default forward. addr.: 0.0.0.0
    Multicast forwarding:   Enabled
    Inter-area multicast:   Enabled
    Demand Circuits:        Enabled

        --Area configuration--
Area ID          AuType          Stub? Default-cost Import-summaries?
0.0.0.0          0=None          No         N/A           N/A


   --Interface configuration--
    IP address        Area    Cost  Rtrns  TrnsDly  Pri  Hello Dead
    128.185.184.11    0.0.0.1   1      5       1     1    10    60
    128.185.177.11    0.0.0.1   1      5       1     1    10    60
    128.185.142.11    0.0.0.0   1      5       1     1    10    60
```

OSPF protocol	Displays whether OSPF is enabled or disabled.
# AS ext. routes	Displays the estimated number of Autonomous System external routes. The router cannot accept more than this number of AS external routes.
Estimated # routers	Displays the estimated number of routers found in the OSPF configuration.
Maximum LSA size	Displays the maximum size LSA that will be originated by this router.
External comparison	Displays the external route type used by OSPF when importing external information into the OSPF domain and when comparing OSPF external routes to RIP/BGP routes.
AS boundary capability	Displays whether the router will import external routes into the OSPF domain.
Import external	Displays which routes will be imported.
Orig default route	Displays whether the router will import a default into the OSPF domain. When the value is “YES,” and a non-zero network number is displayed in parentheses. This indicates that the default route will be originated only if a route to that network is available.
Default route cost	Displays the cost and type that will be used in the imported default route.
Default forward addr	Displays the forwarding address that will be used for the originated default route.
Multicast forwarding	Displays whether IP multicast datagrams will be forwarded.
Demand circuits	Displays whether demand circuit processing is supported.
External comparison	Displays the external route type used by OSPF when importing external information into the OSPF domain and when comparing OSPF external routes to RIP/BGP routes.

Inter-area multicast	Displays whether IP multicast datagrams will be forwarded between areas.
Area-ID	Displays the attached area ID (area summary information)
AuType	Displays the method used for area authentication. “Simple-pass” means a simple password scheme is being used for the area’s authentication.
Stub area	Displays whether or not the area being summarized is a stub area. Stub areas do not carry external routes, resulting in a smaller routing database. However, stub areas cannot contain AS boundary routers, nor can they support configured virtual links.
OSPF interfaces	For each interface, its IP address is printed, together with configured parameters. “Area” is the OSPF area to which the interface attaches. “Cost” indicates the TOS 0 cost (or metric) associated with the interface. “Rtrns” is the retransmission interval, which is the number of seconds between retransmissions of unacknowledged routing information. “TrnsDly” is the transmission delay, which is an estimate of the number of seconds it takes to transmit routing information over the interface (it must be greater than 0). “Pri” is the interface’s Router Priority, which is used when selecting the designated router. “Hello” is the number of seconds between Hello Packets sent out the interface. “Dead” is the number of seconds after Hellos cease to be heard that the router is declared down.
Virtual links	Lists all virtual links that have been configured with this router as end-point. “Virtual endpoint” indicates the OSPF Router ID of the other end-point. “Transit area” indicates the non-backbone area through which the virtual link is configured. Virtual links are considered treated by the OSPF protocol similarly to point-to-point networks. The other parameters listed in the command (“Rtrns,” “TrnsDly,” “Hello,” and “Dead”) are maintained for all interfaces. See the OSPF list interfaces command for more information.

areas Lists all information concerning configured OSPF areas.

Example: `list areas`

```
                              --Area configuration--
Area ID          AuType         Stub? Default-cost Import-summaries?
0.0.0.0          0=None          No         N/A           N/A
0.0.0.1          1=Simp-Pass     No         N/A           N/A
```

Area-ID	Displays the attached area ID (area summary information).
AuType	Displays the method used for area authentication. “Simple-pass” means a simple password scheme is being used for the area’s authentication.
Stub area	Displays whether or not the area being summarized is a stub area. Stub areas do not carry external routes, resulting in a smaller routing database. However, stub areas cannot contain AS boundry routers, nor can they support configured virtual links.
Default-cost	For stub areas the cost of the default to be originated as an OSPF summary (type 3) Link State Advertisement (LSA). For transit areas (for example, non-stub areas), this field is N/A.
Import-summaries	For stub areas, indicates whether or not OSPF summary (type 3) Link State Advertisements are to be originated into the stub area. This question does not apply to the default summary. For transit areas (for example, non-stub areas, this field is N/A.

interfaces

For each interface, its IP address is printed, together with configured parameters. “Area” is the OSPF area to which the interface attaches. “Cost” indicates the TOS 0 cost (or metric) associated with the interface.

"Rtrns" is the retransmission interval, which is the number of seconds between retransmissions of unacknowledged routing information. "TrnsDly" is the transmission delay, which is an estimate of the number of seconds it takes to transmit routing information over the interface (it must be greater than 0). "Pri" is the interface's router priority, which is used when selecting the designated router. "Hello" is the number of seconds between Hello Packets sent out the interface. "Dead" is the number of seconds after Hellos cease to be heard that the router is declared down.

Example: `list interfaces`

```
                --Area configuration--
IP address        Area     Cost  Rtrns  TrnsDly  Pri Hello Dead
153.2.2.25        0.0.0.0   1      5       1       1    10   40
10.69.40.1        0.0.0.0   1      5       1       1    10   40
10.69.1.1         0.0.0.0   1      5       1       1    10   40
154.2.2.25        0.0.0.0   1      5       1       1    10   40


                --Demand circuit parameters--
IP address        DoNotAge    Hello Suppression  Poll Interval
153.2.2.25        Off         Allow                 0
10.69.40.1        On          Disable             100
10.69.1.1         On          Allow                60
154.2.2.25        Off         Allow                 0


                --Multicast parameters--
IP address        MCForward   DLUnicast  IGMPoll  IGMPtimeout
153.2.2.25        On          Off        60       180
10.69.40.1        On          Off        60       180
10.69.1.1         On          Off        60       180
154.2.2.25        On          Off        60       180
```

Note: Multicast parameters are not displayed if multicast is disabled. Demand circuit parameters are not displayed if none of the interfaces are configured as demand circuits.

neighbors

Lists neighbors to non-broadcast networks. It displays IP address of the neighbor and the IP address of the interface to that neighbor. It also indicates whether the neighbor is eligible to become the "Designated Router" on the net.

Example: `list neighbors`

```
          --Neighbor configuration--
Neighbor Addr     Interface Address   DR eligible?
2.3.4.5           1.2.3.4             yes
2.5.6.7           5.6.7.8             no
```

non-broadcast

Lists all information related to interfaces connected to non-broadcast multi-access networks. For each non-broadcast interface, as long as the router is eligible to become designated router on the attached network, the polling interval is displayed together with a list of the router's neighbors on the non-broadcast network.

Example: `list non-broadcast`

```
          --NBMA configuration--
Interface Addr      Poll Interval
128.185.235.34      120
```

virtual-links

Lists all virtual links that have been configured with this router as end-point. "Virtual endpoint" indicates the OSPF router ID of the other end-point. "Transit area" indicates the non-backbone area through which

the virtual link is configured. Virtual links are considered treated by the OSPF protocol similarly to point-to-point networks. The other parameters listed in the command (“Rtrns,” “TrnsDly,” “Hello,” and “Dead”) are maintained for all interfaces. See the OSPF **list interfaces** command for more information.

Example: `list virtual-links`

```
          --Virtual link configuration--
Virtual endpoint   Transit area   Rtrns  TrnsDly Hello Dead
0.0.0.0            0.0.0.1         10      5     30    180
```

Set

Use the **set** command to display or change the configuration information concerning OSPF areas, interfaces, non-broadcast networks, or virtual links. This command also allows you to set the way in which OSPF routes are compared to information obtained from other routing protocols.

Syntax:

set area
comparison
interface
non-broadcast
virtual-link

area Sets the parameters for an OSPF area. If no areas are defined, the router software assumes that all the router’s directly attached networks belong to the backbone area (area ID 0.0.0.0).

Example: `set area`

```
Area number [0.0.0.0]? 0.0.0.1
Authentication type [1]? 1
Is this a stub area? [No]:  yes
Stub default cost? [0]:
Import summaries? [Yes]:
```

- *Area number* - is the OSPF area address.
- *Authentication type* - (security scheme) to be used in the area. The choices for authentication types are 1, which indicates a simple password; or 0, which indicates that no authentication is necessary to pass packets.

  All OSPF routers attached to the same subnet must have the same Authentication Key. For example, suppose the address mask for this network interface is 255.255.255.0, the IP address is 128.185.138.19 and the authentication key is *xyz123*. According to the subnet mask and IP address combination, the interface attaches to the subnet 128.185.138.0 of network 128.185.0.0. All other OSPF routers attached to subnet 128.185.138.0 must have their authentication key set to *xyz123*.

  Valid Values: any 1-8 characters

  Default Value: 0

- *Stub area designation.* If you designate “Yes”:
  - The area does not receive any AS external link advertisements, reducing the size of your database and decreasing memory usage for routers in the stub area.

– You cannot configure virtual links through a stub area.

– You cannot configure a router within the stub area as an AS boundary router.

External Routing in Stub Areas. You cannot configure the backbone as a stub area. External routing in stub areas is based on a default route. Each border area router attaching to a stub area originates a default route for this purpose. The cost of this default route is also configurable with the **set area** command.

comparison

Tells the router where the BGP/RIP/static routes fit in the OSPF hierarchy. The two lower levels consist of the OSPF internal routes. OSPF internal routes take precedence over information gained from any other sources, all of which are located on a single level.

Example: `set comparison`

```
OSPF Config> set comparison
Compare to type 1 or 2 externals [2]?
```

interface Sets the OSPF parameters for the router's network interfaces.

1. The *interface IP address* is for each interface in the router.
2. *attaches to area* is the area to which the interface attaches.
3. The timer values are the same values for all routers attached to a common network segment.

   a. The *retransmission interval* is the interval after which a Link Request for one or more link state advertisements will be resent.

      Valid values: 1 to 65535 seconds

      Default Value: 5

   b. The *Transmission delay* is an estimate of the number of seconds that it takes to transmit link-state information over the interface.

      Each link-state advertisement has a finite lifetime that is equal to the constant MaxAge (1 hour). As each link-state advertisement is sent to the particular interfaces, it is aged by this configured transmission delay. The minimum delay is 1 second.

      Valid Values: 1 to 65535 seconds

      Default Value: 1

   c. The *Hello Interval* is the interval between Hello packets sent on the interface.

      Valid Values: 1 to 65535 seconds

      Default Value: 10

   d. The *Dead Router Interval*

      Dead Router Interval is the interval after which a router that has not sent a Hello will be considered dead. The Dead Router Interval defaults to four times the configured Hello Interval. The value for this parameter must be greater than the Hello Interval.

      Valid Values: 2 to ≥ 65535 seconds

Default Value: 40 (or four times the configured Hello interval)

4. The *Router Priority* value is used for broadcast and non-broadcast multi–access networks to elect the designated router. For point-to-point links, this value should be **0**, which means that this router must not be elected the designated router for its network.

   Valid Values: 0 to 255

   Default Value: 1

5. The *Type of service 0 cost* is cost that will be used for the interface when the shortest path routes are computed for the area..

   Valid Values: 1 to 65535

   Default Value: 1

6. The *Demand Circuit* indicates whether or not the interface will be treated as a demand circuit for purposes of flooding LSAs (Link State Advertisements). Over demand circuits, LSAs will be flooded with the DoNotAge bit set over this interface and will not be flooded unless there is an actual change to the LSA. Refer to RFC 1793 for more information.

   Valid Values: Yes or No

   Default Value: No

7. The *Hello Suppression* indicates whether or not Hello packets will be suppressed on the interface once the neighbors reach the full state. Demand circuits must be enabled on the interface for Hello Suppression to be requested or allowed. Currently, Hello Suppression is only supported on ATM and ISDN Dial-on-Demand links. Refer to RFC 1793 for more information.

   Valid Values: Allow, Request, or Disable

   Default Value: Allow

Allow	Allows a neighbor to request Hello Suppression.
Request	Requests Hello Suppression from a neighbor.
Disable	Disables Hello Suppression and continues sending Hellos.

8. The *Demand Circuit Down Poll Interval* indicates the duration between hello polls sent when there is a failure to send data on a demand circuit with hello suppression active. Currently, hello suppression is only supported on ATM and ISDN Dial-on-Demand links. Refer to RCF 1793 for more information.

   Valid Values: 1 to 65535

   Default Value: 60

9. The *Authentication key* is the parameter that defines the password used for this OSPF area. When password authentication is used, only packets with the correct authentication key are accepted.

   Valid Values: any 1-8 characters

   Default Value: a null string

Example: `set interface`

```
Interface IP address [0.0.0.0]? 128.185.138.19
Attaches to area [0.0.0.0]? 0.0.0.1
Retransmission Interval (in seconds) [5]?
Transmission Delay (in seconds) [1]? 1
Router Priority [1]? 1
Hello Interval (in seconds) [10]? 10
Dead Router Interval (in seconds) [40]? 60
Type Of Service 0 cost [1]? 5
Demand Circuit (Yes or NO) [No]? Yes
Hello Suppression (A-Allow, R-Request, or D-Disable) [A]?
Demand Circuit Poll Interval (in seconds) [60?]
Authentication Key []? xyz_q
Retype Auth.  Key []? xyz_q
Forward multicast datagrams (Yes or No)? Yes
Forward as datalink unicasts (Yes or No)? No
IGMP polling interval (in seconds) [60]? 60
IGMP timeout (in seconds) [180]? 180
```

When responding to the prompts, supply the IP address for each interface in the router and answer the questions that follow. For the following parameters, you must enter the same value for all routers attached to a common network:

- Hello interval
- Dead router interval
- Authentication key (if an authentication of 1 is used)

The first prompt asks for the OSPF area to which the interface attaches. For example, suppose that the interface address mask is 255.255.255.0, indicating that the interface attaches to a subnet (128.185.138.0) of network 128.185.0.0. All other OSPF routers attached to subnet 128.185.138.0 must also have their *Hello interval* set to 10, *dead router interval* set to 40, and their interface *authentication key* set to xyz_q.

Note that IP interfaces to point-to-point lines may be unnumbered. In this case a net index is configured instead of an IP address. This implementation of OSPF will work with these unnumbered interfaces, but to work correctly, both ends of the point-to-point line must use an unnumbered interface.

In a multicast routing configuration (multicast has been enabled), the MOSPF parameters for each OSPF interface are set to their default values. This means that:

- Multicast forwarding is enabled.
- Multicast datagrams are forwarded as data-link multicasts.
- IGMP Host Membership is sent out on the interface every 60 seconds.
- Local group database entries are removed 180 seconds after IGMP Host Membership reports for the group cease to be received by the interface.

If you want to change the MOSPF parameters, use the **set interface** command. You will be queried for multicast parameters (the last five parameters shown in the output display above) only if you have first enabled multicast forwarding.

On networks that lie on the edge of an autonomous system, where multiple multicast routing protocols (or multiple instances of a single multicast routing protocol) may exist, you may need to configure forwarding as data-link unicasts to avoid unwanted datagram replication. In any case, for all routers attached to a common network, the interface parameters “forward multicast datagrams” and “forward as data-link unicasts” should be configured identically.

non-broadcast

Overrides the point-to-multipoint default to select NBMA for X.25, Frame Relay or ATM networks. This parameter specifies the interval that determines the frequency of Hellos sent to neighbors that are inactive. You must set non-broadcast consistently across all interfaces that attach to the same subnetwork for OSPF to function correctly.

For Frame Relay or ATM networks, however, the **set non-broadcast** command is used to configure an OSPF interface as connecting to a non-broadcast multi-access network. If the **set non-broadcast** command is not used, the interface is assumed to be connected to a point-to-multipoint network. In Frame Relay networks, all OSPF interfaces must be configured as connecting to the same type of network (non-broadcast multi-access or point-to-multipoint), so if the **set non-broadcast** command is used for one router's interface, it must be configured on the interfaces for all routers attaching to the network.

Example: set non-broadcast

```
Interface IP address [0.0.0.0]? 128.185.138.19
Poll Interval [120]
```

The *interface IP address* has:

Valid Values: Any valid IP address.

Default Value: none
The NBMA Poll Interval is used to send Hello packets to inactive neighbors. (Inactive neighbors are those neighbors that the router has not heard from for a period greater than the Dead Router interval.) The router still polls these neighbors at a reduced rate. Set the NBMA Poll Interval much higher than the configured Hello Interval for the router.

Valid Values: 1 to 65535 seconds

Default Value: 120 seconds

Example: **`set non-broadcast`**

```
Interface IP address [0.0.0.0]? 128.185.138.19
Poll Interval [120]?
```

virtual-link

Configures virtual links between any two area border routers. To maintain backbone connectivity you must have all of your backbone routers interconnected either by permanent or virtual links. Virtual links are considered to be separate router interfaces connecting to the backbone area. Therefore, you are asked to also specify many of the interface parameters when configuring a virtual link.

Virtual links can be configured between any two backbone routers that have an interface to a common non-backbone area. Virtual links are used to maintain backbone connectivity and must be configured at both end-points.

Note: This OSPF implementation supports the use of virtual links when one end of the virtual link may be an unnumbered point to point line. For this configuration to work, the router id must be used as the source address in OSPF protocol messages sent over the virtual link. Use of the router id can be insured by configuring the internal IP address with the address used as the router id.

Another requirement for this configuration to work is that the OSPF implementations at both ends of the virtual link support it.

1. The *virtual endpoint (router ID)* defines the ID of the virtual neighbor.

   Valid Values: Any valid IP address.

   Default Value: none

2. The *link's transit area*. is the non-backbone, non-stub area through which the virtual link is configured. Virtual links can be configured between any two area border routers that have an interface to a common non-backbone and non-stub area. Virtual links must be configured in each of the link's two end-points.

   Valid Values: 0.0.0.1 to 255.255.255.255

   Default Value: 0.0.0.1

3. The timer values are the same values for all routers attached to a common network segment.

   a. The *retransmission interval* is the interval after which a Link Request for one or more link state advertisements will be resent.

      Valid Values: 1 to 65535 seconds

      Default Value: 10

   b. The *Transmission delay* parameter is an estimate of the number of seconds that it takes to transmit link-state information over the interface.

      Each link-state advertisement has a finite lifetime that is equal to the constant MaxAge (1 hour). As each link-state advertisement is sent to the particular interfaces, it is aged by this configured transmission delay. The minimum delay is 1 second.

      Valid Values: 1 to 65535 seconds

      Default Value: 5

   c. The *Hello Interval* is the interval between Hello packets sent on the interface.

      Valid Values: 1 to 255 seconds

      Default Value: 30

   d. The *Dead Router Interval* is the interval after which a router that has not sent a Hello will be considered dead. This parameter defaults to six times the configured Hello Interval and must be set to a value greater than the Hello Interval.

      Valid Values: 2 to 65535 seconds

      Default Value: 180

4. The *Authentication key*. defines the password used for this OSPF area. When password authentication is used, only packets with the correct authentication key are accepted.

Valid Values: any 1-8 characters

Default Value: a null string

Example: `set virtual-link`

```
Virtual endpoint  (Router ID) [0.0.0.0]? 128.185.138.21
Link's transit area [0.0.0.1]? 0.0.0.1
Retransmission Interval (in seconds) [10]?
Transmission Delay (in seconds) [5]?
Hello Interval (in seconds) [30]?
Dead Router Interval (in seconds) [180]?
Authentication Key []? ACEMAN
```

Accessing the OSPF Monitoring Environment

For information on how to access the OSPF monitoring environment, refer to *Getting Started (Introduction to the User Interface)* in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

OSPF Monitoring Commands

This section summarizes and then explains all the OSPF monitoring commands. These commands enable you to monitor the OSPF routing protocol. Table 18-2 lists the OSPF monitoring commands.

Enter the OSPF monitoring commands at the `OSPF>` prompt.

Table 18-2 (Page 1 of 2). OSPF Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Advertisement	Displays a link state advertisement belonging to the OSPF database.
Area summary	Displays OSPF area statistics and parameters.
AS external	Lists the AS external advertisements belonging to the OSPF link state database.
Database summary	Displays the advertisements belonging to an OSPF area's link state database.
Dump routing tables	Displays the OSPF routes contained in the routing table.
Interface summary	Displays OSPF interface statistics and parameters.
Join	Configures the router to belong to one or more multicast groups.
Leave	Removes the router from membership in multicast groups.
Mcache	Displays a list of currently active multicast forwarding cache entries.
Mgroups	Displays the group membership of the router's attached interfaces.
Mstats	Displays various multicast routing statistics.

Table 18-2 (Page 2 of 2). OSPF Monitoring Command Summary	
Command	Function
Neighbor summary	Displays OSPF neighbor statistics and parameters.
Ping	Continuously sends ICMP Echo Requests (or pings) a given destination, printing a line for each response received.
Routers	Displays the reachable OSPF area-border routers and AS-boundary routers.
Size	Displays the number of LSAs currently in the link state database, categorized by type.
Statistics	Displays OSPF statistics detailing memory and network usage.
Traceroute	Displays the complete route (hop-by-hop) to a given destination.
Weight	Dynamically changes the cost of an OSPF interface.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Advertisement Expansion

Use the **advertisement expansion** command to print the contents of a link state advertisement contained in the OSPF database. For a summary of the router's advertisements use the **database** command.

A link state advertisement is defined by its link state type, link state ID and its advertising router. There is a separate link state database for each OSPF area. Providing an area-id on the command line tells the software which database you want to search. The different kinds of advertisements, which depend on the value given for link-state-type, are:

- Router links - Contain descriptions of a single router's interface.
- Network links - Contain the list of routers attached to a particular interface.
- Summary nets - Contain descriptions of a single inter-area route.
- Summary AS boundary routers - Contain descriptions of the route to an AS boundary router in another area.
- AS external nets - Contain descriptions of a single route.
- Multicast group memberships - Contain descriptions of a particular group's membership in the neighborhood of the advertising router.

  Note: Link State IDs, advertising routers (specified by their router IDs), and area IDs take the same format as IP addresses. For example, the backbone area can be entered as 0.0.0.0.

Example 1 shows an expansion of a router links advertisement. The router's ID is 128.185.184.11. It is an AS boundary router and has three interfaces to the backbone area (all of cost 1). Multicast routing has been enabled. Detailed field descriptions are provided with the example.

This command has also been enhanced in two ways. First of all, when displaying router-LSAs and network-LSAs, the reverse cost of each router-to-router link and router-to-transit-network link is displayed, as well as the previously displayed forward cost. This is done because routing of multicast datagrams whose source

lies in different areas/Autonomous systems is based on reverse cost instead of forward cost. In those cases where there is no reverse link (which means that the link will never be used by the Dijkstra), the reverse cost is shown as “1-way.”

In addition, the LSA's OSPF options are displayed in the same manner as they were displayed in the detailed OSPF **neighbor** command.

New group-membership-LSAs can also be displayed. The “LS destination” of each group-membership-LSA is a group address. A router originates a group-membership-LSA for each group that has members on one or more of the router's attached networks. The group-membership-LSA for the group lists those attached transit networks having group members (the type “2” vertices), and when there are members belonging to one or more attached stub networks, or if the router itself is a member of the multicast group, a type “1” vertex whose ID is the router's OSPF router ID is included.

Syntax:

ad**vertisement** *ls-type link-state-id advertising-router area-id*

Example 1: `advertisement 1 128.185.184.11 0.0.0.0`

```
LS age:     173
LS options:  E,MC,DC
LS type:     1
LS destination (ID): 128.185.184.11
LS originator:   128.185.184.11
LS sequence no:  0x80000047
LS checksum:     0x122
LS length:       60
Router type:  ASBR,W
# router ifcs:   3
         Link ID:          128.185.177.31
         Link Data:        128.185.177.11
         Interface type:   2
                  No. of metrics: 0
                  TOS 0 metric:   3 (0)
         Link ID:          128.185.142.40
         Link Data:        128.185.142.11
         Interface type:   2
                  No. of metrics: 0
                  TOS 0 metric:   4 (0)
         Link ID:          128.185.184.0
         Link Data:        255.255.255.0
         Interface type:   3
                  No. of metrics: 0
                  TOS 0 metric:   1
```

LS age — Indicates the age of the advertisement in seconds.

LS options — Indicates the optional OSPF capabilities supported by the piece of the routing domain described by the advertisement. These capabilities are denoted by E (processes type 5 externals; when this is not set to the area to which the advertisement belongs has been configured as a stub), T (can route based on TOS), MC (can forward IP multicast datagrams), and DC (is capable of demand circuit processing).

LS type — Classifies the advertisement and dictates its contents: 1 (router links advertisement), 2 (network link advertisement), 3 (summary link advertisement), 4 (summary ASBR advertisement), 5 (AS external link) and 6 (group-membership advertisement).

LS destination	Identifies what is being described by the advertisement. Depends on the advertisement type. For router links and ASBR summaries, it is the OSPF router ID. For network links, it is the IP address of the network's designated router. For summary links and AS external links, it is a network/subnet number. For group-membership advertisements, it is a particular multicast group.
LS originator	OSPF router ID of the originating router.
LS sequence number	Used to distinguish separate instances of the same advertisement. Should be looked at as a signed 32-bit integer. Starts at 0x80000001, and increments by one each time the advertisement is updated.
LS checksum	A checksum of advertisement contents, used to detect data corruption.
LS length	The size of the advertisement in bytes.
Router type	Indicates the level of function of the router. ASBR means that the router is an AS boundary router, ABR that the router is an area border router, and W that the router is a wildcard multicast receiver.
# Router ifcs	The number of router interfaces described in the advertisement.
Link ID	Indicates what the interface connects to. Depends on Interface type. For interfaces to routers (i.e., point-to-point links), the Link ID is the neighbor's router ID. For interfaces to transit networks, it is the IP address of the network designated router. For interfaces to stub networks, it is the network's network/subnet number.
Link Data	4 bytes of extra information concerning the link, it is either the IP address of the interface (for interfaces to point-to-point networks and transit networks), or the subnet mask (for interfaces to stub networks).
Interface type	One of the following: 1 (point-to-point connection to another router, 2 (connection to transit network), 3 (connection to stub network) or 4 (virtual link).
No. of metrics	The number of non-zero TOS values for which metrics are provided for this interface.
TOS 0 metric	The cost of the interface. In parenthesis the reverse cost of the link is given (derived from another advertisement). If there is no reverse link, “1-way” is displayed.

The LS age, LS options, LS type, LS destination, LS originator, LS sequence no, LS checksum and LS length fields are common to all advertisements. The Router type and # router ifcs are seen only in router links advertisements. Each link in the router advertisement is described by the Link ID, Link Data, and Interface type fields. Each link can also be assigned a separate cost for each IP Type of Service (TOS); this is described by the No. of metrics and TOS 0 metric fields (the router currently does not route based on TOS, and looks at the TOS 0 cost only).

Example 2 shows an expansion of a group-membership advertisement. A group-membership advertisement for a given group/advertising router combination lists those networks directly attached to the advertising router which have group members. It also lists whether the router itself is a member of the specified group. The example below shows that network 128.185.184.0 has members of group 224.0.1.1.

Example 2: `adv 6 224.0.1.1 128.185.184.114`

```
For which area '0.0.0.0'?

LS age:     168
LS options:  E
LS type:     6
LS destination (ID): 224.0.1.1
LS originator:   128.185.184.114
LS sequence no:  0x80000001
LS checksum:     0x7A3
LS length:       28
Vertex type: 2
Vertex ID:   128.185.184.114
```

Vertex type — Describes the object having group members, one of: 1 (the router itself, or stub networks attached to the router) or 2 (a transit network).

Vertex ID — When the vertex type is 1, always the advertising router's ID. When the vertex type is 2, the IP address of the transit network's designated router.

Area Summary

Use the **area summary** command to display the statistics and parameters for all OSPF areas attached to the router.

In the example below, the router attaches to a single area (the backbone area). A simple password scheme is being used for the area's authentication. The router has three interfaces attaching to the area, and has found 4 transit networks, 7 routers and no area border routers when doing the SPF tree calculation for the backbone.

Syntax:

ar**ea**

Example:

```
Area ID      Authentication   #ifcs  #nets  #rtrs  #brdrs
0.0.0.0       Simple-pass       3      4      7      0
```

ifcs — Indicates the number of router interfaces attached to the particular area. These interfaces are not necessarily functional.

nets — Indicates the number of transit networks that have been found while doing the SPF tree calculation for this area.

rtrs — Indicates the number of routers that have been found when doing the SPF tree calculation for this area.

brdrs — Indicates the number of area border routers that have been found when doing the SPF tree calculation for this area.

AS-external advertisements

Use the **AS-external advertisements** command to list the AS external advertisements belonging to the OSPF routing domain. One line is printed for each advertisement. Each advertisement is defined by the following three parameters: its link state type (always 5 for AS external advertisements), its link state ID (called the LS destination), and the advertising router (called the LS originator).

Syntax:

as**-external**

Example: `as-external`

```
Type LS destination LS originator  Seqno      Age  Xsum
  5  0.0.0.0       128.185.123.22  0x80000084 430  0x41C7
  5  128.185.131.0 128.185.123.22  0x80000080 450  0x71DC
  5  128.185.132.0 128.185.123.22  0x80000080 450  0x66E6
  5  128.185.144.0 128.185.123.22  0x80000002 329  0xF2CA
  5  128.185.178.0 128.185.123.22  0x80000081 450  0x72AA
  5  128.185.178.0 128.185.129.40  0x80000080 382  0xDD28
  5  129.9.0.0     128.185.123.22  0x80000082 451  0x4F30
  5  129.9.0.0     128.185.126.24  0x80000080 676  0x324A
  5  134.216.0.0   128.185.123.22  0x80000082 451  0x505A
  5  134.216.0.0   128.185.126.24  0x80000080 676  0x3374
  5  192.9.3.0     128.185.123.22  0x80000082 451  0xF745
  5  192.9.3.0     128.185.126.24  0x80000080 677  0xDA5F
  5  192.9.12.0    128.185.123.22  0x80000082 452  0x949F
  5  192.9.12.0    128.185.128.41  0x80000080 679  0x31B2
  5  192.26.100.0  128.185.123.22  0x80000081 452  0xFDCD
  5  192.26.100.0  128.185.126.24  0x80000080  21  0xDEE8
                              etc.
            # advertisements:             133
            Checksum total:               0x43CC41
```

Type	Always 5 for AS external advertisements.
LS destination	Indicates an IP network/subnet number. These network numbers belong to other Autonomous Systems.
LS originator	Advertising router.
Seqno, Age, Xsum	It is possible for several instances of an advertisement to be present in the OSPF routing domain at any one time. However, only the most recent instance is kept in the OSPF link state database (and printed by this command). The LS sequence number (Seqno), LS age (Age) and LS checksum fields (Xsum) are compared to see which instance is most recent. The LS age field is expressed in seconds. Its maximum value is 3600.

At the end of the display, the total number of AS external advertisements is printed, along with a checksum total over all of their contents. The checksum total is simply the 32-bit sum (carries discarded) of the individual advertisement's LS checksum fields. This information can be used to quickly determine whether two OSPF routers have synchronized databases.

Database Summary

Use the **database summary** command to display a description of the contents of a particular OSPF area's link state database. AS external advertisements are omitted from the display. A single line is printed for each advertisement. Each advertisement is defined by the following three parameters: its link state type (called Type), its link state ID (called the LS destination) and the advertising router (called the LS originator).

Syntax:

da**tabase** *area-id*

Example: `database 0.0.0.0`

```
Type LS destination LS originator    Seqno     Age  Xsum
  1  128.185.123.22 128.185.123.22 0x80000084  442 0xCE2D
  1  128.185.125.38 128.185.125.38 0x80000082  470 0x344D
  1  128.185.126.24 128.185.126.24 0x80000088 1394 0xCC47
  1  128.185.128.41 128.185.128.41 0x80000082  471 0x16A2
  1  128.185.129.25 128.185.129.25 0x8000008D 1624 0x8B64
  1  128.185.129.40 128.185.129.40 0x8000008A 1623 0xABBE
  1  128.185.136.39 128.185.136.39 0x80000082  469 0x5045
  2  128.185.125.40 128.185.129.40 0x80000049  457 0xA31
  2  128.185.126.25 128.185.129.25 0x80000002 1394 0x56B8
  2  128.185.127.24 128.185.126.24 0x8000007F 1031 0x592D
  2  128.185.129.25 128.185.129.25 0x8000005F 2295 0x8219
  2  128.185.129.40 128.185.129.40 0x80000001 1623 0x12C9
  6  224.0.2.6      128.185.142.9  0x8000003D  232 0x513F
  6  224.0.2.6      128.185.184.11 0x80000003  376 0x2250

              # advertisements:             14
              Checksum total:              0x4BBC2
```

Type	Separate LS types are numerically displayed: type 1 (router links advertisements), type 2 (network links advertisements), type 3 (network summaries), type 4 (AS boundary router summaries), and type 6 (group-membership-LSAs).
LS destination	Indicates what is being described by the advertisement.
LS originator	Advertising router.
Seqno, Age, Xsum	It is possible for several instances of an advertisement to be presenting the OSPF routing domain at any one time. However, only the most recent instance is kept in the OSPF link state database (and printed by this command). The LS sequence number (Seqno), LS age (Age) and LS checksum fields (Xsum) are compared to see which instance is most recent. The LS age field is expressed in seconds. Its maximum value is 3600.

At the end of the display, the total number of advertisements in the area database is printed, along with a checksum total over all of their contents. The checksum total is simply the 32-bit sum (carries discarded) of the individual advertisement's LS checksum fields. This information can be used to quickly determine whether two OSPF routers have synchronized databases.

Note: When comparing multicast-capable to non-multicast routers, the above database checksum (and also # advertisements) will not necessarily match, because non-multicast routers do not handle or store group-membership-LSAs. Also, if demand circuit processing is active in the OSPF routing domain or OSPF stub area, the database checksum will most likely be different among routers with demand circuits. Refer to RFC 1793 for more information.

Dump Routing Tables

Use the **dump routing tables** command to display all the routes that have been calculated by OSPF and are now present in the routing table. Its output is similar in format to the IP monitoring's dump routing tables command.

Syntax:

dump

Example: `dump`

```
Type   Dest net         Mask     Cost Age   Next hop(s)
SPE1   0.0.0.0          00000000  4    3    128.185.138.39
SPF*   128.185.138.0    FFFFFF00  1    1    Eth/0
Sbnt   128.185.0.0      FFFF0000  1    0    None
SPF    128.185.123.0    FFFFFF00  3    3    128.185.138.39
SPF    128.185.124.0    FFFFFF00  3    3    128.185.138.39
SPF    192.26.100.0     FFFFFF00  3    3    128.185.131.10
RIP    197.3.2.0        FFFFFF00  10   30   128.185.131.10
RIP    192.9.3.0        FFFFFF00  4    30   128.185.138.21
Del    128.185.195.0    FFFFFF00  16   270  None

Default gateway in use.

Type Cost Age  Next hop
SPE1 4    3    128.185.138.39

Routing table size: 768 nets (36864 bytes), 36 nets known
```

Type (route type)
: Indicates how the route was derived.

  Sbnt - Indicates that the network is subnetted; such an entry is a place-holder only.

  Dir - Indicates a directly connected network or subnet.

  RIP - Indicates the route was learned through the RIP protocol.

  Del - Indicates the route has been deleted.

  Stat - Indicates a statically configured route.

  BGP - Indicates routes learned through the BGP protocol.

  BGPR - Indicates routes learned through the BGP protocol that are readvertised by OSPF and RIP.

  Fltr - Indicates a routing filter.

  SPF - Indicates that the route is an OSPF intra-area route.

  SPIA - Indicates that it is an OSPF inter-area routes.

  SPE1, SPE2 - Indicates OSPF external routes (type 1 and 2 respectively).

  Rnge - Indicates a route type that is an active OSPF area address range and is not used in forwarding packets.

Dest net
: IP destination network/subnet.

Mask
: IP address mask.

Cost
: Route Cost.

Age
: For RIP and BGP routes, the time that has elapsed since the routing table entry was last refreshed.

Next Hop
: IP address of the next router on the path toward the destination host. Also displayed is the interface type used by the sending router to forward the packet.

An asterisk (*) after the route type indicates the route has a static or directly connected backup. A percent sign (%) after the route type indicates that RIP updates will always be accepted for this network/subnet.

A number in parentheses at the end of the column indicates the number of equal-cost routes to the destination. The first hops belonging to these routes can be displayed with the IP monitoring's **route** command.

Interface Summary

Use the **interface summary** command to display statistics and parameters related to OSPF interfaces. If no arguments are given (see Example 1), a single line is printed summarizing each interface. If an interface's IP address is given (see Example 2), detailed statistics for that interface will be displayed.

Syntax:

interface *interface-ip-address*

Example 1: `interface`

```
Ifc Address      Phys    assoc. Area     Type   State   #nbrs #adjs
9.67.217.66      TKR/0   2.2.2.2        Brdcst   64        0    0
```

Ifc Address	Interface IP address.
Phys	Displays the physical interface.
Assoc Area	Attached area ID.
Type	Can be either Brdcst (broadcast, e.g., an Ethernet interface), P-P (a point-to-point network, e.g., a synchronous serial line), P-2-MP (point-to-multipoint, e.g., a Frame-Relay network), Multi (non-broadcast, multi-access, e.g., an X.25 connection) or VLink (an OSPF virtual link).
State	Can be one of the following: 1 (down), 2 (looped back), 4 (waiting), 8 (point-to-point), 16 (DR other), 32 (backup DR) or 64 (designated router).
#nbrs	Number of neighbors. This is the number of routers whose hellos have been received, plus those that have been configured.
#adjs	Number of adjacencies. This is the number of neighbors in state Exchange or greater. These are the neighbors with whom the router has synchronized or is in the process of synchronization.

Example 2: `interface 128.185.125.22`

```
Interface address:      128.185.125.22
Attached area:          0.0.0.1
Physical interface:     Eth/1
Interface mask:         255.255.255.0
Interface type:         Brdcst
State:                  32

Designated Router:      128.185.184.34
            Backup DR:              128.185.184.11

DR Priority:       1  Hello interval:   10  Rxmt interval:     5
Dead interval:    40  TX delay:          1  Poll interval:     0
Demand Circuit   off  Max pkt size:   2044  TOS 0 cost:        1

# Neighbors:       0  # Adjacencies:     0  # Full adjs.:      0
# Mcast floods:    0  # Mcast acks:      0

MC forwarding:    on  DL unicast:      off  IGMP monitor:     on
# MC data in:      0  # MC data acc:     0  # MC data out:     0

Network Capabilities:    Broadcast    Real Network
IGMP polls snt:   75  IGMP polls rcv:    0  Unexp polls:       0

IGMP reports:      0
```

Interface Address	Interface IP address.
Attached Area	Attached area ID.

Physical interface	Displays physical interface type and number.
Interface Mask	Displays interface subnet mask.
Interface type	Can be either Brdcst (broadcast, e.g., an Ethernet interface), PP (a point-to-point network, e.g., a synchronous serial line), P-2-MP (point-to-multipoint, e.g., a Frame-Relay network), Multi (non-broadcast, multi-access, e.g., an X.25 connection) and VLink (an OSPF virtual link).
State	Can be one of the following: 1 (Down), 2 (Looped back), 4 (Waiting), 8 (Point-to-Point), 16 (DR other), 32 (Backup DR), 64 (Designated router) or 128 (Full).
Designated Router	IP address of the designated router.
Backup DR	IP address of the backup designated router.
DR Priority	Displays priority assigned to designated router.
Hello interval	Displays the current hello interval value.
Rxmt interval	Displays the current retransmission interval value.
Dead interval	Displays the current dead interval value.
TX delay	Displays the current transmission delay value.
Poll interval	Displays the current poll interval value.
Max pkt size	Displays the maximum size for an OSPF packet sent out this interface.
Demand circuit	Indicates whether or not demand circuit processing is active on the interface.
TOS 0 cost	Displays the interface's TOS 0 cost.
# Neighbors	Number of neighbors. This is the number of routers whose hellos have been received, plus those that have been configured.
# Adjacencies	Number of adjacencies. This is the number of neighbors in state Exchange or greater.
# Full adj	Number of full adjacencies. The number of full adjacencies is the number of neighbors whose state is Full (and therefore, with which the router has synchronized databases).
# Mcast Floods	Number of link state updates flooded out the interface (not counting retransmissions).
# Mcast acks	Number of link state acknowledgments flooded out the interface (not counting retransmissions).
MC forwarding	Displays whether multicast forwarding has been enabled for the interface.
DL unicast	Displays whether multicast datagrams are to be forwarded as data-link multicasts or as data-link unicasts.
IGMP monitor	Displays whether IGMP is enabled on the interface.
# MC data in	Displays the number of multicast datagrams that have been received on this interface and then successfully forwarded.
# MC data acc	Displays the number of multicast datagrams that have been successfully forwarded.
# MC data out	Displays the number of datagrams that have been forwarded out the interface (either as data-link multicasts or data-link unicasts).
Network Capabilities	Displays the network capabilities for the interface.

IGMP polls sent	Displays the number of IGMP Host Membership Queries that have been sent out the interface.
IGMP polls rcv	Displays the number of IGMP Host Membership Queries that have been received on the interface.
Unexp polls	Displays the number of IGMP Host Membership Queries that have been received on the interface that were unexpected (that is, received when the router itself was sending them).
IGMP reports	Displays the number of IGMP Host Membership Reports received on the interface.
Nbr node: type and ID	Displays the identity of the upstream node if the router were supposed to receive datagrams on this interface. Type here is an integer from 1 to 3, with 1 indicating router, 2 indicating transit net and 3 indicating stub net.

Join

Use the **join** command to establish the router as a member of a multicast group.

This command is similar to the join command in the OSPF configuration monitoring with two differences:

- The effect on group membership is immediate when the commands are given from the OSPF monitor (that is, a restart/reload is not required). Similarly, the IP groups joined are not retained across router restarts and reloads.
- The command keeps track of the number of times a particular group is “joined.”

When the router is the member of a multicast group, it responds to pings and SNMP queries sent to the group address.

Syntax:

j**oin** *multicast-group-address*

Example: **`join 224.185.0.0`**

Leave

Use the **leave** command to remove a router's membership in a multicast group. This will keep the router from responding to pings and SNMP queries sent to the group address.

This command is similar to the leave command in the OSPF configuration monitoring with two differences:

- The effect on group membership is immediate when the commands are given from the OSPF monitor (i.e., a restart/reload is not required).
- The command will not delete group membership until the “leaves” executed equals the number of “joins” previously executed. Similarly, the IP multicast groups left are not retained across router restarts and unloads.

Syntax:

l**eave** *multicast-group-address*

Example: **`leave 224.185.0.0`**

Mcache

Use the **mcache** command to display a list of currently active multicast cache entries. Multicast cache entries are built on demand, whenever the first matching multicast datagram is received. There is a separate cache entry (and therefore a separate route) for each datagram source network and destination group combination.

Cache entries are cleared on topology changes (e.g., a point-to-point line in the MOSPF system going up or down), and on group membership changes.

Syntax:

mc**ache**

Example 1: `mcache`

```
     0: TKR/0          1: SDLC/0          2: FR/0
     3: Internal

Source          Destination     Count   Upst    Downstream
133.1.169.2     225.0.1.10      8       Local   2 (4),3
133.1.169.2     225.0.1.20      8       Local   2 (4),3
3.3.3.3         225.0.1.10      8       2       3
```

Source	Source network/subnet of matching datagrams.
Destination	Destination group of matching datagrams.
Count	Displays the number of received datagrams that have matched the cache entry.
Upst	Displays the neighboring network/router from which the datagram must be received in order to be forwarded. When this reads as “none,” the datagram will never be forwarded.
Downstream	Displays the total number of downstream interfaces/neighbors to which the datagram will be forwarded. When this is 0, the datagram will not be forwarded.

There is more information in a multicast forwarding cache entry. A cache entry can be displayed in detail by providing the source and destination of a matching datagram on the command line. If a matching cache entry is not found, one is built. A sample of this command is shown in Example 2.

Example 2: `mcache 128.185.182.9 224.0.1.2`

```
source Net:     128.185.182.0
Destination:    224.0.1.2
Use Count:      472
Upstream Type:  Transit Net
Upstream ID:    128.185.184.114
Downstream:     128.185.177.11 (TTL = 2)
```

In addition to the information shown in the short form of the mcache command, the following fields are displayed:

Upstream Type	Indicates the type of node from which the datagram must be received in order to be forwarded. Possible values for this field are “none” (indicating that the datagram will not be forwarded), “router” (indicating that the datagram must be received over a point-to-point connection), “transit network,” “stub network,” and “external” indicating that the datagram is expected to be received from another Autonomous System).

Downstream — Prints a separate line for each interface or neighbor to which the datagram will be sent. A TTL value is also given, indicating that datagrams forwarded out of or to this interface must have at least the specified TTL value in their IP header. When the router is itself a member of the multicast group, a line specifying “internal Application” appears as one of the downstream interfaces/neighbors.

Mgroups

Use the **mgroups** command to display the group membership of the router's attached interfaces. Only the group membership for those interfaces on which the router is either designated router or backup designated router are displayed.

Syntax:

mg**roups**

Example: `mgroups`

```
                Local Group Database
 Group             Interface                Lifetime (secs)

224.0.1.1         128.185.184.11 (Eth/1)       176
224.0.1.2         128.185.184.11 (Eth/1)       170
224.1.1.1         Internal                     1
```

Group — Displays the group address as it has been reported (via IGMP) on a particular interface.

Interface — Displays the interface address to which the group address has been reported (via IGMP).

The router's internal group membership is indicated by a value of “internal.” For these entries, the lifetime field (see below) indicates the number of applications that have requested membership in the particular group.

Lifetime — Displays the number of seconds that the entry will persist if Membership Reports cease to be heard on the interface for the given group.

Mstats

Use the **mstats** command to display various multicast routing statistics. The command indicates whether multicast routing is enabled and whether the router is an inter-area and/or inter-AS multicast forwarder.

Syntax:

ms**tats**

Example: `mstats`

```
                MOSPF forwarding:       Enabled
                Inter-area forwarding:  Enabled
                DVMRP forwarding:       Disabled

Datagrams received:            2496  Datagrams (ext source):    0
Datagrams fwd (multicast):        0  Datagrams fwd (unicast):   0
Locally delivered:                0  No matching rcv interface: 0
Unreachable source:               3  Unallocated cache entries: 0
Off multicast tree:               0  Unexpected DL multicast:   0
Buffer alloc failure:             0  TTL scoping:               0

# DVMRP routing entries:          0  # DVMRP entries freed:     0
# fwd cache alloc:                1  # fwd cache freed:         0
# fwd cache GC:                   0  # local group DB alloc:    0
# local group DB free:            1
```

MOSPF forwarding	Displays whether the router will forward IP multicast datagrams.
Inter-area forwarding	Displays whether the router will forward IP multicast datagrams between areas.
DVMRP forwarding	Displays whether the router is configured to use DVMRP for multicast routing.
Datagrams received	Displays the number of multicast datagrams received by the router (datagrams whose destination group lies in the range 224.0.0.1 - 224.0.0.255 are not included in this total).
Datagrams (ext source)	Displays the number of datagrams that have been received whose source is outside the AS.
Datagrams fwd (multicast)	Displays the number of datagrams that have been forwarded as data-link multicasts (this includes packet replications, when necessary, so this count could very well be greater than the number received).
Datagrams fwd (unicast)	Displays the number of datagrams that have been forwarded as data-link unicasts.
Locally delivered	Displays the number of datagrams that have been forwarded to internal applications.
No matching rcv interface	Displays the count of those datagrams that were received by a non-inter-AS multicast forwarder on a non-MOSPF interface.
Unreachable source	Displays a count of those datagrams whose source address was unreachable.
Unallocated cache entries	Displays a count of those datagrams whose cache entries could not be created due to resource shortages.
Off multicast tree	Displays a count of those datagrams that were not forwarded either because there was no upstream neighbor or no downstream interfaces/neighbors in the matching cache entry.
Unexpected DL multicast	Displays a count of those datagrams that were received as data-link multicasts on those interfaces that have been configured for data-link unicast.
Buffer alloc failure	Displays a count of those datagrams that could not be replicated because of buffer shortages.
TTL scoping	Indicates those datagrams that were not forwarded because their TTL indicated that they could never reach a group member.
DVMRP routing entries	Displays the number of DVMRP routing entries
DVMRP entries freed	Indicates the number of DVMRP entries that have been freed. The size will be the number of routing entries minus the number of entries freed.

# fwd cache alloc	Indicates the number of cache entries allocated. The current forwarding cache size is the number of entries allocated (“# fwd cache alloc”) minus the number of cache entries freed (“# fwd cache freed”).
# fwd cache freed	Indicates the number of cache entries freed. The current forwarding cache size is the number of entries allocated (“# fwd cache alloc”) minus the number of cache entries freed (“# fwd cache freed”).
# fwd cache GC	Indicates the number of cache entries were cleared because they were not recently used and the cache overflowed.
# local group DB alloc	Indicates the number of local group database entries allocated. The number allocated (“# local group DB alloc”) minus the number freed (“# local group DB free”) equals the current size of the local group database.
# local group DB free	Indicates the number of local group database entries freed. The number allocated (“# local group DB alloc”) minus the number freed (“# local group DB free”) equals the current size of the local group database.

The number of cache hits can be calculated as the number of datagrams received (“Datagrams received”) minus the total of datagrams discarded due to “No matching rcv interface,” “Unreachable source” and “Unallocated cache entries,” and minus “# local group DB alloc.” The number of cache misses is simply “# local group DB alloc.”

Neighbor Summary

Use the **neighbor summary** command to display statistics and parameters related to OSPF neighbors. If no arguments are given (see Example 1), a single line is printed summarizing each neighbor. If a neighbor's IP address is given (see Example 2), detailed statistics for that neighbor will be displayed.

Syntax:

n**eighbor** *neighbor-ip-address*

Example 1: `neighbor`

```
Neighbor addr   Neighbor ID     State  LSrxl  DBsum  LSreq  Ifc
128.185.125.39  128.185.136.39  128      0      0      0   PPP/1
128.185.125.41  128.185.128.41    8      0      0      0   PPP/1
128.185.125.38  128.185.125.38    8      0      0      0   PPP/1
128.185.125.25  128.185.129.25    8      0      0      0   PPP/1
128.185.125.40  128.185.129.40  128      0      0      0   PPP/1
128.185.125.24  128.185.126.24    8      0      0      0   PPP/1
```

Neighbor addr	Displays the neighbor address.
Neighbor ID	Displays the neighbor's OSPF router ID.
Neighbor State	Can be one of the following: 1 (Down), 2 (Attempt), 4 (Init), 8 (2-Way), 16 (ExStart), 32 (Exchange), 64 (Loading) or 128 (Full).
LSrxl	Displays the size of the current link state retransmission list for this neighbor.
DBsum	Displays the size of the database summary list waiting to be sent to the neighbor.
LSreq	Displays the number of more recent advertisements that are being requested from the neighbor.
Ifc	Displays the interface shared by the router and the neighbor.

Example 2: `neighbor 128.185.138.39`

The meaning of most of the displayed fields is given in section 10 of the OSPF specification (RFC 1583) .

```
           Neighbor IP address:    128.185.184.34
           OSPF Router ID:         128.185.207.34
           Neighbor State:         128
           Physical interface:     Eth/1
           DR choice:              128.185.184.34
           Backup choice:          128.185.184.11
           DR Priority:            1
           Nbr options:            E,MC


DB summ qlen:      0  LS rxmt qlen:      0  LS req qlen: 0
Last hello:        7  No Hello         Off

# LS rxmits:     108  # Direct acks:    13  # Dup LS rcvd: 572
# Old LS rcvd:     2  # Dup acks rcv:  111  # Nbr losses:   29
# Adj. resets:    30
```

Neighbor IP addr	Neighbor IP address.
OSPF router ID	Neighbor's OSPF router ID.
Neighbor State	Can be one of the following: 1 (Down), 2 (Attempt), 4 (Init), 8 (2-Way), 16 (ExStart), 32 (Exchange), 64 (Loading) or 128 (Full).
Physical interface	Displays physical interface type and number of the router and neighbor's common network.
DR choice, backup choice, DR priority	Indicate the values seen in the last hello received from the neighbor.
Nbr options	Indicates the optional OSPF capabilities supported by the neighbor. These capabilities are denoted by E (processes type 5 externals; when this is not set the area to which the common network belongs has been configured as a stub), T (can route based on TOS) and MC (can forward IP multicast datagrams). This field is valid only for those neighbors in state Exchng or greater.
DBsumm qlen	Indicates the number of advertisements waiting to be summarized in Database Description packets. It should be zero except when the neighbor is in state Exchange.
LS rxmt qlen	Indicates the number of advertisements that have been flooded to the neighbor, but not yet acknowledged.
LS req qlen	Indicates the number of advertisements that are being requested from the neighbor in state Loading.
Last hello	Indicates the number of seconds since a hello has been received from the neighbor.
# LS rxmits	Indicates the number of retransmissions that have occurred during flooding.
# direct acks	Indicates responses to duplicate link state advertisements.
# Dup LS rcvd	Indicates the number of duplicate retransmissions that have occurred during flooding.
# Old LS rcvd	Indicates the number of old advertisements received during flooding.
# Dup acks rcvd	Indicates the number of duplicate acknowledgments received.
# Nbr losses	Indicates the number of times the neighbor has changed to Down state.

Adj. resets Counts entries to state ExStart.

Ping

See “Ping” on page 16-44 for an explanation of the **Ping** command.

Traceroute

See “Traceroute” on page 16-47 for an explanation of the **Traceroute** command.

Routers

Use the **routers** command to display all router routes that have been calculated by OSPF and are now present in the routing table. With the **dump routing tables** command, the Net field indicates that the destination is a network. The routers command covers all other destinations.

Syntax:

routers

Example:

```
DType RType Destination       AREA          Cost   Next hop(s)

 ASBR  SPF   128.185.142.9    0.0.0.1         1   128.185.142.9
 Fadd  SPF   128.185.142.98   0.0.0.1         1    0.0.0.0
 Fadd  SPF   128.185.142.7    0.0.0.1         1    0.0.0.0
 Fadd  SPF   128.185.142.48   0.0.0.1         1    0.0.0.0
 Fadd  SPF   128.185.142.111  0.0.0.1         1    0.0.0.0
 Fadd  SPF   128.185.142.38   0.0.0.1         1    0.0.0.0
 Fadd  SPF   128.185.142.11   0.0.0.1         1    0.0.0.0
   BR  SPF   128.185.142.9    0.0.0.2         1   128.185.142.9
   BR  SPF   128.185.142.9    0.0.0.2         2   128.185.184.114
 Fadd  SPF   128.185.142.47   0.0.0.2         1    0.0.0.0
```

DType — Indicates destination type:

- Net — indicates that the destination is a network
- ASBR — indicates that the destination is an AS boundary router
- ABR — indicates that the destination is an area border router
- Fadd — indicates a forwarding address (for external routes)

RType — Indicates route type and how the route was derived:

- SPF — indicates that the route is an intra-area route (comes from the Dijkstra calculation)
- SPIA — indicates that it is an inter-area route (comes from considering summary link advertisements).

Destination — Destination router's OSPF ID. For Type D entries, one of the router's IP addresses is displayed (which corresponds to a router in another AS).

Area — Displays the AS area to which it belongs.

Cost — Displays the route cost.

Next hop — Address of the next router on the path toward the destination host. A number in parentheses at the end of the column indicates the number of equal-cost routes to the destination.

Size

Use the **size** command to display the number of LSAs currently in the link state database, categorized by type.

Syntax:

si**ze**

Example:

```
# Router-LSAs:            6
# Network-LSAs:           2
# Summary-LSAs:           45
# Summary Router-LSAs:    6
# AS External-LSAs:       2
# Group-membership-LSAs:  11

# Intra-area routes:      11
# Inter-area routes:      15
# Type 1 external routes: 0
# Type 2 external routes: 2
```

Statistics

Use the **statistics** command to display statistics generated by the OSPF routing protocol. The statistics indicate how well the implementation is performing, including its memory and network utilization. Many of the fields displayed are confirmation of the OSPF configuration.

Syntax:

st**atistics**

Example:

```
S/W version:            2.1
OSPF Router ID:         128.185.184.11
External comparison:    Type 2
AS boundary capability: Yes
Import external routes: BGP RIP STA DIR SUB
Orig. default route:    No (0,0.0.0.0)
Default route cost:     (1, Type 2)
Default forward. addr:  0.0.0.0

Attached areas:               1  Estimated # external routes: 10
Estimated # OSPF routers:    30  Estimated heap usage:      2368
OSPF packets rcvd:            0  OSPF packets rcvd w/ errs:   0
Transit nodes allocated:      6  Transit nodes freed:         0
LS adv. allocated:           24  LS adv. freed:               2
Queue headers alloc:         32  Queue headers avail:         3
Maximum LSA size           2048


 # Dijkstra runs:             1  Incremental summ. updates:   0
Incremental VL updates:       0  Buffer alloc failures:       0
Multicast pkts sent:        625  Unicast pkts sent:           0
LS adv. aged out:             0  LS adv. flushed:             0

External LSA database:
Current state:           Normal
Number of LSAs:               9
Number of overflows           0
```

S/W version — Displays the current OSPF software revision level.

OSPF Router ID — Displays the router's OSPF ID.

External comparison	Displays the external route type used by the router when importing external routes.
AS boundary capability	Displays whether external routes will be imported.
Import external routes	Displays which external routes will be imported.
Orig default route	Displays whether the router will advertise an OSPF default route. If the value is “Yes” and a nonzero number is displayed in parentheses, then a default route will be advertised only when a route to the network exists.
Default route cost	Displays the cost and type of the default route (if advertised).
Default forward addr	Displays the forwarding address specified in the default route (if advertised).
Attached areas	Indicates the number of areas that the router has active interfaces to.
Estimated heap usage	Rough indication of the size of the OSPF link state database (in bytes).
Transit nodes	Allocated to store router links and network links advertisements.
LS adv.	Allocated to store summary link and AS external link advertisements.
Queue headers	Form lists of link state advertisements. These lists are used in the flooding and database exchange processes; if the number of queue headers allocated is not equal to the number freed, database synchronization with some neighbor is in progress.
# Dijkstra runs	Indicates how many times the OSPF routing table has been calculated from scratch.
Maximum LSA size	The maximum size LSA that can be originated by this router. This is the minimum of the value configured through OSPF configuration and the maximum packet size computed or configured through general configuration.
Incremental summ updates, incremental VL updates	Indicate that new summary link advertisements have caused the routing table to be partially rebuilt.
Buffer alloc failures.	Indicate buffer allocation failures. The OSPF system will recover from temporary lack of packet buffers.
Multicast pkts sent	Covers OSPF hello packets and packets sent during the flooding procedure.
Unicast pkts sent	Covers OSPF packet retransmissions and the Database Exchange procedure.
LS adv. aged out	Counts the number of advertisements that have hit 60 minutes. Link state advertisements are aged out after 60 minutes. Usually they will be refreshed before this time.
LS adv. flushed	Indicates number of advertisements removed (and not replaced) from the link state database.
Incremental ext. updates.	Displays number of changes to external destinations that are incrementally installed in the routing table.

External LSA database:

Provides information about the LSA database:

Current state
: Whether the database of current AS external LSAs is in normal or overload state.

Number of LSA
: The number of external LSAs currently in the database

Number of overflows
: Number of times the external AS LSA database has entered overload state.

Weight

Use the **weight** command to change the cost of one of the routers OSPF interfaces. This new cost is immediately flooded throughout the OSPF routing domain, causing routes to be updated accordingly.

The cost of the interface will revert to its configured cost whenever the router is restarted or reloaded. To make the cost change permanent, you must reconfigure the appropriate OSPF interface after invoking the weight command. This command will cause a new router links advertisement to be originated, unless the cost of the interface does not change.

Syntax:

w**eight** *ip-interface-address new-cost*

Example: `weight 128.185.124.22 2`

Chapter 19. Using SNMP

This chapter describes SNMP.

Network Management

Refer to the *Planning and Setup Guide* for information about Network Management.

SNMP Management

The server provides a Simple Network Management Protocol (SNMP) interface to network management platforms and applications, such as IBM NetView for AIX and the Nways Campus Manager products.

SNMP is used for monitoring and managing IP hosts in an IP network and uses software called an SNMP agent to enable network hosts to read and modify some of the server's operational parameters. In this way, SNMP establishes network management for the IP community.

You need to consider the following aspects of SNMP when you configure SNMP for your server.

Community

The community allows you to define the IP address of the SNMP management station that is allowed to access the information in the SNMP agent's Management Information Base (MIB). You define a community name for use in accessing the MIB.

Authentication

The community name is used as an authentication scheme to prevent unauthorized users from learning information about an SNMP agent or modifying its characteristics.

This scheme involves defining one or more sets of MIB data (referred to as MIB views) and associating an access privilege (read-only, read-write), an IP mask, and a community name with each MIB view. The IP mask establishes which IP addresses can originate access requests for a given MIB view and the community name serves as a password that must be matched by the SNMP requests. The community name is included in each SNMP message and verified by the IBM 8210 SNMP agent. An SNMP request will be rejected if it does not provide the correct community name, does not match the IP mask, or attempts an access that is inconsistent with the assigned access privilege.

MIB Support

A MIB is a virtual information store that provides access to management information. This information is defined as MIB objects which can be accessed and, in some cases, be modified using network management tools.

IBM 8210 provides a comprehensive set of standard and enterprise-specific MIBs for monitoring and managing resources

You can find readme files documenting IBM 8210 MIB support by accessing the appropriate release directory on the World Wide Web at URL:

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- **ftp://ftp.nways.raleigh.ibm.com/pub/netmgmt/mss/**

To receive a copy of a specific MIB, enter the **get** command with the name of the MIB. For example, **get ibm8210.mib**. Using this command places a copy of the specified MIB in the directory from which you connected to the FTP server.

You can access the following information from the ftp site:

- Standard MIBs
- Enterprise MIBs
- SNMP generic traps
- Enterprise-specific MIBs
- Settable values

Except for the settable values, all supported MIB attributes are in READ-ONLY mode.

Trap Messages

Trap messages are unsolicited messages sent from the SNMP agent in the server to an SNMP manager in response to a server or network condition, such as a server reload or network down.

Chapter 20. Configuring and Monitoring SNMP

This chapter describes the SNMP configuring and monitoring commands. It includes the following sections:

- "SNMP Management" on page 19-1
- "Accessing the SNMP Configuring Environment"
- "SNMP Configuration Commands"
- "Accessing the SNMP Monitoring Environment" on page 20-11
- "SNMP Monitoring Commands" on page 20-11

Accessing the SNMP Configuring Environment

To access the SNMP configuring environment, enter the following command at the `Config>` prompt:

```
Config> protocol snmp
SNMP user configuring
SNMP Config>
```

SNMP Configuration Commands

This section describes the SNMP configuring commands.

Table 20-1 on page 20-2 lists the SNMP configuring commands. The SNMP configuring commands allow you to specify parameters that define the relationship between the SNMP agent and the network management station. The information you specify takes effect immediately after a restart or reload of the IBM 8210.

Enter the SNMP configuring commands at the `SNMP Config>` prompt.

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Table 20-1. SNMP Configuring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds a community to the list of SNMP communities, an IP address with mask to a community, or a subtree to a MIB view.
Delete	Removes a community from the list of SNMP communities, an IP address with mask from a community, or a subtree from a MIB view.
Enable/Disable	Enables/disables SNMP protocol and traps associated with named communities.
List	Displays the current communities with their associated access modes, enabled traps, IP addresses, and views. Also displays all views and their associated MIB subtrees.
Set	Sets a community’s access mode or view. A community’s access mode is one of the following: Read and trap generation Read, write and trap generation Trap generation only This command is also used to set a trap UDP port.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add a community name to the list of SNMP communities, add an address to a community, or assign a portion of the MIB (subtree) to a view.

Syntax:

add community
address
sub_tree

community

Use the **add community** command to create a community. It will be created with a default access of read_trap, a view of all, all traps disabled, and all IP addresses allowed.

Note: The **add community** command no longer allows you to select access type or trap control. Use the set community access command to assign access types to existing SNMP communities and use the **enable trap** or the **disable trap** command for trap control.

The *community name* parameter provides the community name used by the SNMP client. This community name is used when accessing the management information base (MIB) in the device from the host specified by the Community IP address parameter.

Valid Values: A string of 1 to 31 alphanumeric characters. Characters such as spaces, tabs, or <ESC> key sequences are not supported.

Default Value: public

Example: **`add community <community_name>`**

```
Community Name  []?
```

Community Name	Specifies the name of community (32 visual characters maximum). Characters such as spaces, tabs, or <esc> key sequences are not accepted.

address Use the **add address** command to add to the community definition an address of a network management station in the network that should be allowed to communicate with this box. You must supply the name of the community and the network address (in standard a.b.c.d notation). You also may supply a net mask to restrict access to either an individual host (mask = 255.255.255.255) or to a network of hosts. More than one address can be added to a community; enter the command each time you want to add another address.

If you do not specify an address for a community, requests are handled from any host.

Addresses also specify hosts that receive the traps. If no address is specified, no trap is generated.

1. The *community name* has:

   Valid Values: A string of 1 to 32 alphanumeric characters. Characters such as spaces, tabs, or <ESC> key sequences are not supported.

   Default Value: none

2. The *IP address* has:

   Valid Values: Any valid IP address.

   Default Value: none

3. You also may supply a *net mask* to restrict access to either an individual host (mask = 255.255.255.255) or to a network of hosts.

   Valid Values: 0.0.0.0 - 255.255.255.255

   Default Value: none

Example: **`add address <community_name> <ipAddress> <ipMask>`**

```
Community Name []?
New Address [0.0.0.0]?
```

sub_tree Use the **add sub_tree** command to add a portion of the MIB to a view or to create a new view. The default is the entire MIB. The **add sub_tree** command is used to manage MIB views. More than one subtree can be added to a view defined by <view_text_name>. To create a new MIB view, issue the **add sub_tree** command with the new view name.

Note: You must assign a view to one or more communities using the **set community view** command to have it take effect. The subtree definitions are inclusive; that is, the subtree OID

specified and any OID that is lexicographically greater than the specified OID is considered part of the MIB view.

Valid Values:

- All - Assigns all supported MIB views to the named community.
- View - Assigns a specified MIB view to the named community.

Default Value: All

The *MIB OID name* is the parameter that specifies the MIB Object ID for the sub_tree. This must be entered as a numeric value, not a symbolic value.

This parameter contains a MIB subtree name included in the view defined with the View name parameter. All children of a specified MIB subtree are also included in the view.

For example, to provide a view that would give access to the system group in MIB-II, specify **1.3.6.1.2.1.1**.

Valid Values:

An object identifier in the form of <element1>.<element2>.<element3>..., where:

- You need a minimum of 3 elements.
- You can define a maximum of 49 elements.
- element1 is 0, 1, or 2.
- element2 is an integer between 1 and 40.
- element3 and subsequent elements are integers between 1 and the size of an unsigned byte integer.

Default Value: None

Example: `add sub_tree`

```
View Name  []?
MIB OID name []?
```

View Name — Specify the name of the view (32 visual characters maximum). Characters such as spaces, tabs, or <Esc> key sequences are not accepted.

MIB OID — Specifies the MIB Object ID for the sub_tree. This must be entered as a numeric value in dotted notation, *not* a symbolic value.

Delete

Use the **delete** command to delete:

- a specific address.
- a community and all of its addresses.
- a subtree from a view.

Syntax:

delete community
address
sub_tree

community

Removes a community and its IP addresses. You must supply the community name.

The *community name*. **Valid Values**: A string of 1 to 31 alphanumeric characters. Characters such as spaces, tabs, or <ESC> key sequences are not supported.

Default Value: public

This parameter provides a community name used by the SNMP client. This community name is used when accessing the management information base (MIB) in the device from the host specified by the Community IP address parameter.

Example: `delete community <community_name>`

address Removes an address from a community. You must supply the name.

1. The *community name* has:

   Valid Values: A string of 1 to 31 alphanumeric characters. Characters such as spaces, tabs, or <ESC> key sequences are not supported.

   Default Value: public

   This parameter provides a community name used by the SNMP client. This community name is used when accessing the management information base (MIB) in the device from the host specified by the Community IP address parameter.

2. The *IP address* has:

   Valid Values: Any valid IP address.

   Default Value: none

3. You also may supply a *net mask* to restrict access to either an individual host (mask = 255.255.255.255) or to a network of hosts.

   Valid Values: 0.0.0.0 - 255.255.255.255

   Default Value: none

Example: `delete address <comm_name> <ipAddress> <ipMask>`

sub_tree Removes a MIB or a portion of the MIB from a view. You must supply the name of the subtree. If all subtrees are deleted, the MIB view is also deleted and all references to it from any associated SNMP communities are removed.

1. The *view name* to be removed is the parameter that allows you to select the view used by the community defined in the Community name parameter. This view determines which MIB objects this community may access. If no view is specified, the community may access all objects known to the router's SNMP agent.

   This parameter should be answered if you decide to restrict a community from accessing the entire MIB managed by the router's SNMP agent.

   You must configure the View name parameter and the MIB Subtree parameter before you can configure this parameter.

   Valid Values:

   - All - Assigns all supported MIB views to the named community.

- View - Assigns a specified MIB view to the named community.

Default Value: All

2. The *MIB OID name* is the parameter that specifies the MIB Object ID for the sub_tree. This must be entered as a numeric value, not a symbolic value.

   This parameter contains a MIB subtree name included in the view defined with the View name parameter. All children of a specified MIB subtree are also included in the view.

   For example, to provide a view that would give access to the system group in MIB-II, specify **1.3.6.1.2.1.1**.

   Valid Values:

   An object identifier in the form of <element1>.<element2>.<element3>..., where:
   - You need a minimum of 3 elements.
   - You can define a maximum of 49 elements.
   - element1 is 0, 1, or 2.
   - element2 is an integer between 1 and 40.
   - element3 and subsequent elements are integers between 1 and the size of an unsigned byte integer.

   Default Value: None

Example: **`delete sub_tree <view_text_name> <oid>`**

Disable

Use the **disable** command to disable the SNMP protocol or specified traps on the router.

Syntax:

disable snmp
trap

snmp Disables SNMP

The *community name* has:

Valid Values: A string of 1 to 31 alphanumeric characters. Characters such as spaces, tabs, or <ESC> key sequences are not supported.

Default Value: public

Example: **`disable snmp`**

trap Disables specified traps or all traps. You must specify the trap type from the following options.

Example: **`disable trap <trap_type> <community_name>`**

Trap Type	Description
all	Disables all traps in a specified community. Specify the community name as part of the command line.

Trap Type	Description
cold_start	Disables cold start traps in a specified community. A cold start trap means that the transmitting router is reinitializing and that the agent's configuring or the protocol entity implementation may be altered. Specify the community name as part of the command line.
link_down	Disables link_down traps in a specified community. A link_down trap recognizes a failure in one of the communication links represented in the agent's configuring. The link_down trap-PDU contains the name and value of the ifIndex instance for the affected link as the first element of its variable-bindings.
link_up	Disables link_up traps in a specified community. A link_up trap recognizes that a previously inactive link in the network has come up. The link_up trap-PDU contains the name and value of the ifIndex instance for the affected link as the first element of its variable-bindings.
auth_fail	Disables authentication failure traps for a specified community. Authentication failure traps indicate that the sender of the SNMP request does not have the proper permission to talk to this box's SNMP agent.
enterprise	Disables enterprise specific traps in a specified community. Enterprise specific traps indicate that some enterprise specific event has occurred. The specific-trap field identifies the particular trap that occurred. For example, when configured to do so, ELS event messages are sent in enterprise-specific traps.

Enable

Use the **enable** command to enable the SNMP protocol or specified traps on the router.

Syntax:

enable snmp
trap

snmp Enables SNMP

Example: `enable snmp`

trap Enables specified traps or all traps. You must specify the trap type from the options shown below.

The *community name* has:

Valid Values: A string of 1 to 31 alphanumeric characters.

Characters such as spaces, tabs, or <ESC> key sequences are not supported.

Default Value: public

Example: `enable trap <trap_type> <community_name>`

Trap Type	Description
all	Enables all traps in a specified community. Specify the community name as part of the command line.
cold_start	Enables cold start traps in a specified community. A cold start trap means that the transmitting router is reinitializing and that the agent's configuring or the protocol entity implementation may be altered. Specify the community name as part of the command line.

Trap Type	Description
link_down	Enables link_down traps in a specified community. A link_down trap recognizes a failure in one of the communication links represented in the agent's configuring. The link_down trap-PDU contains the name and value of the ifIndex instance for the affected link as the first element of its variable-bindings.
link_up	Enables link_up traps in a specified community. A link_up trap recognizes that a previously inactive link in the network has come up. The link_up trap-PDU contains the name and value of the ifIndex instance for the affected link as the first element of its variable-bindings.
auth_fail	Enables authentication failure traps for a specified community. Authentication failure traps indicate that the sender of the SNMP request does not have the proper permission to talk to this box's SNMP agent.
enterprise	Enables enterprise specific traps in a specified community. Enterprise specific traps indicate that some enterprise specific event has occurred. The specific-trap field identifies the particular trap that occurred. For example, when configured to do so, ELS event messages are sent in enterprise-specific traps.

List

Use the **list** command to display the current configuring of SNMP communities, access modes, traps, network addresses, and views.

Syntax:

list all
community
views

list all Displays the current configuring of SNMP communities for Access, Traps, Address, and View. See the description for the list community command on the next page for details on the options.

Example: `list all`

```
SNMP Config>list all

   SNMP is enabled
   Trap UDP port: 162
   SRAM write is enabled

            Community Name                 Access
   -------------------------------  -------------------
   oxnard                           Read, Write, Trap
   public                           Read, Trap


           Community Name             IP Address         IP Mask
   -------------------------------  ---------------  ---------------
   oxnard                           1.1.1.2          255.255.255.255
   public                           All              N/A


           Community Name                  Enabled Traps
   -------------------------------  -------------------------------
   oxnard                           Link Down, Cold Restart
   public                           None


            Community Name                    View
   -------------------------------  -------------------------------
   oxnard                           mib2
   public                           All


             View Name                     Sub-Tree
   -------------------------------  -------------------------------
   mib2                             1.3.6.1.2
```

list community *option*

Displays the current attributes of an SNMP community. Options are access, traps, address, view.

Option	Description
Access	Displays the access modes for the community.
Address	Displays the network address for the community.
Traps	Displays the types of traps generated for the community.
View	Displays the MIB view for the community.

list community access

Example: `list community access`

```
Community Name   Access
public           Read, Write, Trap
oxnard           Read, Trap
```

list community traps

Example: `list community traps`

```
Community Name   Enabled Traps
public           Link Down, Cold Restart
oxnard           NONE
```

list community address

Example: `list community address`

```
Community Name   IP Address   IP Mask
public           All          N/A
oxnard           1.1.1.2      255.255.255.255
```

list community view

Example: `list community view`

```
Community Name   View
public           All
oxnard           mib2
```

list views

Displays the current views for a specified SNMP community.

Example: `list views`

```
View Name   Sub-Tree
mib2        1.3.6.1.2.1
```

Set

Use the **set** command to assign a MIB view to a community, to set the SNMP UDP trap port number, or set the access mode of the community or SNMP password.

Syntax:

set community access

community view

trap_port

password

community access

Use the **set community access** command to assign one of three access types to a community. You must supply the name of the community and the access type.

The *community name* has:

Valid Values: A string of 1 to 31 alphanumeric characters.

Characters such as spaces, tabs, or <ESC> key sequences are not supported.
Default Value: public

Example: `set community access <options> <comm_name>`

Options	Description
read_trap	Allows read access and trap generation to the named community.
write_read_trap	Allows write and read access and trap generation to the community specified.
trap_only	Indicates the community is used only when sending an SNMP trap.

community view

Use the **set community view** command to assign a MIB view to a community.

Example: `set community view <comm_name> <options>`

Options	Description
all	Allows access to all MIB objects for the named community. All is the default.

Options	Description
view_text_name	Assigns a specified MIB view to the named community.

trap_port Use the **set trap_port** command to specify a UDP port number, other than the default standard port 162, to send traps to. The default is the standard port.

Example: **`set trap_port <udpport#>`**

UDP Port Number	Specifies a User Datagram Protocol port other than the standard UDP port (default # 162).

password

Use the set password command to specify the password to encrypt and authenticate the security sensitive MIB objects that are defined in the MIB. Setting the password to a string of zero length provides the maximum security by disallowing any access or setting of the security sensitive MIB objects. Setting the password to "clear" gives the least amount security by allowing data to flow without authentication. Setting the password to any other string allows access and setting of the security sensitive MIB objects which are encrypted and authenticated with this password.

Examples:

Monitoring SNMP

This section describes the SNMP monitoring commands.

Accessing the SNMP Monitoring Environment

To access the SNMP monitoring environment, enter the following command at the **+** (GWCON) prompt:

```
+ protocol snmp
SNMP>
```

SNMP Monitoring Commands

This section describes the SNMP monitoring commands.

Table 20-2 on page 20-12 lists the SNMP monitoring commands. The SNMP monitoring commands allow you to view the parameters of the SNMP configuration and display some statistics relating to the SNMP agent.

Temporary changes to the runtime SNMP parameters can be made through the monitoring. They will immediately affect the operation of the SNMP agent. If you want to make the temporary changes permanent, then use the SAVE command. If the original SNMP configuration needs to be restored, use the REVERT command. This feature allows you to temporarily alter the behavior of the SNMP agent, without permanently changing the configuring. For the temporary changes to take affect, you must EXIT the SNMP monitoring process.

Enter the SNMP monitoring commands at the `SNMP>` prompt.

Table 20-2. SNMP Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds a community to the list of SNMP communities, an IP address with mask to a community, or a subtree to a MIB view.
Delete	Removes a community from the list of SNMP communities, an IP address with mask from a community, or a subtree from a MIB view.
Enable/Disable	Enables/disables SNMP protocol and traps associated with named communities. These actions are only allowed in the SNMP Configuring environment.
List	Displays the current configuring of SNMP communities, views, access modes, traps, and network addresses.
Revert	Erases the specified changes and restores the settings to the values in the permanent SNMP configuring.
Save	Takes the specified changes and saves then permanently in the SNMP configuring.
Set	Sets a community’s access mode or view. A community’s access mode is one of the following: • Read and trap generation • Read, write and trap generation • Trap generation only Also allows setting of trap UDP port.
Statistics	Displays statistics about the SNMP agent.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add a community name to the list of SNMP communities, add an address to a community, or assign a portion of the MIB (subtree) to a view.

For information on using the **add** command, see “add” on “Add” on page 20-2.

Delete

Use the **delete** command to delete:

- A specific address.
- A community and all of its addresses.
- A subtree from a view.

For information on using the **delete** command, see “Delete” on page 20-4.

Disable

Use the **disable** command to disable the SNMP protocol or specified traps on the router. This command is available only in the SNMP Configuring environment.

For information on using the **disable** command, see “Disable” on page 20-6.

Enable

Use the **enable** command to enable the SNMP protocol or specified traps on the router. This command is available only in the SNMP Configuring environment.

For information on using the **enable** command, see “Enable” on page 20-7.

List

Use the **list** command to display the current configuring of SNMP communities, views, access modes, traps, and network addresses.

Syntax:

list all
community
views

list all Displays the current configuring of SNMP communities for Access, Traps, Address, and View. See the description for the list community command on the next page for details on the options.

See 20-8 for an example of the **list** command.

list community option

Displays the current attributes of a specified SNMP community. Options are access, traps, address, view.

Example: **`list community`** option

Option	Description
Access	Displays the access modes for the community.
Address	Displays the network address for the community.
Traps	Displays the types of traps generated for the community.
View	Displays the MIB view for the community.

list community access

Example: **`list community access`**

```
Community Name   Access
public           Read, Write, Trap
oxnard           Read, Trap
```

list community traps

Example: **`list community traps`**

```
                 Community Name   Enabled Traps
public           Link Down, Cold Restart
oxnard           None
```

list community address

Example: **`list community address`**

```
Community Name   IP Address   IP Mask
public           All          N/A
oxnard           1.1.1.2      255.255.255.255
```

list community view

Example: **`list community view`**

```
Community Name   View
public           All
oxnard           mib2
```

list views

Displays the current views for a specified SNMP community.

Example: `list views`

```
View Name   Sub-Tree
mib2        1.3.6.1.2.1
```

Revert

Use the **revert** command to erase the specified changes and restore the settings to the values in the permanent SNMP configuring.

Save

Use the **save** command to save the specified changes permanently.

Set

For information on using the **set** command, see “Set” on page 20-10.

Statistics

Use the **statistics** command to display statistics about the SNMP agent.

Syntax:

statistics

Example: `statistics`

```
SNMP memory in use = 9416
```

Chapter 21. Using IPX

This chapter describes how to use the IPX protocol on your IBM 8210. It includes the following sections:

- "IPX Overview"
- "Configuring IPX"
- "Optional Configuration Tasks" on page 21-2

IPX Overview

IBM's implementation of IPX allows the router to function as a Novell NetWare internetwork router. It has these characteristics:

- Compatibility with all previous Novell NetWare version environments.
- Compatibility with the bridging function in a NetWare file server, plus a stand-alone NetWare bridge.
- Support for the Novell NetBIOS emulator.

IPX Addressing

Every IPX interface must have a unique address that corresponds to the network number assigned to the attached IPX network. A simple solution is to use multi-part addresses like the city-street-house address on a piece of mail. For example, IPX refers to network numbers (city), host numbers (street), and socket numbers (house).

Network Numbers

An IPX network number specifies the location of a particular network in an internetwork. These addresses allow communication between two entities on different networks.

Host Numbers

Each IPX interface needs a 6-byte host (node) number.

Token-Ring, FDDI, and Ethernet interfaces use their hardware MAC address as their host number, and you cannot change them.

Because serial lines have no hardware MAC addresses, you must specify a unique host number.

ATM interfaces use their End System Identifier (ESI) as their host number. Their burned-in ESI will be used if one has not been configured.

Configuring IPX

This section describes how to initially configure IPX. The following sections describe optional parameters you can set.

1. Display the IPX configuration prompt as shown here:

```
* talk 6
  Config> protocol ipx
  IPX protocol user configuration
  IPX config>
```

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2. Enable the IPX protocol on the router.

```
IPX Config>enable ipx
```

3. Enable IPX and assign an IPX network number on each interface on which you want to run IPX. Every interface must have a unique network number that corresponds to the network number that is assigned to the attached IPX network.

   Repeat this step for each interface.

```
IPX Config>enable interface
Which interface [0]? 0
Configure an IPX network number for this interface.
Network number in hex
(0 is allowed only on IPXWAN
Static Routing interfaces) [1]? 180
```

Note: You cannot enter X'FFFFFFFE' or X'FFFFFFFF' as network numbers. Novell has reserved these numbers. You may only enter 0 if you configured the interface to use IPXWAN Static Routing.

Optional Configuration Tasks

Optional settings that you can adjust are described in the following sections.

- "Specifying the Size of IPX RIP Network Table"
- "Specifying RIP Update Interval"
- "Specifying the Size of IPX SAP Services Table" on page 21-3
- "Specifying SAP Update Interval" on page 21-3
- "Configuring Multiple Routes" on page 21-4
- "Configuring Static Routes" on page 21-4
- "Configuring Static Services" on page 21-5
- "Configuring the RIP Default Route" on page 21-6
- "Configuring Global IPX Filters (IPX Access Controls)" on page 21-6
- "Global SAP Filters" on page 21-8
- "IPX Interface Filters - Overview" on page 21-9
- "IPX Performance Tuning" on page 21-12
- "Split-Horizon Routing" on page 21-14

Specifying the Size of IPX RIP Network Table

The IPX RIP network table contains information about each IPX network. The default table size is 32. You can configure the table size from 1 to 2048; however, there may be memory limitations on the router that can prevent the maximum table size from being used.

```
IPX config>set maximum networks
New Network table size [32]? 32
```

Specifying RIP Update Interval

IPX uses RIP to maintain routes in its routing tables. A route indicates the path a packet follows. The RIP update interval determines how often the router broadcasts its routing information tables to its interfaces. It also determines how long a RIP entry remains before being aged-out.

Valid entries remain in the routing tables for a period of three multiples of the RIP update interval, and the router broadcasts its RIP tables once every update interval.

For example, the default interval is 1 minute, which allows a valid entry to remain in the table for 3 minutes. After this time, if an entry is not refreshed by a RIP update, the route is marked with a hop count of infinity (16) and then it is deleted. Every 60 seconds the router broadcasts its RIP tables to corresponding interfaces.

You can configure the RIP interval from 1 to 1440 minutes (24 hours). Increasing the RIP interval reduces traffic on WAN lines and dial circuits. It also prevents dial-on-demand circuits from dialing out as often.

Note: While complete RIP advertisements are controlled by the interval, the router still propagates network topology changes as quickly as it learns them.

The RIP interval is not configurable on the Novell file server.

```
IPX config>set rip-update-interval
Which interface [0]? 2
RIP timer value(minutes) [1]? 2
```

Specifying the Size of IPX SAP Services Table

The IPX Service Advertising Protocol (SAP) services table is a distributed database used to find NetWare Services, such as file servers. Services are uniquely identified by a 2-byte numeric type and a 47-character name. Each service provider advertises its services, specifying service type, name, and address. The router accumulates this information in a table and sends it to other routers. The default table size is 32.

You can configure the table size from 1 to 2048; router memory constraints may prevent the maximum table size from being used.

```
IPX config>set maximum services
New Service table size [32]? 32
```

Specifying SAP Update Interval

The IPX Service Advertising Protocol (SAP) interval lets you configure the time between IPX SAP updates on a per-interface basis. All router interfaces on the same network must use the same SAP interval. This interval determines both the age-out time for table information, and the interval between broadcasts to router interfaces.

Valid entries remain in the SAP services table for a period of three multiples of the SAP update interval, and the router broadcasts its SAP services table information once every update interval.

You can configure the SAP interval from 1 to 1440 minutes (24 hours). Increasing the SAP interval reduces traffic on WAN lines and dial circuits. It also prevents dial-on-demand circuits from dialing out as often.

Note: While complete SAP advertisements are controlled by this interval, the router still propagates network topology changes as quickly as it learns them.

The SAP interval is not configurable on the Novell file server.

```
IPX config>set sap-update
Which interface [0]? 2
SAP timer value(minutes) [1]? 4
```

Configuring Multiple Routes

You can configure IPX so that it keeps more than one routing table entry for the same destination network. The benefit of this feature is that if a route goes down, the alternate route is used immediately. The router does not have to wait for a RIP broadcast, which could take from a few seconds to a minute, to learn a new route. The router stores only equal-cost paths in the routing table.

Use the following command to configure the maximum number of routes that will be stored in the routing table for each destination. The range is 1 to 64. The default is 1.

```
IPX config>set maximum routes-per-destination
New maximum number of routes per destination net [1]? 4
```

Use the following command to set the total number of entries kept in the routing table. The range is 1 to 4096. The default is 32. Set the number of entries to at least the same size as the RIP network table. (Configure the size of the RIP network table using the **set maximum networks** command explained in this chapter.)

```
IPX config> set maximum total-route-entries
New route table size [32]? 40
```

Configuring Static Routes

Static routes can be configured per destination network number. Each static route is associated with an interface and is installed in the routing table when IPX is activated on the interface. The static route is removed from the routing table when IPX is deactivated on the interface, the interface itself is taken down, or any dynamically-learned route to the destination network is learned.
Dynamically-learned routes (via RIP) always override static routes. The static route will be reinstalled in the routing table when IPX is reactivated on the interface, the interface itself comes back up, or when all RIP routes to the destination network are lost.

Static routes are particularly useful over dial-on-demand circuits where RIP is disabled and routes to destination networks are statically configured on the dial-on-demand circuit.

Static routing may be used on an interface by itself or in combination with RIP. The only exception to this is when static routing is enabled on an IPXWAN PPP interface. In this case, static routing is the only routing type negotiated by IPXWAN.

Static routes will be advertised by RIP, subject to split-horizon and applicable filters.

When multiple static routes per destination network are configured, the same rules used to choose RIP routes are used to determine which static routes are installed in the routing table. Multiple static routes to the same destination network will be installed in the routing table if they are of equal cost. Up to the configured routes per destination can be concurrently stored in the routing table.

The following example shows how to configure an IPX static route.

```
IPX Config> disable rip
Which interface [0]? 2

IPX Config> enable route-static

IPX Config> add route-static
IPX net address: (1-fffffffe) [1]? 30
Which interface [0]? 2
Next-hop address, in hex [];? 400000003000
Ticks: (0-30000) [0]? 4
Hops: (0-14) [0]? 4
```

Configuring Static Services

Static services can be configured per service type or name pair. Each static service is associated with an interface and is installed in the SAP services table when IPX is activated on the interface, and a route to the service's network is known (either by static route or RIP advertisement). The static service is removed from the SAP table when IPX is deactivated on the interface, the interface itself is taken down, the route to the server's network is lost, or the same service is learned dynamically. As long as a route to the server's network is known, the static service will be reinstalled in the service table when IPX is reactivated on the interface, the interface itself comes back up, or when the SAP-learned service is lost. Dynamically-learned services (using SAP) always override static services.

Static services are particularly useful over dial-on-demand circuits where SAP is disabled and services are statically configured on the dial-on-demand circuit.

Static services may be used on an interface by itself or in combination with RIP/SAP. The only exception to this is when static routing is enabled on a IPXWAN PPP interface. In this case, static routing is the only routing type negotiated by IPXWAN.

Static services will be advertised by SAP, subject to split-horizon and applicable filters.

When multiple static services per name or type are configured, the same rules used to choose SAP services are used to determine which static service is installed in the routing table. Note that if there are equal-cost static services configured, the one defined on the same interface as the current route to the server's network will be installed in the service table.

The following example shows how to configure an IPX static service.

```
IPX Config> disable sap
Which interface [0]? 2

IPX Config> enable sap-static

IPX Config> add sap-static
Sap type: (0-ffff) [4]?
Sap name: []? FILE_SERVER01
Which interface [0]? 2
IPX net address: (1-fffffffe) [1]? 30
IPX node address, in hex: []? 400000202000
IPX socket: (0-ffff) [451]?
Hops: (0-14) [0]? 4
```

Configuring the RIP Default Route

The default route is a special case of a static route. It is used as a last resort as a next hop for unknown destination networks.

The default route is especially useful on dial-on-demand circuits when RIP is disabled. Configuring the default route on the dial-on-demand circuit allows clients to request routes and send packets to destination networks on the other side of the circuit without having to configure a static route for each destination.

RIP Handling

For routers using RIP, the default route is designated by network number FFFFFFFE.

When advertising RIP routes, the default route (like any other static route) will be advertised, after being subjected to the RIP filters and split-horizon.

When responding to a RIP request for an unknown destination network, the router responds to the request only if it has a default route in the routing table.

When forwarding packets, if the route to the destination network is unknown, the forwarder will forward the packet to the next-hop router that is advertising the default route (or the next-hop router indicated by the local static default route definition in the case of static routing).

The following example shows how to configure a RIP default route.

```
IPX Config> enable route-static

IPX Config> add route-static
IPX net address: (1-fffffffe) [1]? fffffffe
Which interface [0]? 2
Next-hop address, in hex: []? 400000003030
Ticks: (0-30000) [0§? 4
Hops: (0-14) [0]? 4
```

Interaction with SAP

Generally, SAP advertisements are accepted only if a route to the server's network is known. If the route to the server's network is not known, but a default route is known, the advertisement is also accepted (after being subjected to the SAP filters).

SAP advertisements that are accepted by virtue of the existence of the default route will be advertised on all IPX interfaces other than the one from which the SAP advertisement was accepted (split-horizon). Of course, the advertisement will be subjected to the SAP filters before being advertised. The same rules apply to responses to SAP requests.

Configuring Global IPX Filters (IPX Access Controls)

Global IPX filters are applied to all IPX interfaces. They can be used to prevent the router from forwarding packets based on IPX addresses (network/host/socket). You can use global IPX filters to provide security or to stop the forwarding of packets from "noisy" applications beyond the area of interest.

Global IPX filters are based on the originating IPX source address and the ultimate destination IPX address. Intermediate hop addresses are not important.

An IPX address (source or destination) for a global filter consists of an IPX network number, an IPX host number, and a range of IPX socket numbers that are specified in hexadecimal. The network number and host number can be specified as 0, which is a wildcard that matches all network and host numbers, respectively. A range of 0 to FFFF is a wildcard for sockets.

The global filter list is an ordered list of entries. Each global filter entry can be configured as inclusive or exclusive. The router compares packets it receives against the global filter list.

- If a packet matches an inclusive entry, the router forwards the packet.
- If a packet matches an exclusive entry, the router drops the packet.
- If the router reaches the end of the list without matching the packet to an entry, the router drops the packet. (This is equivalent to having a wildcard exclusive entry at the end of the list.)

When creating global filter lists, consider the following things about IPX:

- First, never block the RIP and SAP sockets (X'0453' and X'0452'). RIP and SAP are required to correctly forward IPX packets.
- Remember that the global filter list applies to all interfaces. You will have to use source and/or destination network numbers in the global filters to enact directional controls.
- Understand where the services you are trying to protect are located. At the IPX> prompt, enter the **slist** command to determine the address of a service.

  Note: All services on a Novell file server (version 3.0 or higher) are on the server's internal network, usually at host 000000000001. Because that internal network number is unique over an entire IPX network, you can protect it by blocking all packets to the internal network socket range 0–FFFF. To block only the file server, use a socket range of 0451–0451.
- When extracting socket numbers from an **slist** to build a global filter list, remember that some services have fixed socket numbers and some have dynamic (temporary) socket numbers. Because sockets in the range 4000–7FFF are dynamic, there is no guarantee that the service will have the same socket number the next time the file server is rebooted. However, socket numbers in the range 8000–FFFF are assigned by Novell, and will generally remain constant.

Note: The global filters and interface filters are mutually-exclusive. If global SAP filtering is enabled, interface SAP filters cannot be enabled (and vice versa). If global IPX filtering is enabled (*access-controls*), interface IPX filters cannot be enabled (and vice versa).

The router examines each IPX frame to see if it matches an entry in the global filter list. It applies the first match, therefore the order of global filters is critical. The router examines IPX packets for the following criteria:

1. Type of global filter (two types):
   a. Inclusive, indicating that if the packet matches the following criteria, forward it
   b. Exclusive, indicating that if the packet matches the following criteria, discard it

2. Destination network - taken directly from the packet's IPX destination network field.
3. Destination host - taken directly from the packet's IPX destination host field.
4. Starting/Ending destination socket - taken directly from the packet's IPX destination socket field (not host field). (The socket number is the location within the protocol that binds the packet to an application service.)
5. Source network - taken directly from the packet's IPX source network field.
6. Source host - taken directly from the packet's IPX source host field.
7. Starting/Ending source socket - taken directly from the packet's IPX source socket field.

The result of the following example would be to forward only those IPX packets from any client on IPX net 1871, destined for the NCP application, on the Novell File Server 0000 C93A 0912, on network 18730. All other traffic would be dropped.

```
IPX config>add access control
Enter type [E]? I
Destination network number (in hex) [ ]? 18730
Destination host number (in hex) [ ]? 0000C93A0912
Starting destination socket number (in hex) [ ]? 0451
Ending destination socket number (in hex) [ ]? 0451
Source network number (in hex) [ ]? 1871
Source host number (in hex) [ ]? 0
Starting source socket number (in hex) [ ]? 4000
Ending source socket number (in hex) [ ]? 7FFF
```

Global SAP Filters

Global SAP filters apply to all interfaces. They can be used to prevent service advertising information from being propagated through the router. There are four primary reasons to use global SAP filters:

- You are using servers with small bindery sizes (for example, NetWare Version 2.15 or lower) and must limit the amount of information in the SAP database.
- You do not want to advertise certain services outside the local area, because remote access to them would be inappropriate.
- You want to remove clutter from the SAP table.
- You want to reduce needless SAP advertisements on WAN links, since SAP advertisements can consume a considerable amount of WAN bandwidth.

Note: None of these reasons explicitly mentions security. Global SAP filters cannot protect a service. All that SAP does is provide a name-to-address translation for services. If a potential intruder knows the address of the service, blocking its advertisement via global SAP filters will not protect the service. Only access controls can provide security.

The global SAP filter is based on setting a maximum hop count for a particular service, or group of services. Any matching service advertisement received with the specified hop count (or less) is accepted into the SAP table. Others are ignored. Only those services in the SAP database are re-advertised or used to answer queries.

Note: The router allows you to enter service names in 7-bit ASCII only. Some service names use binary data, in violation of Novell SAP specifications. You will not be able to filter those services by name.

A global SAP filter can apply to all services of a type. Novell assigns 4-digit hexadecimal type numbers for each type of service. Alternately, a global SAP filter can apply to one particular service of a type. This is done by specifying the name of the service.

There can be several servers of the same service type, each with a unique service name. In this case, you can configure multiple global SAP filters with the same service type to filter unique service names, or you can configure a single SAP filter which filters the service type for all service names (wildcard filter).

Creating Global SAP Filters

To configure global SAP filters:

1. Enter **add filter** at the `IPX Config>` prompt. You must specify several key entries that are normally found in the SAP broadcasts:
   a. Number of hops. This entry indicates the hop count allowed for a SAP entry (if higher, discard).
   b. Service type
   c. Service name
2. Enter **set filter on** at the `IPX Config>` prompt to enable the filter.

The following example shows the creation of a global SAP filter against a specific print server.

```
IPX config> add filter
Maximum number of hops allowed [1]? 2
Service type [4]? 0047
Optional service name [ ]? rem-ptr1
IPX config> set filter on
```

This global SAP filter causes the router to ignore SAP advertisements from any print server (service type 0047) named **rem-ptr1** that is more than two hops away. The filter prevents the router from propagating advertisements that match these criteria.

Determining the Service Type for a Global SAP Filter

To determine the SAP type for a filter you want to establish, follow these steps:

1. At the * prompt, enter **talk 5**. Then, at the + prompt, enter **protocol ipx**.

   At the `IPX>` prompt enter **slist**. Note the entry for the services you want to filter.
2. At the `*` prompt, enter **talk 6**. Then, at the `Config>` prompt, enter **protocol ipx**. Add the appropriate global SAP filter and the appropriate hop count for the service you want to filter.
3. After creating the filter, restart the router.
4. If you have successfully filtered a service, it should no longer be listed. Check that the service is no longer listed by entering **slist** at the `IPX>` prompt.

IPX Interface Filters - Overview

The IPX routing feature supports four types of interface-based filters: ROUTER, RIP, SAP, and IPX. One *input* and one *output filter* can be defined per interface. Filter criteria, referred to as *items*, are assembled into *filter-lists* and are then attached to the input and/or output filters. A filter-list can be attached to more than one filter. This prevents you from having to configure the same filter criteria on multiple interfaces.

Note: The global filters and interface filters are mutually-exclusive. If global SAP filtering is enabled, interface SAP filters cannot be enabled (and vice versa). If global IPX filtering is enabled (*access-controls*), interface IPX filters cannot be enabled (and vice versa).

Configuring IPX Interface Filters

To configure IPX Interface Filters:

1. Create a filter-list and give it a name, using the **create list** command.
2. Modify the filter-list using the **update** command and its subcommands to specify the filter criteria and whether this filter-list is inclusive or exclusive.
3. Create a filter on the desired interface using the **create filter** command, specifying whether it is an input or output filter.
4. Enable the filter using the **enable** command.
5. Attach filter-lists to the filter using the **attach** command.
6. Set the default action for the filter using the **default** command. The default action will be taken if no match is made on any of the attached filter-lists.

There are also commands to delete a filter on a network interface, disable a filter on a network interface (or all network interfaces), detach a filter-list from a filter, move the filter-lists within the filter (because the filter-lists are ordered), list a filter, and set the size of the filter cache (for IPX Filtering only).

ROUTER Filtering

The ROUTER Filter operates on the IPX header of all received RIP response packets. Output ROUTER filtering is not supported. ROUTER filtering can be used to group individual IPX networks into several distinct IPX internets by controlling which routers are allowed to exchange routing information.

RIP Router Filters are kept in ordered lists of items by interface. The items are applied in order to each received RIP response packet. If a match is found, the action specified in the matching filter-list is performed (Exclude = discard packet, Include = receive packet for processing). Because Excluded packets are discarded, the information contained in their network entries is not entered into the RIP routing tables. If no match is found, the specified default filter action is performed.

RIP Filtering

The RIP filter operates on the network entries of RIP response packets. It can be used to control the extent to which routing information about selected networks is disseminated. As an *input* filter, this filter can prevent the *storing* of routing information about selected networks. This prevents ***all*** other networks from learning about the selected networks (at least through this router).

RIP filters (input) are kept in ordered lists of items by interface. The items are applied in order to each network entry in each received RIP response packet. If a match is found, the action specified in the matching filter-list is performed (Exclude = ignore network entry, Include = process network entry). Because Excluded network entries are ignored, they are not entered into the RIP routing tables. If no match is found, the specified default filter action is performed.

As an *output* filter, this filter can prevent the *advertising* (as opposed to the storing) of routing information about selected networks. It prevents *some* (as opposed to all) networks from learning about the selected networks (at least through this router).

RIP filters (output) are kept in ordered lists of items by interface. The items are applied in order to each network entry to be transmitted in a RIP response packet. If a match is found, the action specified in the matching filter-list is performed (Exclude = exclude network entry from packet, Include = include network entry in packet). This filter has no effect on the contents of the RIP routing tables. If no match is found, the specified default filter action is performed.

SAP Filtering

The SAP filter operates on the server entries of all SAP response packets. It can be used to control the extent to which information about services is disseminated, and can reduce the amount of SAP traffic on lower speed WANs.

As an *input* filter, this filter can prevent the *storing* of service information about selected servers. This prevents ***all*** other networks from learning about the selected servers (at least through this router).

SAP filters (input) are kept in ordered lists of items by interface. The items are applied in order to each server entry in each received SAP response packet. If a match is found, the action specified in the matching filter-list is performed (Exclude = ignore server entry, Include = process server entry). Because Excluded server entries are ignored, they are not entered into the SAP services table. If no match is found, the specified default filter action is performed.

As an *output* filter, this filter can prevent the *advertising* (as opposed to the storing) of service information about selected servers. This prevents *some* (as opposed to all) networks from learning about the selected servers (at least through this router).

SAP filters (output) are kept in ordered lists of items by interface. The items are applied in order to each server entry in each SAP response packet to be transmitted. If a match is found, the action specified in the matching filter-list is performed (Exclude = exclude server entry, Include = include server entry in packet). This filter has no effect on the contents of the SAP services table. If no match is found, the specified default filter action is performed.

IPX Filtering

The IPX Filter operates on the IPX header of IPX packets. It can be used to control the extent to which selected servers and workstations are allowed to communicate with other selected servers and workstations, based on source and destination network, node, and socket fields, as well as protocol type and hop count.

As an *input* filter, a match that indicates that the packet should be discarded prevents the packet from being transmitted on ***all*** interfaces.

IPX Filters (input) are kept in ordered lists of items by interface. The items are applied in order to each received IPX packet. If a match is found, the action specified in the matching filter-list is performed (Exclude = discard packet, Include = receive packet for processing or forwarding). If no match is found, the specified default filter action is performed.

As an *output* filter, the decision whether to forward the packet is made based on the output interface, and therefore might allow a received packet to be forwarded out on one interface but not out on some other interface.

IPX filters (output) are kept in ordered lists of items by interface. The items are applied in order to each IPX packet to be transmitted. If a match is found, the action specified in the matching filter-list is performed (Exclude = discard packet, Include = transmit packet). If no match is found, the specified default filter action is performed.

Because IPX filters are invoked for each received packet, it is recommended that they be used only where a high degree of specificity is required (that is, where the RIP Router, RIP and SAP filters cannot be used). Generally, the RIP filters deal with internetworking between ***all*** stations on a particular set of networks; the SAP filters control which servers are reachable by workstations throughout the internetwork; the IPX filters deal with internetworking between ***individual*** workstations (or individual applications on individual workstations).

" IPX Interface Filter Configuration Commands" on page 22-22 describes in more detail the commands used to configure IPX Interface Filters.

IPX Performance Tuning

The IPX router implements a dual path for packet forwarding, a fast path and a slow path, to route traffic more efficiently.

The fast path forwards only data packets, while a slower path handles administration packets, such as RIP and SAP packets. Fast path uses an address cache that enables the router to forward a packet quickly.

The slower routing table lookups are performed only during the creation of a cache entry. The cache has an aging mechanism that allows overflows to be dealt with intelligently. You can configure the cache size through the IPX configuration menu.

The IPX fast path cache includes two entries: local and remote. Each entry can handle the requirements of that type of addressing.

The cache commands are used to set a limit on the maximum number of entry types allowed in the cache.

Local Cache

The size of the local cache should equal the total number of clients on each router's local or client network plus a 10% buffer to prevent excessive purge requests. Using the example in Figure 21-1 on page 21-14, router 5 (RTR R5) has 9 clients (C) plus the server (S) for a total of 10. Based on this total:

1. Multiply by 10% (10 in our example).
2. Add that total (1) to the client total (for a safety margin).
3. Use the new total (11) for the number of local cache entries.

For example:

```
IPX config>set local-cache size
New IPX local node cache size [32]? 11
```

When all cache entries are in use, the least frequently used entries are purged.

Remote Cache

The size of the remote cache should equal the total number of remote networks used by the router plus a 10% buffer to prevent excessive purge requests. In Figure 21-1 on page 21-14, there are 10 IPX networks that RTR R5 can read via IPX network 5. Therefore, RTR/R5 has a total of 10 clients. Based on this total:

1. Multiply by 10% (10 in our example).
2. Add that total (1) to the remote network total (10) for a safety margin.
3. Use the new total (11) for the number of remote cache entries.

For example:

```
IPX config>set remote-cache size
New IPX remote network cache size [32]? 11
```

You can view the cache entries using the IPX monitoring **sizes** command.

```
IPX>sizes
Current IPX cache size:
Remote network cache size (max entries): 45
0 entries now in use

Local node cache size (max entries): 86
0 entries now in use
```

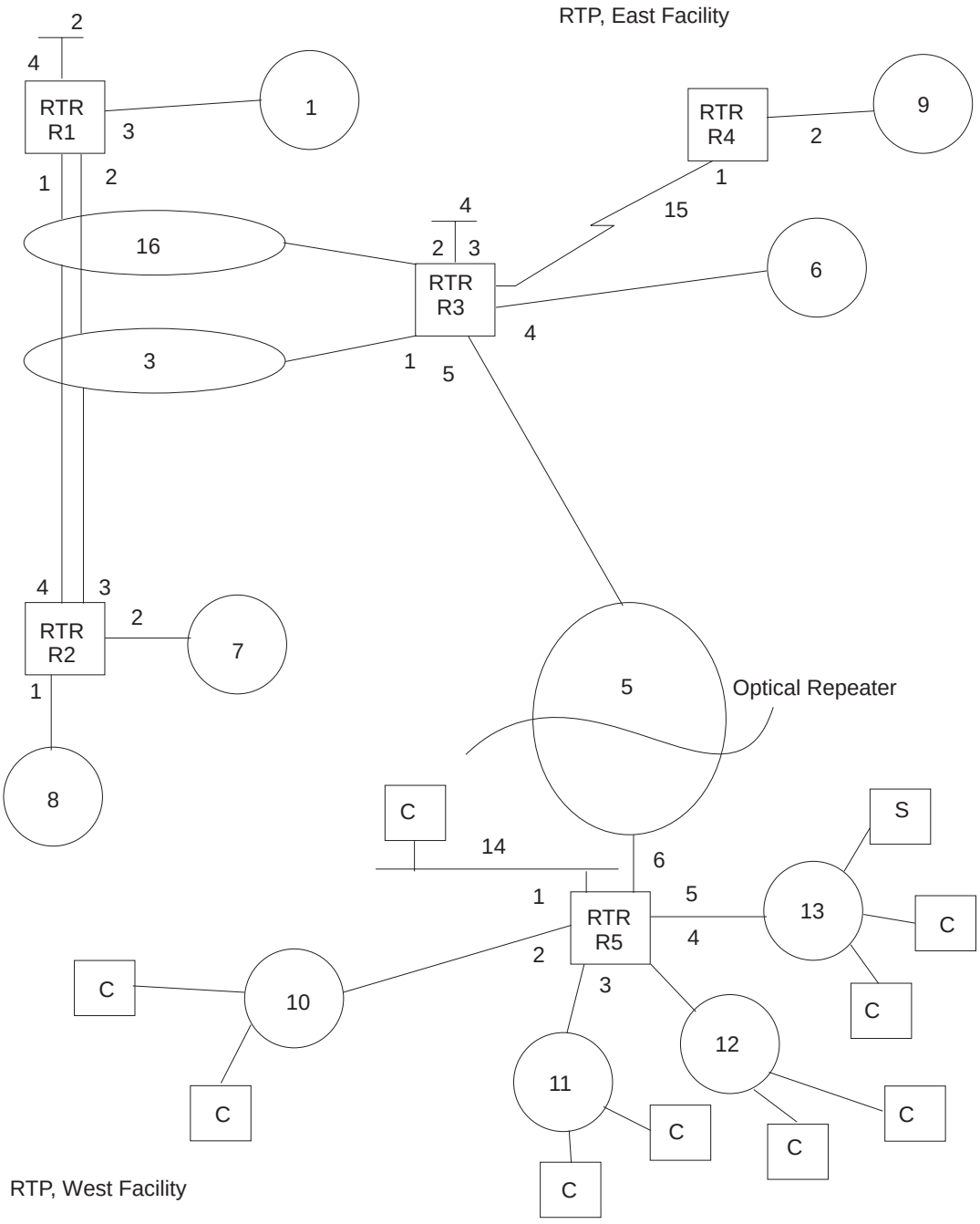

Figure 21-1. Sample IPX Network

Split-Horizon Routing

Split-horizon is a method of routing that avoids broadcasting RIP and SAP updates to the router from which they were learned.

Generally, split-horizon should be enabled on every interface to prevent packets from counting to infinity and to avoid unnecessary RIP and SAP advertisements. However, there are some cases, such as partially-meshed frame-relay, ATM, and X.25 configurations, where it may be necessary to disable split-horizon.

A Partially-meshed RFC 1483-Supported IPX Routing configuration is another case where it may be necessary to disable split-horizon.

In a partially-meshed frame-relay network, as shown in Figure 21-2, the routers at the branches cannot communicate with each other unless the router at headquarters broadcasts all routing information to all other routers. In this case, split-horizon should be disabled on the frame-relay interface at headquarters, and enabled at each of the branches to keep them from generating unnecessary traffic.

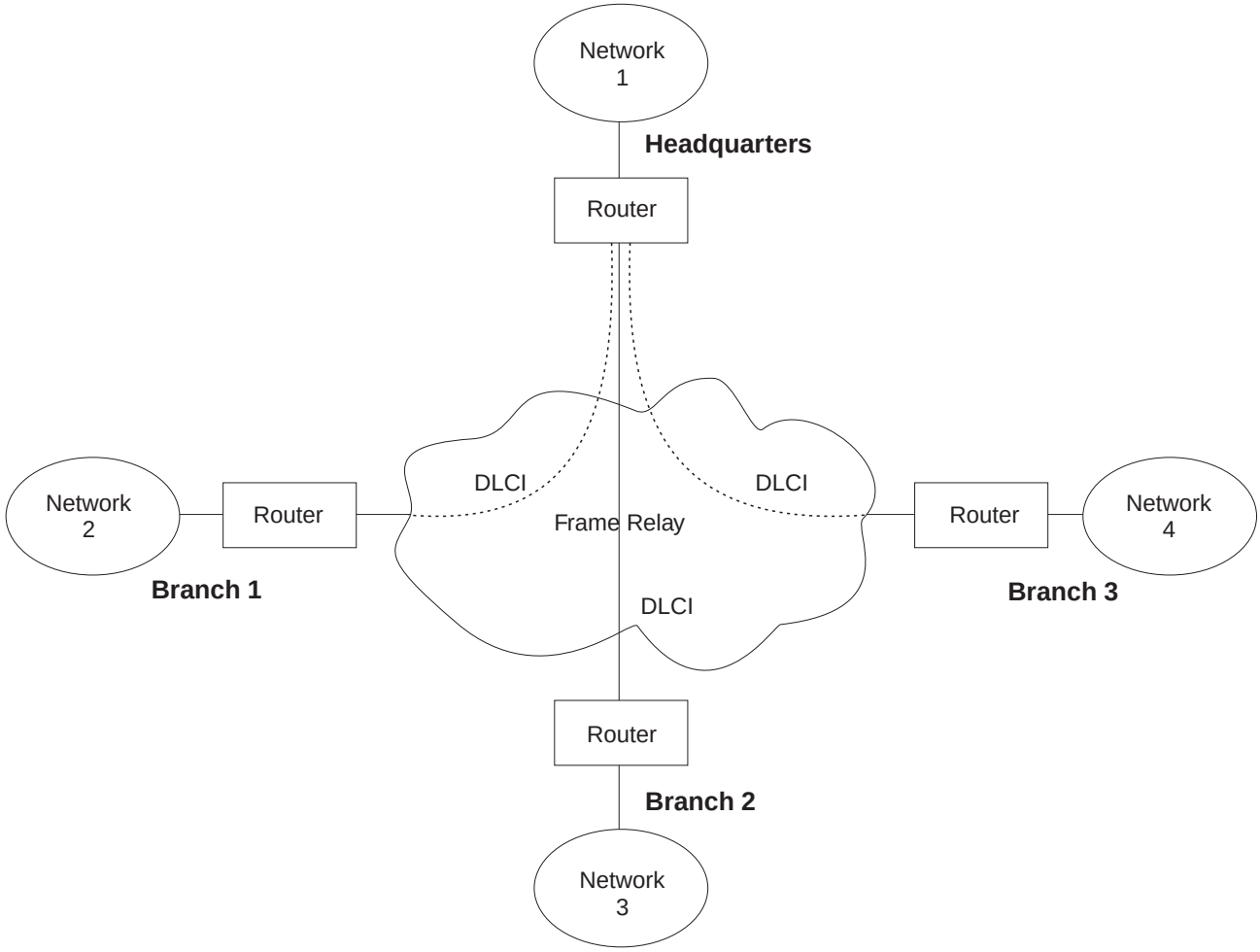

Figure 21-2. Partially Meshed Frame-Relay Network

If you do need to change the split-horizon setting, use the **set split-horizon** command as follows:

```
IPX Config>set split-horizon enabled
Which interface [0]? 2

IPX Config>set split-horizon disabled
Which interface [0]? 2

IPX Config>set split-horizon heuristic
Which interface [0]? 2
```

Chapter 22. Configuring and Monitoring IPX

This chapter describes how to configure the IPX protocol and use the IPX monitoring commands. It includes the following sections:

- "Accessing the IPX Configuration Environment"
- "IPX Configuration Commands"
- "Accessing the IPX Monitoring Environment" on page 22-33
- "IPX Monitoring Commands" on page 22-33

Accessing the IPX Configuration Environment

To access the IPX configuration environment, enter the following command at the `Config>` prompt:

```
Config> protocol IPX
IPX Protocol user configuration
IPX Config>
```

IPX Configuration Commands

This section discusses the IPX configuration commands. Table 22-1 on page 22-2 lists the IPX configuration commands. These commands specify the network parameters for router interfaces transmitting IPX packets. These commands are entered at the `IPX config>` prompt. To activate the configuration changes, restart the router.

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Table 22-1. IPX Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds global IPX filters (access controls), global SAP filters, static routes or services.
Delete	Deletes global IPX filters (access controls), global SAP filters, static routes, or services.
Disable / Enable	Disables or enables IPX globally or on specific interfaces. Globally disables or enables static routes and services.
Filter-lists	Accesses the `IPX` *`filter-type`*`-List Config>` prompt. This is the environment where the IPX interface filters (Router, RIP, SAP, and IPX) are configured.
Frame	Specifies the data link format for Ethernet, Token-Ring interfaces and FDDI. This also applies to Token-Ring and Ethernet LAN Emulation Clients.
List	Displays the current IPX configuration.
Move	Changes the line numbers set when adding access control.
Set	Sets the host number, IPXWAN router name and node ID, IPXWAN routing type, connection timeout and retry timer, IPX network numbers, maximum RIP and SAP table sizes, local and remote cache sizes, global IPX filter (access controls) and global SAP filter states, cache sizes, RIP and SAP update intervals,
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add a global IPX filter (access controls), a global SAP filter, and a static route or service to your IPX configuration, which determines whether the router drops or forwards IPX packets. The **add** command also adds global SAP filters to your IPX configuration; this determines which SAP service advertisements will be ignored or accepted by the router.

Syntax:

add access-control . . .
filter . . .
route-static . . .
sap-static . . .

access-control *type dest-net dest-host dest-socket-range src-net src-host src-socket-range*

Determines whether to pass a packet at the IPX level. IPX access controls provide a global access control function at the IPX packet level for the IPX protocol. The access control list is an ordered set of entries that the router uses to filter packets. Each entry can be either Inclusive or Exclusive. Each entry has source and destination network numbers, host addresses, and socket ranges.

When a packet is received from a network for the IPX protocol, and access control is enabled, it is checked against the access control list. It

is compared with the net/address/socket pairs in the list until there is a match. If there is a match and the entry is of the Inclusive type, reception of the packet (and potential forwarding) proceeds. If the matching entry is of the Exclusive type, the packet is dropped. If there is no match, the packet is also dropped.

After you create an access-control list with the **add access-control** command, enable the entries with the **set access-control on** command. Use the **move** command to change the order of the access-control list.

Note: Access controls apply to all received packets. If you do not enable reception of RIP (socket 453 hexadecimal) or SAP (socket 452 hexadecimal) packets, the IPX forwarder will be nonfunctional.

```
add access I 0 0 453 453 0 0 0 FFFF
add access I 0 0 452 452 0 0 0 FFFF

Enter type [E] i
Destination network number (in hex) [0]? 0
Destination host (in hex) [ ]? 0
Starting destination socket number in hex [0]? 452
Ending destination socket number in hex [0]? 453
Source network number (in hex) [0]? 0
Source host number (in hex) [ ]? 0
Starting source socket number in hex [0]? 0
Ending source socket number in hex [452]? FFFF
```

Type

Identifies whether packets are sent or dropped for a specific address or set of addresses. Enter I for include. This causes the router to receive the packet and to forward it if it matches criteria in the remaining arguments. Enter E for exclude. This causes the router to discard the packets.

Dest-net

Network number of the destination. Enter the network number in hexadecimal.

Valid Values: X'00000000' to X'FFFFFFFF'

Zero (0) specifies all networks.

Default Value: 0

Dest-host

Host number on the destination network. Enter the host number in hexadecimal.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Zero (0) specifies all hosts on the network.

Default Value: None

Dest-socket-range

Two numbers that specify an inclusive range of destination sockets. The destination socket value is used for filtering IPX packets.

Valid Values: X'0000' to X'FFFF'

Default Value: 0

Src-net

Network number of the source. Enter the network number in hexadecimal.

This parameter defines the network number of the source IPX network whose packets are filtered by this router.

If you choose to filter on *only* the source network value, the filter applies to all source sockets, source networks, packet types, and number of hops.

Valid Values: X'00000000' to X'FFFFFFFF'

Zero (0) specifies all networks.

Default Value: 0

Src-host

Host number on the source network. Enter the host number in hexadecimal.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Zero (0) specifies all hosts on the network.

Default Value: None

Src-socket-range

Two numbers that specify an inclusive range of source sockets.

Valid Values: X'0000' to X'FFFF'

Default Value: 0

Note: It is not necessary to use access controls and SAP filters for IPX to work in a NetWare environment. Use them only if necessary.

Example: `add access-control E 201 1 451 451 329 0 0 FFFF`

This access control prevents all nodes on network 329 from accessing the file server with internal network number 201.

filter *hops service-type service-name*

Prevents NetWare bindery overflows for users on large networks by enabling you to determine the number of hops reasonable for a given service. IPX SAP filters allow the protocol to be configured to ignore certain entries in SAP advertisements. This is done to limit the size of the SAP database. This could be necessary due to size limitations in older versions of NetWare file servers. This could also be necessary to limit the amount of SAP data sent across WAN links.

The SAP filters are a global ordered list of filter entries. Each filter entry has a maximum hop count, a service type, and an optional service name. When a SAP response packet is received, each SAP entry is compared with the filter list. If the SAP entry matches an entry in the filter list and is greater than the specified hops, it is ignored and not entered into the local SAP database. If the SAP entry matches an entry in the filter list, and is less than or equal to the specified hops, it is accepted and entered into the local SAP database. If there is no match, the SAP entry is accepted. The arguments for this command are as follows:

Hops
Maximum number of hops permitted for the service.

Valid Values: An integer in the range of 0 to 16.

Default Value: 1

Service-type
Numeric service class.

Valid Values: A hexadecimal value in the range of X'0000' to X'FFFF'.

Use a value of X'0000' to filter all service types.

Default Value: 4

You can see a list of service types by entering the **slist** command at the IPX> prompt.

Service-name
Identifies the name of the server. In general, this field is not entered.

Valid Values: A string of 1 to 47 ASCII characters (X'20' through X'7E').

Default Value: none

Example: `add filter 2 039B NOTES-CHICAGO`

This example ignores all SAP advertisements for the Lotus Notes server "NOTES-CHICAGO" at more than 2 hops.

route-static *dest-net interface# nextHop ticks hops*
Adds a static route.

dest-net
Specifies the destination IPX network number.

Valid Values: X'1' to X'FFFFFFFE'

Default Value : 1

interface#
Specifies an existing interface on which the static route will be configured.

Valid Values: an existing interface number

Default Value: 0

nextHop
Specifies the IPX host number of the next-hop router through which the destination network can be reached.

Valid Values: X'1' to X'FFFFFFFFFFFE'

Default Value: none

ticks
Indicates the number of ticks between the destination network and this router. The number of ticks represents the amount of time it takes to transmit a 576-byte IPX packet from this router to the destination network. Each tick is 55 milliseconds.

Valid Values: 0 to 30000

Default Value: 0

hops
Indicates the number of hops between the destination network and this router.

Valid Values: 0 to 14

Default Value: 0

Example:

```
add route-static
IPX net address: (1-fffffffe) [1]? 30
Which interface [0]? 1
Next-hop address, in hex: []? 400000004040
Ticks: (0-30000) [0]? 4
Hops: (0-14) [0]? 4
```

sap-static *serviceType serviceName interface# serverNet serverNode serverSocket hops*
Adds a static SAP service.

serviceType
Specifies the hexadecimal service class of the service.

Valid Values: X'0' to X'FFFF'

Default Value: 4

serviceName
Specifies the ASCII name of the service.

Valid Values: up to 47 of the following ASCII characters: 'A'–'Z', 'a'–'z', '0'–'9', '_', '-', '@'.

Default Value: None

interface#
Specifies an existing interface on which the SAP static service should be configured.

Valid Values: an existing interface number

Default Value: 0

serverNet
Specifies the internal IPX network number or home IPX network number of the server.

Valid Values: X'1' to X'FFFFFFFE'

Default Value: 1

serverNode
Specifies the IPX node of the server.

Valid Values: X'1' to X'FFFFFFFFFFFE'

Default Value: None

serverSocket
Specifies the socket number of the server.

Valid Values: X'0' to X'FFFF'

Default Value: 451

hops

Indicates the number of hops between the server and this router.

Valid Values: 0 to 14

Default Value: 0

Example:

```
add sap-static
Sap type: (0-ffff) [4]? 4
Sap name: []? filesrv1
Which interface: [0]? 1
IPX net address: (1-fffffffe) [1]? 40
IPXnode address, in hex:  []? 000000000001
IPX socket:  (0-ffff) [451]?
Hops: (0-14) [0] 4
```

Delete

Use the **delete** command to delete a global IPX filter (access control), a global SAP filter, a static route or service.

Syntax:

delete access-control . . .
filter . . .
route-static . . .
sap-static . . .

access-control *line#*

Deletes the access control that matches the line number you enter. Enter the **list** command to display the current line numbers.

Example: `delete access-control 2`

filter *hops service-type service-name*

Deletes the specified SAP filter. You must type the SAP filter exactly as it appears when you run the list command. The arguments are as follows:

Hops

Maximum number of hops permitted for the service.

Valid Values: 0 to 16

Default Value: 16

Service-type

Numeric service class. Enter a 2-byte hexadecimal number.

Valid Values: X'0000' to X'FFFF'

Default Value: None

Service-name

If the entry you are deleting has a name, specify the name.

Valid Values: A string of 1 to 47 ASCII characters (X'20' through X'7E').

Default Value: None

Example: `delete filter 2 039B NOTES-CHICAGO`

route-static *dest-net interface# nextHop*

Deletes a static route.

dest-net

Specifies the destination IPX network number.

Valid Values: X'1' to X'FFFFFFFE'

Default Value: 1

interface#

Specifies an existing interface on which the static route can be configured.

Valid Values: an existing interface number

Default Value: 0

nextHop

Specifies the IPX host number of the next-hop router through which the destination network can be reached.

Valid Values: X'1' to X'FFFFFFFFFFFE'

Default Value :none

Example:

```
delete route-static
IPX net address: (1-fffffffe) [1]? 30
Which interface [0]? 1
Next-hop address, in hex: []? 400000000020
Entry deleted
```

sap-static *serviceType serviceName interface#*

Deletes a static SAP service.

serviceType

Specifies the hexadecimal service class of the service.

Valid Values: X'0' to X'FFFF'

Default Value: 4

serviceName

Specifies the ASCII name of the service.

Valid Values: up to 47 of the following ASCII characters: 'A'–'Z', 'a'–'z', '0'–'9', '_', '-', '@'.

Default Value: None

interface#

Specifies an existing interface on which the SAP static service should be configured.

Valid Values: an existing interface number

Default Value: 0

Example:

```
delete sap-static
Sap type: (0-ffff) [4]? 4
Sap name: []? filesrv1
Which interface: [0]? 1
Entry deleted.
```

Disable

Use the **disable** command to disable IPX on specific interfaces, or to globally disable the IPX protocol. Also, use the **disable** command to disable replies to SAP get-nearest-server requests, RIP-SAP Broadcast Pacing, IPX, IPXWAN, RIP, or SAP on specific interfaces.

Syntax:

disable
- interface . . .
- ipx
- reply-to-get-nearest-server . . .
- rip . . .
- rip-sap-pacing . . .
- route-static . . .
- sap . . .
- sap-static . . .

interface *interface#*

Prevents the router from sending IPX packets over specific interfaces.

Example: `disable interface 2`

ipx Prevents the router from sending IPX packets over any of the interfaces.

Example: `disable ipx`

reply-to-get-nearest-server *interface#*

Prevents the router from responding to SAP get-nearest-server requests from workstations that are attempting to locate a server.

Note: Disabling this feature should be done with great caution. This command should be used only when there are multiple routers (or servers) on an IPX network and it is known that the “best” server is not behind this router.

Example: `disable reply 3`

rip *interface#*

Disables RIP on the interface indicated by *interface#*. The default is for RIP to be enabled on all interfaces. RIP will automatically be disabled on interfaces using IPXWAN Static Routing, even if it is configured as enabled.

Example: `disable rip 1`

rip-sap-pacing *interface#*

Prevents the router from pacing RIP and SAP periodic broadcast packets on specific interfaces. When pacing is disabled, RIP and SAP periodic broadcasts are transmitted on the interface with a 55 msec interpacket gap (the default setting). Enable pacing only on interfaces where RIP and SAP broadcasts might cause congestion (for example, you can enable pacing on frame-relay or X.25 interfaces with many virtual circuits).

Example: `disable rip-sap-pacing 3`

route-static

Globally disables the use of static routes.

Example: `disable route-static`

sap *interface#*

Disables SAP on the interface indicated by *interface#*. The default is for SAP to be enabled on all interfaces. SAP will automatically be disabled on interfaces using IPXWAN Static Routing, even if it is configured as enabled.

Example:`disable sap 3`

sap-static

Globally disables the use of static services.

Example: `disable sap-static`

Enable

Use the **enable** command to enable IPX on specific interfaces, or to globally enable the IPX protocol. Also use the **enable** command to enable replies to SAP get-nearest-server requests, RIP-SAP Broadcast Pacing on specific interfaces, IPX, IPXWAN, RIP or SAP, on specific interfaces.

Syntax:

enable
- interface . . .
- ipx
- reply-to-get-nearest-server . . .
- rip . . .
- rip-sap-pacing . . .
- route-static . . .
- sap . . .
- sap-static . . .

interface *interface# network#*

Allows the router to send IPX packets over specific interfaces. Every interface must have a unique network number that corresponds to the network number that is assigned to the attached IPX network. You will be prompted for a valid IPX network number if one has not already been configured.

interface#

Specifies an existing interface on which IPX is to be enabled.

Valid values: an existing interface number

Default Value: 0

network#

Specifies the IPX network to be used on the interface. You need to specify this parameter only if you have not configured a valid IPX network number previously. IPX network number 0 is valid only on IPXWAN Static Routing interfaces. Do not use IPX network numbers X'FFFFFFFE' and X'FFFFFFFF'.

Valid values: X'0' to X'FFFFFFFD'

Default Value: 1

Example:

```
enable interface
Which interface: [0]? 1
Configure an IPX network number for this interface
Network number in hex
(0 is allowed only on IPXWAN
Static Routing interfaces) [1]? 2
```

ipx Allows the router to send IPX packets over all of the interfaces on which IPX has been enabled.

Example: `enable ipx`

reply-to-get-nearest-server *interface#*

Allows the router to respond to SAP get-nearest-server requests from workstations that are attempting to locate a server. This is the default setting.

Note: Disabling this feature should be done with great caution. The **disable reply-to-get-nearest-server** command should be used only when there are multiple routers (or servers) on an IPX network and it is known that the “best” one is not behind this router.

Example: `enable reply 2`

rip *interface#*

Enables RIP on the interface indicated by *interface#*. The default is for RIP to be enabled on all interfaces. RIP will automatically be disabled on interfaces using IPXWAN static-routing, even if it is configured as enabled.

Example: `enable rip 1`

rip-sap-pacing *interface#*

Enables pacing of RIP and SAP periodic broadcast packets on specific interfaces. When pacing in enabled, RIP and SAP periodic broadcasts are transmitted on the interface with an interpacket gap calculated by the router (a value from 55 msec to 5 seconds).

Note: The router calculates an interpacket gap that guarantees that broadcast completion within the configured RIP and SAP update intervals. Configuring these intervals to a larger value may be necessary for the router to calculate a sufficiently large interpacket gap.

Pacing should be enabled only on interfaces where RIP and SAP broadcasts might cause congestion (for example, on frame-relay or X.25 interfaces with many virtual circuits).

Example: `enable rip-sap-pacing 3`

route-static

Globally enables the use of static routes.

Example: `enable route-static`

sap *interface#*

Enables SAP on the interface indicated by *interface#*. The default is for SAP to be enabled on all interfaces. SAP will automatically be disabled on interfaces using IPXWAN static-routing, even if it is configured as enabled.

Example: `enable sap 1`

sap-static

Globally enables the use of static services.

Example: `enable sap-static`

Filter-lists

Use the **filter-lists** command to access the `IPX filter-type-List Config>` prompt. Valid filter list types are router, rip, sap, and ipx.

For information about the commands available at the `IPX filter-type.-List Config>` prompt, see " IPX Interface Filter Configuration Commands" on page 22-22.

Syntax:

filter-lists router-lists
rip-lists
sap-lists
ipx-lists

Example: `filter-lists router-lists`

Frame

Use the **frame** command to specify the packet format for IPX interfaces. (Encapsulation can also be set using the CONFIG **network** command.)

Note: When there are incorrect or invalid configuration records, the default frame values are used.

Syntax:

frame ethernet_II . . .
ethernet_8022 . . .
ethernet_8023 . . .
ethernet_SNAP . . .
token-ring MSB . . .
token-ring LSB . . .
token-ring_SNAP MSB . . .
token-ring_SNAP LSB . . .
fddi . . .
fddi_snap . . .

ethernet_type *interface#*

Selects the Ethernet encapsulation format. This is required if you are using NetWare-VMS on the Ethernet, and is often used when there are ISO nodes on the same Ethernet. The following options are available:

- ethernet_II - uses Ethernet version 2.0 protocol 81-37.
- ethernet_8022 (default of NetWare 4.0 and greater) - uses Ethernet 802.3 with 802.2 SAP E0.
- ethernet_8023 (default of pre-NetWare 4.0 and lower) - uses Ethernet 802.3 without any 802.2 header.
- ethernet_SNAP - uses 802.3, 802.2 with SNAP PID 00-00-00-81-37.

Note: The ethernet_SNAP encapsulation it is not architecturally valid and is not fast-pathed. No cache entries will appear for network entries using this encapsulation.

The default value for Ethernet frames is “ethernet_8023.”

Example: `frame ethernet_II 1`

token-ring_type *interface#*

Selects the token-ring encapsulation format. The default value is “token-ring MSB.” The following options are available:

- token-ring MSB (router default) - uses 802.5 with 802.2 SAP E0, and uses the non-canonical format for host addresses in the IPX packet header. The router builds outgoing packets with a three-byte 802.2 header (X'E0', X'E0', X'03').
- token-ring LSB - uses 802.5 with 802.2 SAP E0, and uses the canonical format for host addresses in the IPX packet header.
- token-ring_SNAP MSB - uses 802.5, 802.2 with SNAP PID 00-00-00-81-37, and uses the non-canonical format for host addresses in the IPX packet header.
- token-ring_SNAP LSB - uses 802.5,802.2 with SNAP PID 00-00-00-81-37, and uses the canonical format for host addresses in the IPX packet header.

Example: `frame token-ring_SNAP MSB 3`

fddi_type *interface#*

Defines the FDDI type for the specified interface.

fddi Selects the IPX encapsulation to FDDI IEEE 802.2.

Example: `IPX Config>` **`frame fddi 3`**

fddi_snap

Selects the IPX encapsulation to FDDI SNAP.

Example: `IPX Config>` **`frame fddi_snap 3`**

List

Use the **list** command to display the current IPX configuration.

Syntax:

list access-controls
all
filters
route-static
sap-static
summary

access-controls

Lists the global IPX filters (access-controls).

Example: `list access-controls`

```
Access Control Configuration:
-----------------------------
IPX access controls:  Enabled
# T Dest Net         Host  Sck  Sck   Src Net         Host Sck Sck
1 I        1            0  451  451         4 200300040050  451 451
2 E 2000D003 200300400060  452  45F         0             1  452 452
```

all Lists the entire IPX configuration.

Example: `list all`

```
IPX Configuration:
------------------
IPX Globally                    Enabled
Host Number                     400000200000
Maximum Services                2000
Maximum Networks                2000
Maximum Routes                  4000
Maximum Routes per Destination  64
Maximum Local Cache Entries     32
Maximum Remote Cache Entries    32
Keepalive-Filtering Table Size  32
              Keepalive
Ifc  NetNum    Filtering  Encapsulation
  0  20000000  Disabled   TOKEN-RING MSB
  1  20000001  Disabled   N/A

RIP Configuration:
------------------
                         Update    Split     Broadcast
Ifc  NetNum    RIP       Interval  Horizon   Pacing
  0  20000000  Enabled      1      Enabled   Disabled
  1  20000001  Disabled     1      Disabled  Enabled

SAP Configuration:
------------------
                         Update    Split     Broadcast  Get Nearest
Ifc  NetNum    SAP       Interval  Horizon   Pacing     Reply
  0  20000000  Enabled      5      Enabled   Disabled   Enabled
  1  20000001  Disabled     5      Disabled  Enabled    Enabled

Static Routes Configuration:
----------------------------
Static Routes:  Enabled
Dest Net  Hops  Ticks   Ifc  Next Hop
20202020  10    30        2  400000302200

Static Services Configuration:
------------------------------
Static Services:  Enabled
Type Service Name                   Srv Net  Host        Sck  Hops  Ifc
0004  FILESRV3                      20202020 000000000001 451    10    2

SAP Filter Configuration:
-------------------------
SAP filters:  Enabled
Max Hops  Type  Service Name
  5          4  FILESRV01
  10        34  NEWLONDON_XTC02

Access Control Configuration:
-----------------------------
IPX access controls:  Enabled
# T Dest Net         Host  Sck  Sck   Src Net         Host Sck Sck
1 I        1            0  451  451         4 200300040050  451 451
2 E 2000D003 200300400060  452  45F         0            1  452 452
```

filters Lists the global SAP filters.

Example: `list filters`

```
SAP Filter Configuration:
-------------------------
SAP filters:  Enabled
Max Hops  Type  Service Name
  5          4  FILESRV01
  10        34  NEWLONDON_XTC02
```

route-static

Lists the static routes.

Example: `list route-static`

```
Static Routes Configuration:
----------------------------
Static Routes:  Enabled
Dest Net  Hops  Ticks   Ifc  Next Hop
20202020    10     30     2  400000202030
```

sap-static

Lists the static services.

Example: `list sap-static`

```
Static Services Configuration:
------------------------------
Static Services:  Enabled
Type Service Name                  Srv Net  Host         Sck  Hops Ifc
0004  FILESRV3                    20202020  000000000001 451    10   2
```

summary Lists a summary of the IPX, RIP, SAP, IPXWAN, and Keepalive filtering configuration for all interfaces on which IPX is enabled.

Example: `list summary`

```
IPX Configuration:
------------------
IPX Globally                    Enabled
Host Number                     400000200000
Maximum Services                2000
Maximum Networks                2000
Maximum Routes                  4000
Maximum Routes per Destination  64
Maximum Local Cache Entries     32
Maximum Remote Cache Entries    32
Keepalive-Filtering Table Size  32
               Keepalive
Ifc  NetNum    Filtering  Encapsulation
  0  20000000  Disabled   TOKEN-RING MSB
  1  20000001  Disabled   N/A

RIP Configuration:
------------------
                           Update    Split     Broadcast
Ifc  NetNum    RIP         Interval  Horizon   Pacing
  0  20000000  Enabled       1       Enabled   Disabled
  1  20000001  Disabled      1       Disabled  Enabled

SAP Configuration:
------------------
                           Update    Split     Broadcast  Get Nearest
Ifc  NetNum    SAP         Interval  Horizon   Pacing     Reply
  0  20000000  Enabled       5       Enabled   Disabled   Enabled
  1  20000001  Disabled      5       Disabled  Enabled    Enabled
```

IPX Configuration

The following global information is displayed:

- Whether IPX is globally enabled or disabled
- IPX host number
- Maximum services
- Maximum networks
- Maximum routes
- Maximum routes per destination
- Maximum local cache entries
- Maximum remote cache entries
- Keepalive-filtering table size

The following is displayed for each interface on which IPX is enabled:

- Interface number (Ifc)
- IPX network number (Netnum)
- Keepalive filtering
- Encapsulation

RIP Configuration

The following information is displayed for each interface on which IPX is enabled:

- Interface number
- IPX network number
- Whether RIP is enabled or disabled
- RIP update interval timer
- Whether split-horizon is enabled or disabled
- Whether RIP broadcast pacing is enabled or disabled

SAP Configuration

The following information is displayed for each interface on which IPX is enabled:

- Interface number
- IPX network number
- Whether SAP is enabled or disabled
- SAP update interval timer
- Whether split-horizon is enabled or disabled
- Whether SAP broadcast pacing is enabled or disabled
- Whether reply to SAP get-nearest-server request is enabled.

Static Routes Configuration

Displays whether static routes are globally enabled or disabled. In addition, the following is displayed for each configured static route.

- IPX dest net number
- Hops
- Ticks
- Interface number
- Next hop node address

Static Services Configuration

Displays whether static services are globally enabled or disabled. In addition, the following is displayed for each configured static service:

- Service type
- Service name
- IPX network number of service
- IPX node address of Service
- Socket
- Hops
- Interface number

SAP Filter Configuration

Displays whether the global SAP filters are enabled or disabled. In addition, the following information is displayed for each configured global SAP filter:

- Max hops
- Service type
- Service name

Access Control Configuration

Displays whether the global IPX filters (access controls) are enabled or disabled. In addition, the following information is displayed for each configured global IPX filter (access control):

- Access control index
- Filter type (include or exclude)
- Destination IPX network number
- Destination IPX node number
- Destination IPX socket range

- Source IPX network number
- Source IPX node number
- Source IPX socket range

Move

Use the **move** command to change the line numbers for the Global IPX filters (access controls) After you move the lines, they are renumbered to reflect the new order.

Syntax:

m**ove access-control** *line# line#*

Example: **`move 5 2`**

```
About to move:
 # T Dest Net         Host  Sck  Sck  Src Net         Host  Sck  Sck
 5 E       30 020000000006   30   32        2 020000000004   45   46
to be after:
 2 I     2487 020300000008    0    0    45230 020000000042    0    0
Are you sure this is what you want to do(Yes or [No]):
```

Set

Use the **set** command to configure the host number, IPXWAN router name and node ID, IPXWAN routing type, connection timeout and retry timer, IPX network numbers, maximum RIP and SAP table sizes, local and remote cache sizes, global IPX filter (access control) and global SAP filter states, RIP and SAP update intervals, Keepalive filter table size and split-horizon usage.

Syntax:

set
- access-control . . .
- filter . . .
- host-number . . .
- ipxwan . . .
- local-cache size . . .
- maximum routes-per-destination . . .
- maximum networks . . .
- maximum services . . .
- maximum total-route-entries . . .
- name . . .
- net-number . . .
- node-id . . .
- remote-cache size . . .
- rip-update-interval . . .
- sap-update-interval . . .
- split-horizon . . .

access-control *on* **or** *off*

Turns the global IPX filters (access controls) on or off. Enter **on** or **off**.

Example: **`set access-control on`**

filter *on* **or** *off*

Turns the global SAP filters on or off. Enter **on** or **off**.

Example: **`set filter on`**

host-number *host#*

Specifies the host number used for serial interfaces running IPX. Each IPX router operating over serial interfaces must have a unique host number. This is required because serial interfaces do not have hardware node addresses from which to build a host number.

Valid Values: An 12-digit hexadecimal number in the range of X'000000000001' to X'FFFFFFFFFFFE'.

Default Value: none

This number must be unique on each router.

Example: `set host-number 0000000000F4`

Note: IPXWAN requires a router node ID and name to be configured. Use the **set node-ID** and **set name** commands to configure these parameters.

ipxwan *interface# routing-type connection-timeout retry-timer network#*

Sets up or modifies an interface to use the IPXWAN protocol when starting IPX on a serial interface using the PPP. Before the **set ipxwan** command can be invoked, IPXWAN must be enabled using the **enable ipxwan** command. This command also queries for a routing type, a connection timer value, retry timer value, and an IPX network number.

interface#

Specifies an existing interface on which IPX is configured.

Valid values: an existing interface number

Default Value: 0

routingType

Specifies the IPXWAN routing type to be negotiated. Specify 'r' for numbered RIP or 's' for static routing.

Valid values: 'r', 's', 'R', 'S'

Default Value: 'r'

connection-timeout

This value specifies the time limit, in seconds, within which the IPXWAN negotiation must be successfully completed. If it cannot be successfully completed before the connection timer expires, IPXWAN starts a retry timer. The device will not retry the negotiation until the retry timer expires.

Valid values: An integer number of seconds in the range of 5 to 300.

Default Value: 60 seconds

retry-timer

This parameter specifies the amount of time to wait after a connection is timed out before trying to reestablish the connection.

Valid values: An integer number of seconds in the range of 5 to 600.

Default Value: 60 seconds

network#

Specifies the IPX network to be used on the interface. You need to specify this parameter only if you have not configured a valid IPX network number previously. IPX network number 0 is valid only on IPXWAN Static Routing interfaces. Do not use IPX network numbers X'FFFFFFFE' and X'FFFFFFFF'.

Valid values: X'0' to X'FFFFFFFD'

Default Value: 1

Example: `set ipxwan`

```
Which interface [0]? 1
Routing type ('r'=RIP, 's'=static) [r]?
Connection Timeout (in sec) [60]?60
Retry timer (in sec) [60]? 60
Network number in hex (0 is allowed only on IPXWAN
Static Routing interfaces) [1]? 2
```

local-cache size *size*

Specifies the size of the local cache routing table.

The size of the local cache should equal the total number of clients on each router's local or client network plus a 10% buffer to prevent excessive purge requests.

Valid Values: The range is 1 to 10000.

Default Value: 64. For more information, see "Local Cache" on page 21-12 and "Remote Cache" on page 21-13.

Example: `set local-cache size`

```
New IPX local node cache size [64]? 80
```

maximum routes-per-destination *routes*

Specifies the maximum number of routes per destination network to store in the IPX RIP routes table.

Valid Values: An integer in the range of 1 to 64.

Default Value: 1. For additional information on multiple routes, see "Configuring Multiple Routes" on page 21-4.

Example: `set maximum routes-per-destination 8`

maximum networks *size*

Specifies the size of the IPX RIP network table. This reflects the number of networks in the internet on which IPX operates.

Valid Values: 1 to 2048

Router memory constraints can prevent the maximum table size from being used.

Default Value: 32 This value cannot be larger than the maximum total-route-entries *size*.

Example: `set maximum networks 30`

maximum services *size*

Specifies the size of the IPX SAP service table. This reflects the number of SAP services in the internetwork on which IPX operates.

Valid Values: 1 to 2048

Router memory constraints can prevent the maximum table size from being used.

Default Value: 32

Example: **`set maximum services 30`**

maximum total-route-entries *size*

Specifies the size of the IPX RIP routes table. This reflects the total number of routes, including alternate routes, in the internetwork on which IPX operates.

Valid Values: 1 to 4096

Default Value: 32

This value must be at least as large as the *maximum networks size*. For additional information of multiple routes, see “Configuring Multiple Routes” on page 21-4.

Example: **`set maximum total-route-entries 40`**

name *router_name*

Lets you assign a symbolic name to the router. IPXWAN requires a router to have a primary network number and a name.

Valid Values: A variable length string of 1 to 47 characters.

The router_name can contain the characters A through Z, 0 through 9, underscore (_), hyphen (-), and "at" sign (@).

Default Value: none.

Example: **`set name newyork_accounting`**

net-number *interface# network#*

Assigns an IPX network number to the associated directly-connected network. Every IPX interface must have a unique network number.

interface#

Specifies an existing interface on which IPX is configured.

Valid values: an existing interface number

Default Value: 0

network#

Specifies the IPX network number to be used on the interface. IPX network number 0 is valid only on IPXWAN interfaces configured to use the Static Routing routing type. IPX network number X'FFFFFFFF' is not a valid IPX network number. IPX network number X'FFFFFFFE' is reserved for the IPX Default Route and may not be used as an IPX network number. IPX will be disabled on the interface if a valid IPX network number is not configured.

Valid values: X'0' to X'FFFFFFFD'

Default Value: 1

Example: **`set net-number`**

```
Which interface [0]? 1
Network number in hex (0 is allowed only on IPXWAN
Static Routing interfaces) [1]? 2
```

node-id *network#*

Specifies the IPXWAN node ID (internal network number). IPX network number 0 is not a valid IPXWAN node ID. IPX network number FFFFFFFF is not a valid IPXWAN node ID. IPX network number FFFFFFFE is reserved for the IPX Default Route and may not be used as an IPXWAN node ID. IPXWAN will not be enabled unless a valid node ID is configured.*IPXWAN detailed*

Default Value:1

Example: `set node-id 1`

remote-cache size *size*

Specifies the size of the remote cache routing table.

The size of the remote cache should equal the total number of remote networks used by the router plus a 10% buffer to prevent excessive purge requests.

Valid Values: The range is 1 to 10000.

Default Value: 64.

Example: `set remote-cache size`

```
New IPX remote network cache size [64]? 80
```

rip-update-interval *interface# minutes*

Specifies the time delay in minutes between complete RIP updates given on an interface.

Increasing the RIP interval reduces traffic on WAN lines and dial circuits. It also prevents dial-on-demand circuits from dialing out so often.

Note: While complete RIP advertisements are controlled by the interval, the router still propagates network topology changes as quickly as it learns them.

Valid Values: The range is from 1 to 1440 minutes.

Default Value: 1 minute. For additional information on RIP interval, see “Specifying RIP Update Interval” on page 21-2.

Example: `set rip-update-interval`

```
Which interface [0]? 0
RIP Timer Value (minutes) [1]?2
```

sap-update-interval *interface# minutes*

Specifies the time delay in minutes between complete SAP updates given on an interface.

Valid Values: The range is from 1 to 1440 minutes.

Default Value: 1 minute.

Example: `set sap-update-interval`

```
Which interface [0]? 0
SAP Timer Value (minutes) [1]? 2
```

split-horizon *value interface#*

Specifies the type of split-horizon on the specified interface.

The value *enabled* enables split-horizon on the specified interface. The value *disabled* disables split-horizon on the specified interface. The value *heuristic* enables split-horizon on all types of interfaces except frame-relay. For frame-relay, split-horizon is enabled only if the specified

interface has exactly one PVC defined, otherwise split-horizon is disabled.

Generally, split-horizon should be set to *enabled*. It is sometimes necessary to disable split-horizon for partially-meshed frame-relay, X.25, and ATM configurations. For additional information on split-horizon, see "Split-Horizon Routing" on page 21-14.

Example: `set split-horizon enabled 0`

keepalive-table-size *value interface#*

Sets the number of entries that the Keepalive table holds. These entries include all current client/server and server/server pairs connected over the WAN link. The default is 32. The range is 1 to 250.

Example: `set keepalive-table-size`

```
which interface[0]? 0
Number of entries [32]?
```

Accessing the IPX Interface Filter Configuration Environment

To access the IPX Interface Filter configuration environment, enter the following command at the `IPX config>` prompt:

```
IPX Config> filter-lists type
IPX type-List Config>
```

Where *type* is the type of IPX filter to be configured. Valid types are *router-lists, rip-lists, sap-lists,* and *ipx-lists*.

IPX Interface Filter Configuration Commands

This section lists and then explains the commands to configure the IPX interface-based filters; ROUTER, RIP, SAP, and IPX. To configure these filters, enter the `filter-lists` *type* command at the `IPX Config>` prompt, and then enter the configuration commands at the `IPX` *type*`-List Config>` prompt.

Table 22-2 (Page 1 of 2). IPX Filter Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Attach	Attaches a specified filter-list to a specified filter.
Create	Creates a filter or filter-list.
Default	Sets the default action of a filter to *include* or *exclude*
Delete	Deletes a filter or filter-list.
Detach	Detaches a filter-list from a filter.
Disable	Disables filtering.
Enable	Enables filtering.
List	Displays the current filtering configuration.
Move	Reorders filter-lists attached to a filter.
Set-cache	Sets the caching size for a specified filter.

Table 22-2 (Page 2 of 2). IPX Filter Configuration Command Summary	
Command	Function
Update	Accesses the `IPX type-List filter-list Config>` prompt.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Attach

Use the **attach** command to attach a filter-list to a filter.

Syntax:

a**ttach** *list-name* *filter#*

list-name
Specifies the name of the filter-list. The **list** command can be used to display a list of the configured filter-list names.

Valid Values: Any alphanumeric string up to 16 characters

Default Value: None

filter#
Specifies the number of the filter. A numbered list of configured filters can be obtained using the list command.

Example: `attach test_list 1`

Create

Use the **create** command to create a filter-list or filter.

Syntax:

c**reate** l**ist** ...
f**ilter** ...

list *list-name*
Creates a list with the specified name.

Valid Values: Any alphanumeric string up to 16 characters

Default Value: none

You can also enter the **create list** command with no list name. You will then be prompted for the list name.

Example: `create list example_list`

filter *direction interface_number*
Creates a filter for the specified direction on the specified interface. Specify *input* to filter packets received on the specified interface. Specify *output* to filter packets to be sent by the specified interface.

A number is automatically assigned to a filter when it is created and from that point on is used to identify the filter, rather than having to key in the interface and direction (input or output) for all subsequent commands.

Example: `create filter input 1`

Default

Use the **default** command to set the default action for a filter. The default action is taken when no match is found for any of the filter items.

Syntax:

def**ault** *action filter#*
Example: **`default exclude 1`**

action
Specifies the default action. **Include** specifies that when no match is found to any of the filter items, the packet is processed. **Exclude** indicates that when no match is found, the packet is dropped.

filter#
Specifies the number of the filter. Use the **list** command to display a numbered list of configured filters.

Delete

Use the **delete** command to delete a filter-list or filter.

Syntax:

del**ete** list ...
filter ...

list *list-name*
Deletes the specified list. The list command can be used to display the configured filter list names.

Example: **`delete list example_list`**

filter *filter#*
Deletes the specified filter. The list command can be used to display a numbered list of configured filters.

Example: **`delete filter 1`**

Detach

Use the **detach** command to detach a filter-list from a filter.

Syntax:

det**ach** *list-name filter#*

list-name
Specifies the name of the filter-list. The list command can be used to display a list of the configured filter names.

Valid Values: Any alphanumeric string up to 16 characters

Default Value: None

filter#
Specifies the number of the filter. The list command can be used to display a numbered list of configured filters.

Example: **`detach test_list 1`**

Disable

Use the **disable** command to disable filtering globally or for a specified filter.

Syntax:

disable all
filter ...

all Disables all filters of the current type (ROUTER, RIP, SAP, or IPX).

Example: disable all

filter *filter#*
Disables the specified filter. Use the list command to display a numbered list of configured filters.

Example: disable filter 1

Enable

Use the **enable** command to enable filtering globally or for a specified filter.

Syntax:

enable all
filter ...

all Enables all filters of the current type (ROUTER, RIP, SAP, or IPX).

Example: enable all

filter *filter#*
Enables the specified filter. Use the list command to display a numbered list of configured filters

Example: enable filter 1

List

Use the **list** command to globally display the state of the current filtering type, or to display information about a specific filter.

Syntax:

list all
filter ...

all Lists information about the state of all filters of the current type.

Example: list all

```
IPX IPX-List Config>list all
Filtering: ENABLED

Filter Lists:
Name                           Action
------------------------------ ----------
ipx01                          EXCLUDE
ipx02                          INCLUDE
ipx03                          EXCLUDE

Filters:
Id   Default    State      Ifc  Direction  Cache
---- ---------- ---------- ---- ---------- -----
1    INCLUDE    ENABLED    0    INPUT      10
2    INCLUDE    ENABLED    0    OUTPUT     10
3    INCLUDE    DISABLED   1    INPUT      10
4    INCLUDE    DISABLED   1    OUTPUT     10
```

filter *filter#*

Lists information about the specified filter. Use the list command to display a numbered list of configured filters.

Example: list filter 1

```
Filter:
Id   Default    State      Ifc  Direction  Cache
---- ---------- ---------- ---- ---------- -----
1    INCLUDE    ENABLED    0    INPUT      10

Filter Lists:
Name                           Action
------------------------------ ----------
ipx01                          EXCLUDE
ipx02                          INCLUDE
```

Move

Use the **move** command to change the order of filter lists within a filter. Packets are evaluated against the filter lists in the order the lists occur. The first match stops the filtering process.

Syntax:

m**ove** *src-list-name dst-list-name filter#*

src-list-name
Specifies the list to be moved within the filter.

dst-list-name
Specifies the list before which the src-list-name will be moved.

filter#
Specifies the filter to which the lists belong. The list command can be used to display a list of the configured filters and their attached filter lists.

Example: `move test-list-1 test-list-2 2`

Set-cache

Use the **set-cache** command to set the size of the filter cache. A filter cache is only supported for the IPX interface filter; the ROUTER, RIP and SAP interface filters do not support a cache.

Syntax:

s**et-cache** *s*ize filter#

size
Specifies the size of the filter cache (in number of entries).

Valid Values: 4 to 64 cache entries.

Default Value: 10 entries.

filter#
Specifies the number of the filter. The list command can be used to display a numbered list of configured filters.

Example: `set-cache 10 1`

Update

The **update** command accesses the `IPX type-List list-name Config>` prompt. From this prompt you can issue commands to add, delete, or move items within the list being updated. From this prompt you can also set the action for the filter-list being updated.

Syntax:

u**pdate** *list-name*

list-name
Specifies the name of the filter-list. The list command can be used to display the configured filter-list names.

Example: `update test-list`

Add (Update subcommand)

Use the **add** subcommand to add items to a filter-list. The list item parameters vary based on the type of interface filter (ROUTER, RIP, SAP, or IPX) being configured. For all types of interface filter, the **add** command can be entered without parameters. You will then be prompted for the required parameters.

Add (ROUTER)

Syntax:

a**dd** ***address mask***

address
Specifies the value to be compared against the source node address of the router which sent the RIP response packet (after being ANDed with the mask). If you want to match on a single address, set the address parameter to the address and set the mask to FFFFFFFFFFFF. If you want to match on all addresses, set the address parameter and the mask parameter to 000000000000.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Default Value: none

mask
Specifies the value to be ANDed with the source node address of the router which sent the RIP response packet (before being compared with the address parameter).

If you want to match on a single address, set the address parameter to the address and set the mask to FFFFFFFFFFFF. If you want to match on all addresses, set the address parameter and the mask parameter to 000000000000.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Default Value: X'FFFFFFFFFFFF'

Example: `add 400000001000 ffffffff0000`

Add (RIP)

Syntax:

add ***net-range-start net-range-end***

net-range-start

Specifies the start of a range (inclusive) of IPX network numbers to be filtered. If you want to match on a single network number, set the net-range-start and net-range-end parameters to that network number. If you want to match on all network numbers, set the net-range-start to X'00000001' and the net-range-end to X'FFFFFFFE'.

Valid Values: X'1' to X'FFFFFFFE'

Default Value: X'1'

net-range-end

Specifies the end of a range (inclusive) of IPX network numbers to be filtered.

Valid Values: X'1' to X'FFFFFFFE'

Default Value: X'1'

Example: add 00000001 FFFFFFFE

Add (SAP)

Syntax:

add ***comparitor hops sap-type name***

comparitor

Specifies the type of hop count comparitor for this list item.

Valid Values:

- <
- <=
- =
- >=
- >

Default Value: <= The comparitor and hops parameters are ignored on output filters.

hops

Specifies the hop count for this list item. If you do not want to filter based on hop count, enter <= 16 for the comparitor and hop count. The comparitor and hops parameters are ignored on output filters.

Valid Values: 0 to 16

Default Value: 16

sap-type

Specifies the service type to be filtered. Enter the service type, or X'0000' for all service types.

Valid Values: X'0' to X'FFFF'

Default Value: 4

name
Specifies the service name to be filtered.

Valid Values:

A string of 1 to 47 ASCII characters (X'20' through X'7E').

The question mark (?) and asterisk (*) characters serve as wildcard characters. The question mark may be used multiple times to represent any single character within the server name. The asterisk may be used multiple times to represent any portion of the server name. The question mark and asterisk may also be used together.

Default Value: none

Example: `add < 6 0004 *`

Add (IPX)

Syntax:

add ***comparitor hops ipx-type dst-net-range-start dst-net-range-end dst-address dst-mask dst-sck-range-start dst-sck-range-end src-net-range-start src-net-range-end src-address src-mask src-sck-range-start src-sck-range-end***

comparitor
Specifies the type of hop count comparitor for this list item. The comparitor and hops parameters are ignored on output filters.

Valid Values:

- <
- <=
- =
- >=
- >

Default Value: <=

hops
Specifies the hop count for this list item. If you do not want to filter based on hop count, enter <= 16 for the comparitor and hop count. The comparitor and hops parameters are ignored on output filters.

ipx-type
Specifies the IPX packet type to be filtered. Enter the packet type, or 00 for all packet types.

Valid Values: X'0' to X'FF'

Default Value: X'0'

dst-net-range-start
Specifies the start of a range (inclusive) of destination IPX network numbers to be filtered. If you want to match on a single network number, set the dst-net-range-start and dst-net-range-end parameters to that network number. If you want to match on all network numbers, set the dst-net-range-start to X'00000001' and the dst-net-range-end to X'FFFFFFFE'.

Valid Values: X'00000000' to X'FFFFFFFF'

Default Value: X'00000000'

dst-net-range-end
Specifies the end of a range (inclusive) of destination IPX network numbers to be filtered. If you want to match on a single network number, set the dst-net-range-start and dst-net-range-end parameters to that network number. If you want to match on all network numbers, set the dst-net-range-start to X'00000001' and the dst-net-range-end to X'FFFFFFFE'.

Valid Values: X'00000000' to X'FFFFFFFF'

Default Value: X'00000000'

dst-address
Specifies the value to be compared against the destination node address (after being ANDed with the dst-mask). If you want to match on a single address, set the dst-address parameter to the address and set the dst-mask to X'FFFFFFFFFFFF'. If you want to match on all addresses, set the dst-address parameter and the dst-mask parameter to X'000000000000'.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Default Value: X'000000000000'

dst-mask
Specifies the value to be ANDed with the destination node address (before being compared with the dst-address parameter). If you want to match on a single address, set the dst-address parameter to the address and set the dst-mask to X'FFFFFFFFFFFF'. If you want to match on all addresses, set the dst-address parameter and the dst-mask parameter to X'000000000000'.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Default Value: X'000000000000'

dst-sck-range-start
Specifies the start of a range (inclusive) of destination IPX sockets to be filtered. If you want to match on a single socket, set the dst-sck-range-start and dst-sck-range-end parameters to that socket. If you want to match on all sockets, set the dst-sck-range-start to X'0000' and the dst-sck-range-end to X'FFFF'.

Valid Values: X'0000' to X'FFFF'

Default Value: 0

dst-sck-range-end
Specifies the end of a range (inclusive) of destination IPX sockets to be filtered. If you want to match on a single socket, set the dst-sck-range-start and dst-sck-range-end parameters to that socket. If you want to match on all sockets, set the dst-sck-range-start to X'0000' and the dst-sck-range-end to X'FFFF'.

Valid Values: X'0000' to X'FFFF'

Default Value: 0

src-net-range-start
Specifies the start of a range (inclusive) of source IPX network numbers to be filtered. If you want to match on a single network number, set the

src-net-range-start and src-net-range-end parameters to that network number. If you want to match on all network numbers, set the src-net-range-start to X'00000001' and the src-net-range-end to X'FFFFFFFE'.

Valid Values: X'00000000' to X'FFFFFFFE'

Default Value: X'00000000'

src-net-range-end
Specifies the end of a range (inclusive) of source IPX network numbers to be filtered. If you want to match on a single network number, set the src-net-range-start and src-net-range-end parameters to that network number. If you want to match on all network numbers, set the src-net-range-start to X'00000001' and the src-net-range-end to X'FFFFFFFE'.

Valid Values: X'00000000' to X'FFFFFFFE'

Default Value: X'00000000'

src-address
Specifies the value to be compared against the source node address (after being ANDed with the src-mask). If you want to match on a single address, set the src-address parameter to the address and set the src-mask to X'FFFFFFFFFFFF'. If you want to match on all addresses, set the src-address parameter and the src-mask parameter to X'000000000000'.

Valid Values: X'00000000' to X'FFFFFFFF'

Default Value: X'00000000'

src-mask
Specifies the value to be ANDed with the source node address (before being compared with the src-address parameter). If you want to match on a single address, set the src-address parameter to the address and set the src-mask to X'FFFFFFFFFFFF'. If you want to match on all addresses, set the src-address parameter and the src-mask parameter to X'000000000000'.

Valid Values: X'000000000000' to X'FFFFFFFFFFFF'

Default Value: X'000000000000'

src-sck-range-start
Specifies the start of a range (inclusive) of source IPX sockets to be filtered. If you want to match on a single socket, set the src-sck-range-start and src-sck-range-end parameters to that socket. If you want to match on all sockets, set the src-sck-range-start to X'0000' and the src-sck-range-end to X'FFFF'.

Valid Values: X'0000' to X'FFFF'

Default Value: X'0000'

src-sck-range-end
Specifies the end of a range (inclusive) of source IPX sockets to be filtered. If you want to match on a single socket, set the src-sck-range-start and src-sck-range-end parameters to that socket. If you want to match on all sockets, set the src-sck-range-start to 0000 and the src-sck-range-end to FFFFF.

Valid Values: X'0000' to X'FFFF'

Default Value: X'0000'

Example:

```
add  <= 16  0  00000004 00000004 000000000000 000000000000
0000 FFFF 0000005A 0000006A 000000000000 000000000000 0000 FFFF
```

This example filters all packets from IPX networks 5A through 6A to IPX network 4.

Delete (Update subcommand)

Use the **delete** subcommand to delete an item from the current filter-list.

Syntax:

delete *item#*

item#
Specifies the number of the item in the list. The number can be obtained by using the list command to list the items in the filter-list.

Example: `delete 4`

List (Update subcommand)

Use the **list** subcommand to display the filter-list action and list filter items.

Syntax:

list

Example: `list`

```
IPX IPX-List 'ipx01' Config>list
Action: EXCLUDE
Id   Hops Type Net Range           Address      Mask         Sock Range
---- ---- ---- ------------------- ------------ ------------ -----------
1    <=16    0     4320 -     4324 4000003A0002 FFFFFFFFFFFF    0 - FFFF (Dest)
                   3A33 -    13A33 400000010000 FFFFFFFF0000    0 - FFFF (Source)
```

Move (Update subcommand)

Use the **move** subcommand change the order of filter items. After you change the order of filter items, they are renumbered to reflect the new order. The list command can be used to display a numbered list of configured filter items.

The *src-line#* parameter indicates the line to be moved. This line will be moved to precede the item specified by the *dest-line#* parameter.

Syntax:

move *src-line# dest-line#*

Example: `move 5 2`

Set-action (Update subcommand)

Use the **set-action** subcommand to indicate the action to be taken when a match is made to a filter-list

Syntax:

set-action include
exclude

include Specifies that if a match is found for the current filter, the packet will be processed (included) for ROUTER and IPX filters. For RIP and SAP filters, **include** specifies that the RIP or SAP entry will be processed.

Example: `set-action include`

exclude Specifies that if a match is found for the current filter, the packet will be dropped (excluded) for ROUTER and IPX filters. For RIP and SAP filters, **exclude** specifies that if a match is found, the RIP or SAP entry will be ignored.

Example: `set-action exclude`

Accessing the IPX Monitoring Environment

For information on how to access the IPX monitoring environment, refer to "Getting Started (Introduction to the User Interface)" in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

IPX Monitoring Commands

Table 22-3 lists the IPX monitoring commands. The IPX monitoring commands allow you to view the parameters and statistics of the interfaces and networks that transmit IPX packets. Monitoring commands display configuration values for the physical, frame, and packet levels. You also have the option of viewing the values for all three protocol levels at once.

Enter the IPX monitoring commands at the `IPX>` prompt. Table 22-3 summarizes the IPX monitoring commands.

Table 22-3 (Page 1 of 2). IPX Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Access-controls	Displays whether the global IPX filter (access control) is enabled, the IPX access-control statements, and the number of packets that have matched each access-control statement.
Cache	Lists the current contents of the routing cache.
Config	Lists the IPXWAN router name and node-ID. Lists the number, name and type of each interface on which IPX is enabled, as well as the IPX network number and host number, the frame encapsulation type, whether RIP/SAP Broadcast Pacing is enabled on those interfaces, and the RIP and SAP update intervals on those interfaces. This command also displays whether IPX is globally enabled and whether RIP or SAP is enabled on each IPX interface.
Counters	Displays the number of routing errors and packet overflows.
Disable	Disables specific IPX interfaces or globally disables IPX.
Dump routing tables	Displays the contents of the IPX RIP table.
Enable	Enables IPX on specific interfaces or globally enables IPX.

Table 22-3 (Page 2 of 2). IPX Monitoring Command Summary

Command	Function
Filters	Displays whether global SAP filtering is enabled, the SAP filter statements, and a count of the SAP advertisements which have been filtered.
Filter-Lists	Accesses the `IPX type-Lists>` prompt. This is the environment where information regarding the Interface filters (ROUTER, RIP, SAP, and IPX) can be displayed.
IPXWAN	Lists IPXWAN configuration information for each serial interface on which IPXWAN is enabled.
Ping	Sends IPXPING packets to another host and watches for a response. This command can be used to isolate trouble in an internetwork environment.
Recordroute	Sends IPXPING record route packets to another host and watches for a response. Use this command to record and display the round-trip route between this device and another host. Use this information to isolate trouble in an internetwork environment.
Sizes	Displays the configured sizes of the local node and remote network caches, and the number of cache entries currently in use.
Slist	Displays the contents of the IPX SAP server table.
Traceroute	Sends IPXPING trace route packets to another host and watches for a response. Use this command to trace and display each hop a packet takes on its way from this device to a destination host. Use this information to isolate trouble in an internetwork environment.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Access Controls

Use the **access-controls** command to list the status of global IPX filters (access controls), the IPX access control statements, and a count of how many times each control statement has been followed.

Syntax:

a**ccess-controls**

Example: `access-controls`

```
Access Control currently enabled
List of Access Control records:
# T   Dest Net  Host          Sck  Sck  Src Net  Host         Sck Sck  Count
1 E        179  123456789ABC 1234 1234      176  000000000000   0   0    3
2 I          0  000000000000    0  FFF        0  000000000000 426 426    0
```

Type

Identifies whether packets are sent or dropped for a specific address or set of addresses. I means include. This allows the packets to be sent. E means exclude. This causes the router to discard the packets.

Dest-net

Network number of the destination. Zero (0) means all networks.

Dest-host

Host number on the destination network (0) means all hosts on the network.

Dest-sck
Two numbers that specify an inclusive range of destination sockets.

Src-net
Network number of the source. Zero (0) means all networks.

Src-host
Host number on the source network. Zero means all hosts on the network.

Src-sck
Two numbers that specify an inclusive range of source sockets.

Count
Specifies the number of incoming IPX packets that have matched each access-control statement, causing the associated Type (Include or Exclude) to be performed.

Cache

Use the **cache** command to display the contents of the IPX routing cache.

Syntax:

ca**che**

Example: **`cache`**

```
Dest Net/Node         Use Count    via Net/Node        via Int

162                    56476       162/000000000000     Eth/0
162/0000C0239F71       56476       162/0000C0239F71     Eth/0
```

The first entry shows that the remote network 152 can be reached over the serial interface with IPX network number 161. The second entry is the IPX network 162. It is an Ethernet directly attached to the router. This entry is a general local network entry. There will be one general local network entry for each of the directly attached networks after they have begun forwarding IPX packets. The last entry is a local entry on an Ethernet. This IPX cache entry has been used to send 56,476 packets to the IPX node number 0000 C023 9F71 on net number 162.

Config

Use the **config** command to list the number, name, and type of each network interface on which IPX is enabled, as well as listing the IPX network number and host number, the frame encapsulation type, whether RIP or SAP is enabled on the interface, and the RIP and SAP update intervals on those interfaces. The **config** command also displays whether RIP/SAP Broadcast Pacing is enabled on specific interfaces, and the IPXWAN router name and node ID and whether IPX is enabled globally.

Syntax:

con**fig**

Example: **`config`**

Router Configuration
The following global information is displayed:

- Whether IPX is enabled or disabled
- IPX name

- Node ID

In addition, the following is displayed for each IPX interface on which IPX is enabled:

- Interface number (Net)
- Interface name
- Hardware type of the interface
- User-assigned network number and host number (Network/Address)

IPX Encapsulation Frames/Types

The following is displayed for each IPX interface on which IPX is enabled:

- Interface number (Net)
- Interface name
- Hardware type of the interface
- Encapsulation type configured for the interface

RIP/SAP Intervals and Pacing

The following is displayed for each IPX interface on which IPX is enabled:

- Interface number (Net)
- Interface name
- Whether RIP is enabled or disabled
- RIP interval
- Whether SAP is enabled or disabled
- SAP interval
- Whether broadcast pacing is enabled or disabled

Counters

Use the **counters** command to display the number of routing errors and packet overflows that have occurred. In the example, the counters show no recorded errors.

Syntax:

cou**nters**

Example: **`counters`**

```
Routing errors
Count     Type
   0      Unknown
   0      Checksum error
   0      Destination unreachable
   0      Hop count expired
   0      Interface size exceeded

Destination errors
Count      Type
   0       Unknown
   0       Checksum error
   0       Nonexistent socket
   0       Congestion

IPX input packet overflows
    Net     Count
   Eth/0    0
```

Routing Errors

Unknown

An unspecified error occurred before reaching the destination.

Checksum
The checksum is incorrect, or the packet had some other serious inconsistency before reaching the destination.

Destination unreachable
The destination host cannot be reached from here.

Hop count expired
The packet has passed through 15 internet routers without reaching its destination.

Interface size exceeded
The packet is too large to be forwarded through some intermediate network.

Destination errors

Unknown
An unspecified error was detected at destination.

Checksum
The checksum is incorrect, or the packet has some other serious inconsistency detected at destination.

Nonexistent socket
The specified socket does not exist at the specified destination host.

Congestion
The destination cannot accept the packet due to resource limitations.

IPX Input Packet Overflows

Net Specifies the interface name.

Count
Specifies the number of packets that could not be received due to resource limitations.

Delete

Use the **delete** command to remove a Keepalive filtering table entry.

Syntax:

de**lete** *entry#*

entry# Specifies the table entry to be deleted. The **Keepalive** command can be used to list the contents of the Keepalive filtering table.

Example: `delete 1`

Disable

Use the **disable** command to disable IPX on specific interfaces, or to disable IPX globally on all interfaces.

Syntax:

di**sable** interface ...
ipx

interface *interface#*
Disables IPX on the specified interface. IPX can be re-enabled on the interface using the **enable** command.

Example: `disable interface 0`

ipx Disables IPX globally on all interfaces. IPX can be globally re-enabled using the **enable** command.

Example: `disable ipx`

Dump

Use the **dump** command to display the contents of the current IPX RIP routing tables.

Syntax:

du**mp**

Example: `dump`

The screen displays the following information:

```
 11 route entries used out of 32
 11 net entries used out of 32

Type  Dest net  Hops  Delay  Age(M:S)   via Router
 Dir      124     0      1       0: 0    124/AA0004001A04
 Dir      131     0      1       0: 0    131/00000000001A
 Dir      177     0      1       0: 0    177/00000000001A
 Dir       41     0      1       0: 0     41/4000C90401FA
 Dir      249     0      1       0: 0    249/0000C9084F34
 RIP      250     1      2       0:10    249/0000C9093250
 RIP 2C39ABE9     2      3       0:10    249/0000C9093250
 RIP       BB     1      2       0:50     41/4000C9050971
 RIP        1     2      3       0:50     41/4000C9050971
Stat       31     2      3       0:50     41/4000C9050971
 RIP      703     1      2       0:20     41/4000C9041243
```

Type

- Dir - specifies that this network is directly connected to the router.
- RIP - specifies that this route was provided by the IPX routing protocol, RIP.
- Old - specifies that this route has timed out and is no longer being used. The route remains in the table briefly to inform other routers that the route is no longer valid; after this brief interval, it is no longer displayed.
- Stat - specifies that this is a static route.

Dest net Specifies the destination network number.

Hops Specifies the number of hops to this destination.

Delay Specifies the estimate of how long it takes the router to transmit and for the packet to arrive at its destination. The unit of delay is the number of IBM PC clock ticks to send a 576-byte packet, which is 18.21 clock ticks per second. The minimum delay is 1 unit.

Age Specifies the age of the routing information in minutes and seconds. If an entry in the routing table is not updated, the router takes the following actions:

- After three RIP update intervals have passed, the route is specified as Old and the router advertises that the route is no longer valid. The RIP update interval can be displayed using the IPX **config**

command. For additional information on RIP intervals, see “Specifying RIP Update Interval” on page 21-2.

- After an additional 60 seconds, the route is deleted and does not appear in the dump display.

Via router Specifies the next hop for packets going to networks that are not directly connected. For directly connected networks, this is the address of the router interface that transmits the packet.

At the top of the display is the number of route and network entries used and the total available. If all the network entries are used, it is likely that the routing table is not large enough. Use the IPX configuration **set maximum networks** command to increase the size.

If all of the route entries are used, then there may be routes to IPX networks that cannot be kept, including new, incoming networks. If you do not want to increase the number of available routes, reduce the number of maximum routes per network.

Enable

Use the **enable** command to enable IPX on specific interfaces or to globally enable IPX on all interfaces on which IPX has been configured and enabled.

Syntax:

en**able** interface ...
ipx

interface *interface#*
Enables IPX on the specified interface. An IPX network number must have been configured for the interface before IPX can be enabled. For serial interfaces, a host-number must have been configured before IPX can be enabled.

Example: `enable interface 0`

ipx Enables IPX on all interfaces on which IPX has been configured and enabled.

Example: `enable ipx`

Filters

Use the **filters** command to display whether global SAP filtering is enabled, the SAP filter statements, and a count of the SAP advertisements that have been filtered.

Syntax:

filters

Example: `filters`

```
IPX SAP Filter currently enabled
List of IPX SAP Filter records:
Count  Max Hops  Type  Service Name
  0           8     4  ?
  0           1  1234  SomeServer
```

Count Indicates the number of SAP advertisements that have been filtered (discarded).

Max Hops
Indicates the maximum number of hops permitted for the service.

Type Is the numeric service class.

Service name
Is the name of the service if it has a name.

Filter-lists

Use the **filter-lists** command to access the `IPX type-Lists>` prompt. Valid types are: router-lists, rip-lists, sap-lists, and ipx-lists.

For information about the commands available from this prompt, see "IPX Interface Filter Monitoring Commands" on page 22-50.

Syntax:

filter-**lists** router-lists
rip-lists
sap-lists
ipx-lists

Example: **`filter-lists router-lists`**

IPXWAN

Use the **ipxwan** command to list the current configuration information for serial interfaces on which IPXWAN is enabled.

Syntax:

i**pxwan** detailed . . .
summary

detailed *interface#*
Lists the complete current configuration information for the specified serial interface on which IPXWAN is enabled.

Example: **`ipxwan detailed`**

```
Network number [0]? 2
Detailed information for IPXWAN link over interface 2, PPP/1
This side is the IPXWAN slave
Neighbor Name: SKYSURF2
Neighbor Node ID: 727299
Negotiated Routing Type: RIP/SAP
Link Delay: 330 1/18th sec ticks
Common Net#: 132
Connection Timeouts: 0
Connection Retries: 0
Timer Requests Sent: 1
Timer Requests Received: 1
Timer Responses Sent: 1
Timer Responses Received: 0
Info Requests Sent: 0
Info Requests Received: 1
Info Responses Sent: 1
Info Responses Received: 0
```

Network number
The network interface number.

Neighbor Name
The router name of the neighbor as received in the RIP/SAP Information Request Packet.

Neighbor Node ID
The node ID (also known as the primary network number) of the neighbor. This is a IPX network number unique to the entire internetwork. It is a 32-bit quantity.

Negotiated Routing Type
The negotiated routing type. Currently supported are RIP/SAP and Static Routing. When Static Routing is the negotiated routing type, no common network number is required on the link.

Link Delay
The link delay in 1/18th second ticks calculated by the master. It is a 16-bit quantity. It is always calculated, therefore there is no default.

Common Net#
The network number agreed upon by both ends of the link. This number must be unique to the entire internetwork. It is a 32-bit quantity. When the negotiated routing type is Static Routing, the value 0 will be displayed as the Common Net# for both the *IPXWAN detailed* and *IPXWAN summary* commands. There is no default, it must be negotiated.

Connection Timeouts
The number of times the connection timed out. A connection will timeout periodically if the exchange of IPXWAN packets does not proceed. You can configure the timeout period using the **set ipxwan** command. The default for the timeout period is 60 seconds.

Connection Retries
The number of times the connection is retried after timing out. The amount of time to wait (before retrying) is configurable by using the **set ipxwan** command. It defaults to 60 seconds.

Timer Requests Sent
The number of IPXWAN Timer Request packets sent.

Timer Requests Received
The number of IPXWAN Timer Request packets received.

Timer Responses Sent
The number of IPXWAN Timer Response packets sent.

Timer Responses Received
The number of IPXWAN Timer Response packets received.

Info Requests Sent
The number of IPXWAN Information Request packets sent.

Info Requests Received
The number of IPXWAN Information Request packets received.

Info Responses Sent
The number of IPXWAN Information Response packets sent.

Info Responses Received
The number of IPXWAN Information Response packets received.

summary Lists a summary of the current configuration information for each serial interface on which IPXWAN is enabled. Summary information is displayed only for links that have successfully completed the IPXWAN protocol exchange.

Example: `ipxwan summary`

```
Net  Name   Common Net#  NodeID  Neighbor Name

2    PPP/1  132          727299  SKYSURF2
```

Net Network interface number.

Name
Network interface name.

Common Net#
Network number agreed upon by both ends of the link. This number must be unique to the entire internetwork. The common net# will be 0 if the negotiated routing type is Static Routing.

NodeID
Node ID (also known as the primary network number) of the neighbor. This is a IPX network number unique to the entire internetwork.

Neighbor Name
Router name of the neighbor as received in the RIP/SAP Information Request Packet.

Ping

Use the **ping** command to make the router send IPXPING packets to a given destination (“pinging”) and watch for a response. This command can be used to isolate trouble in an internetwork environment.

This process is done continuously. Matching received responses are displayed with the sender’s IPX network number and node number, the number of hops, and the round-trip time in milliseconds.

To stop the pinging process, type any character at the monitoring. At that time, a summary of packet loss, round-trip time, and number of unreachable destinations will be displayed.

When a multicast address is given as destination, there may be multiple responses for each packet sent, one for each group member. Each returned response is displayed with the source address of the responder.

Notes:

1. Care should be taken when specifying the broadcast address (FFFFFFFFFFFF), as this could generate a large number of IPXPING response packets, which would degrade network and routing software performance.
2. If you enter the **ping** command without any parameters, you will be prompted for all parameters. If you enter only ***destination network*** and ***destination node***, default values will be used for the remaining parameters.

Syntax:

ping *dest-net dest-node src-net src-node size rate*

dest-net

Specifies the destination IPX network number. This parameter is required.

Valid Values: X'1' to X'FFFFFFFD'

Default Value: 1

dest-node

Specifies the destination IPX node address. This parameter is required.

Value Value: X'1' to X'FFFFFFFFFFFF'

Default Value: None

src-net

Specifies the source IPX network number. This is an optional parameter. The value must be a known network number that is associated with a directly attached interface. If a source network is not specified, the network number of the interface on which the IPXPING request packets are sent will be used as the source IPX address. If the interface is an IPXWAN Static Routing interface, the network number of some other numbered interface will be used as the source address, since IPXWAN Static Routing interfaces are not assigned an IPX network number.

Value Value: X'1' - X'FFFFFFFD'

Default Value: 1

src-node

Specifies the source IPX node address. This is an optional parameter. The value must be a known node address that is associated with a directly attached interface. If a source node is not specified, the node address of the interface on which the IPXPING request packets are sent will be used as the source IPX node. If the interface is an IPXWAN Static Routing interface, the node address of interface used for the source network number will be used as the source node.

Value Value: X'1' - X'FFFFFFFFFFFE'

Default Value: None

size

Specifies the number of data bytes to be appended to the ping request. This is an optional parameter. The data includes the time the request is first sent so the amount specified cannot be smaller than 4 bytes. It also cannot be larger than the maximum packet size supported by the router or the output interface. This value can vary depending on the configuration.

Value Value: 4 to Router Maximum

Default Value: 56 bytes

rate

Specifies the number of seconds between ping requests. This is an optional parameter.

Value Value: 1 to 60

Default Value: 1

Example: ping

```
Destination network number [1]? 20
Destination node number []? 00000001c200
Source network number [1]? 10
Source node number []? 000000019a00
Data size: [56]?
Rate in seconds [1]?

IPXPING 20/00000001C200: 56 data bytes
56 data bytes from 20/00000001C200: hops=3 time=0 ms
56 data bytes from 20/00000001C200: hops=3 time=40 ms
56 data bytes from 20/00000001C200: hops=3 time=0 ms

----20/00000001C200 IPXPING Statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip (ms) min/ave/max = 0/13/40
```

RecordRoute

Use the **recordroute** command to report every forwarding interface on the path to the destination and back again. If recordroute is invoked with no parameters, you will be prompted for all of them. Only the destination IPX network number and destination IPX node address are required.

There are two events that will end a recordroute. The first is when you press a key. The second is when the maximum number of recordroute request packets have been sent.

Syntax:

recordroute *dest-net dest-node src-net src-node rate number*

dest-net
Specifies the destination IPX network number. This parameter is required.

Value Values: X'1' to X'FFFFFFFD'

Default Value: 1

dest-node
Specifies the destination IPX node address. This parameter is required.

Value Values: X'1' to X'FFFFFFFFFFFE'

Default Value: None

src-net
Specifies the source IPX network number. This is an optional parameter. The value must be a known network number that is associated with a directly attached interface. If a source network is not specified, the network number of the interface on which the recordroute request packets are sent will be used as the source IPX address. If the interface is an IPXWAN Static Routing interface, the network number of some other numbered interface will be used as the source address, since IPXWAN Static Routing interfaces are not assigned an IPX network number.

Value Values: X'1' to X'FFFFFFFD'

Default Value: 1

src-node
Specifies the source IPX node address. This is an optional parameter. The value must be a known node address that is associated with a directly attached

interface. If a source node is not specified, the node address of the interface on which the recordroute request packets are sent will be used as the source IPX node. If the interface is an IPXWAN Static Routing interface, the node address of the interface used for the source network number will be used as the source node.

Value Values: X'1' to X'FFFFFFFFFFFE'

Default Value: None

rate

Specifies the number of seconds between recordroute requests. This is an optional parameter.

Value Values: 1 to 60

Default Value: 1

number

Specifies the maximum number of recordroute requests to be sent. This is an optional parameter. A value of zero will cause the recordroute to continue until a key is pressed.

Value Values: 0 to 60

Default Value: 0

Example: `recordroute`

```
Destination network number [1]? 20
Destination node number []? 00000001c200
Source network number [1]? 10
Source node number []? 000000019a00
Rate in seconds [1]?
Number of packets to send [0]?

RECORDROUTE 20/00000001C200: 784 data bytes
784 data bytes from 20/00000001C200: seq_no=0 time=0 ms
Recorded Routes (in hex):
                10/000000019A00
                500/0000100A0000
                500/0000100C0000
                10/000000019000
                10/000000019A00 (Final Destination)

784 data bytes from 20/00000001C200: seq_no=1 time=30 ms  (same route)
784 data bytes from 20/00000001C200: seq_no=2 time=10 ms  (same route)
...
784 data bytes from 20/00000001C200: seq_no=18 time=0 ms
Recorded Routes (in hex):
                10/000000019A00
                0/0000100A0000
                20/00000001AE00
                20/00000001C200
                0/0000100B0000
                10/000000019000
                10/000000019A00 (Final Destination)

784 data bytes from 20/00000001C200: seq_no=19 time=0 ms  (same route)
784 data bytes from 20/00000001C200: seq_no=20 time=70 ms  (same route)
784 data bytes from 20/00000001C200: seq_no=21 time=0 ms  (same route)
...
784 data bytes from 20/00000001C200: seq_no=48 time=0 ms
Recorded Routes (in hex):
                10/000000019A00
                500/0000100A0000
                500/0000100C0000
                10/000000019000
                10/000000019A00 (Final Destination)

784 data bytes from 20/00000001C200: seq_no=49 time=0 ms  (same route)
784 data bytes from 20/00000001C200: seq_no=50 time=0 ms  (same route)

----20/00000001C200 RECORDROUTE Statistics----
53 packets transmitted, 38 packets received, 28% packet loss
5 unreachables, 0 no usable source addresses, 0 buffer unavailables
round-trip (ms) min/ave/max = 0/23/100
```

The entire path is reported only once on the first response or when the path changed. In the above example, the path changed twice.

Sizes

Use the **sizes** command to display the configured sizes of the local node and remote network caches, and the number of cache entries currently in use. (This command does not display the contents of the caches.)

Syntax:

si**zes**

Example: `sizes`

```
Current IPX cache size:
Remote network cache size (max entries): 64
       2 entries now in use

Local node cache size (max entries): 128
       1 entries now in use
```

Slist

Use the **slist** command to display the contents of the IPX SAP server table.

Syntax:

sl**ist**

Example: `slist`

```
State Typ Service Name Hops Age(M:S)   Net/   Host     /Sock
 SAP 0004 PCS12         3   0:50         1/000000000048/0451
 SAP 0004 ACMPCS        3   0:50         1/00000000004A/0451
 SAP 0004 DEVEL2        1   0:50        11/0000000000B4/0451
 SAP 0004 PLANNING      2   0:50        BB/0000000000B7/0451
 SAP 0004 DEVEL         2   0:50        BB/0000000000EE/0451
 SAP 0004 SOFT2         1   0:30       704/000000000094/0451
 SAP 0004 SKYSURF1      2   0: 5  2C39ABE9/000000000001/0451
 Stat0278 DIRTREE       2   0: 5  2C39ABE9/000000000001/4005
 SAP 026B DIRTREE       2   0: 5  2C39ABE9/000000000001/0045

9 services used out of 32
```

State
Specifies one of the following parameters:

SAP - indicates that this service was obtained by the SAP routing protocol.
Old - indicates that this service has timed out and is no longer being used. The service is kept briefly in the table to inform other routers that the service is no longer valid. After that, it is deleted and is no longer displayed.
Stat – indicates that this service is a static service.

Typ Specifies the server type in hexadecimal. File servers are type 0004. Other type numbers are assigned by Novell.

Service name
Specifies the server's unique name for this type of server. Only the first 30 characters of the 47-character name are displayed to conserve space.

Hops
Specifies the number of router hops from this router to the server.

Age Specifies the age of the service information. If an entry in the SAP table is not updated, the router takes the following actions:

- After 3 SAP update intervals have passed, the service is specified as Old and the router advertises that the service is no longer valid. The SAP update interval can be displayed using the IPX **config** command.
- After an additional 60 seconds, the service is deleted and does not appear in the **slist** display.

Net/Host/Sock
Specifies the address of the service. The address includes the following parameters:

- Network number

- Net host number (the address of the first interface on the network)
- Socket number at which the service can be reached

At the bottom of the display is the number of entries used and the total available. If all the entries are used, it is likely that the service table is not large enough. Use the IPX configuration **set maximum services** command to increase the size.

Traceroute

Use the **traceroute** command to report each hop a ping request takes on its way to a final destination. If traceroute is invoked with no parameters, you will be prompted for all of them. Only the destination IPX network number and destination IPX node address are required.

There are three events that will end a traceroute. The first is when you press a key. The second is when a response is received from the destination address. The third is when the maximum number of hops has been reached.

Syntax:

traceroute *dest-net dest-node src-net src-node size probes rate hops*

dest-net
Specifies the destination IPX network number. This parameter is required.

Value Values: X'1' to X'FFFFFFFD'

Default Value: 1

dest-node
Specifies the destination IPX node address. This parameter is required.

Value Values: X'1' to X'FFFFFFFFFFFE'

Default Value: None

src-net
Specifies the source IPX network number. This is an optional parameter. The value must be a known network number that is associated with a directly attached interface. If a source network is not specified, the network number of the interface on which the traceroute request packets are sent will be used as the source IPX address. If the interface is an IPXWAN Static Routing interface, the network number of some other numbered interfaces will be used as the source address, since IPXWAN Static Routing interfaces are not assigned an IPX network number.

Value Value: X'1' to X'FFFFFFFD'

Default Value: 1

src-node
Specifies the source IPX node address. This is an optional parameter. The value must be a known node address that is associated with a directly attached interface. If a source node is not specified, the node address of the interface on which the traceroute request packets are sent will be used as the source IPX node. If the interface is an IPXWAN Static Routing interface, the node address of the interface used for the source network number will be used as the source node.

Value Values:X'1' to X'FFFFFFFFFFFE'

Default Value: None

size
Specifies the number of data bytes to be appended to the traceroute request. This is an optional parameter. The data includes the time the request is first sent, so the number specified cannot be smaller than 4 bytes. It also cannot be larger than the maximum packet size of the router or the output interface. This value can vary depending on the configuration.

Value Values: 4 to router maximum

Default Value: 56

probes
Specifies how many traceroute requests to send per hop. This is an optional parameter.

Value Values: 1 to 10

Default Value: 3

rate
Specifies the number of seconds to wait between probes, when there is not an answer to the traceroute request. This is an optional parameter.

Value Values: 1 to 60

Default Value: 1

hops
Specifies the maximum number of hops to send traceroute requests. This is an optional parameter. Without NLSP, a packet can traverse a maximum of 16 nodes (hence the default of 16). With NLSP or the IBM 6611 half-router solution, the limit is no longer 16.

Value Values: 1 to 255

Default Value: 16

Example: `traceroute`

```
Destination network number [1]? 20
Destination node number []? 00000001c200
Source network number [1]? 10
Source node number []? 000000019a00
Data size:  [56]?
Number of probes per hop [3]?
Wait time between retries in seconds [1]?
Maximum Hops [16]?

TRACEROUTE 20/00000001C200: 56 data bytes
 1 10/000000019000: 0 ms * 500/0000100B0000 20 ms
 2 * * *
 3 20/00000001C200: 10 ms 60 ms 20 ms
```

The source IPX address of a traceroute response is reported only once as long as it does not change. In the above example, two different routers responded to the one hop traceroute request. This would happen if the route to the destination changed between probes.

There is other information reported by traceroute besides the round trip time of a probe:

- '*' - No response packet was received in the time specified.

- 'H!' - The destination network is unreachable. This would be reported if the route to the destination was lost after traceroute was started.
- 'BF' - No buffers available.

IPX Interface Filter Monitoring Commands

Table 22-4 lists the commands available from the IPX *type*-Lists> prompt. Each of these commands is explained in detail in this section.

To access the IPX type-Lists> prompt, enter **filter-lists** type at the IPX> prompt. Valid types are router-lists, rip-lists, sap-lists, and ipx-lists.

Table 22-4. IPX Interface Filter Command Summary

Command	Function
Cache	Displays the contents of the filter cache for the specified interface. Only the IPX filter supports a filter cache.
Clear	Clears the counters of the specified filter, or clears the counters of all filters of the current type (ROUTER, RIP, SAP, or IPX).
Disable	Disables a specified filter, or all filters of the current type.
Enable	Enables a specified filter, or all filters of the current type.
List	Lists a specified filter, or all filters of the current type.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Cache

Use the **cache** command to display the contents of the filter cache. Only the IPX filter supports a cache. ROUTER, RIP, and SAP filters do not support a filter cache.

Syntax:

ca**che filter** *filter#*

filter# Specifies the number of the filter. The list command can be used to display a numbered list of configured filters.

Example: cache filter 1

```
IPX IPX-Lists>cache filter 1
Hops Type Dst Net  Address      Sock Src Net  Address      Sock Action
---- ---- -------- ------------ ---- -------- ------------ ---- -------
   4   00 04000000 400003900000  802 03000040 400003004400  966 EXCLUDE
   2   00 0004A300 400000233D00  952 0763A020 4000000DD100  920 INCLUDE
```

Clear

Use the **clear** command to clear the counters of the specified filter, or to clear the counters of all filters of the current type (ROUTER, RIP, SAP, or IPX).

Syntax:

c**lear** all
filter ...

all Clears the counters of all filters of the current type (ROUTER, RIP, SAP, or IPX).

Example: `clear all`

filter *filter#*
Clears the counters of the specified filter number. The list command can be used to display a numbered list of configured filters.

Example: `clear filter 1`

Disable

Use the **disable** command to disable specific filters or to disable all filters of the current type (ROUTER, RIP, SAP, or IPX).

Syntax:

disable all
filter *filter#*

all Disables all filters of the current type (ROUTER, RIP, SAP, or IPX).

Example: `disable all`

filter *filter#*
Disables the specified filter number. The list command can be used to display a numbered list of configured filters.

Example: `disable filter 1`

Enable

Use the **enable** command to enable specific filters or to enable all filters of the current type (ROUTER, RIP, SAP, or IPX).

Syntax:

enable all
filter *filter#*

all Enables all filters of the current type (ROUTER, RIP, SAP, or IPX).

Example: `enable all`

filter *filter#*
Enables the specified filter number. The list command can be used to display a numbered list of configured filters.

Example: `enable filter 1`

List

Use the **list** command to display information about specific filters, or about all filters of the current type (ROUTER, RIP, SAP, or IPX).

Syntax:

list all
filter *filter#*

all Lists the configuration of all filters of the current type (ROUTER, RIP, SAP, or IPX).

Example: `list all`

```
IPX IPX-Lists>list all
Filtering: ENABLED

Filter Lists:
Name                           Action
------------------------------ ----------
ipx01                          EXCLUDE
ipx02                          INCLUDE
ipx03                          EXCLUDE

Filters:
Id   Default    State      Ifc  Direction  Cache
---- ---------- ---------- ---- ---------- -----
1    INCLUDE    ENABLED    0    INPUT      10
2    INCLUDE    ENABLED    0    OUTPUT     10
3    INCLUDE    DISABLED   1    INPUT      10
4    INCLUDE    DISABLED   1    OUTPUT     10
```

filter *filter#*

Lists the configuration of the specified filter number. The list command can be used to display a numbered list of configured filters.

Example: `list filter 1`

```
IPX IPX-Lists>list filter 1

Filters:
Id   Default    State      Ifc  Direction  Cache
---- ---------- ---------- ---- ---------- -----
1    INCLUDE    ENABLED    0    INPUT      10

Filter Lists:
Name                           Action     Count
------------------------------ ---------- ----------
ipx01                          EXCLUDE    43
ipx02                          INCLUDE    23453
```

Chapter 23. Using ARP

This chapter describes how to use the Address Resolution Protocol (ARP), Inverse Address Resolution Protocol (Inverse ARP), and ARP Over ATM on your router. It includes the following sections:

- "ARP Overview"
- "Inverse ARP Overview" on page 23-2
- "Classical IP and ARP Over ATM (RFC 1577)" on page 23-3
- "IPX and ARP Over ATM Overview (RFC 1483)" on page 23-15
- "Bridging over ATM Overview (RFC 1483)" on page 23-16
- "Classical IP Redundancy Overview" on page 23-10
- "Distributed ARP Server Overview" on page 23-11

Note: If the device's software load does not contain Asynchronous Transfer Mode (ATM), ATM-related commands are not valid and are not displayed at the ARP configuration and console prompts.

ARP Overview

The ARP Protocol is a low-level protocol that dynamically maps network layer addresses to physical medium access control (MAC) addresses or ATM addresses. Given only the network layer address of the destination system, ARP locates the MAC address or ATM address of the destination host within the same network segment.

For example, a router receives an IP packet destined for a host connected to one of its LANs. The packet contains only a 32-bit IP destination address. To construct the data link layer header, a router acquires the physical MAC address of the destination host. Then, the router maps that address to the 32-bit IP address. This function is called *address resolution*. Figure 23-1 on page 23-2 illustrates how ARP works.

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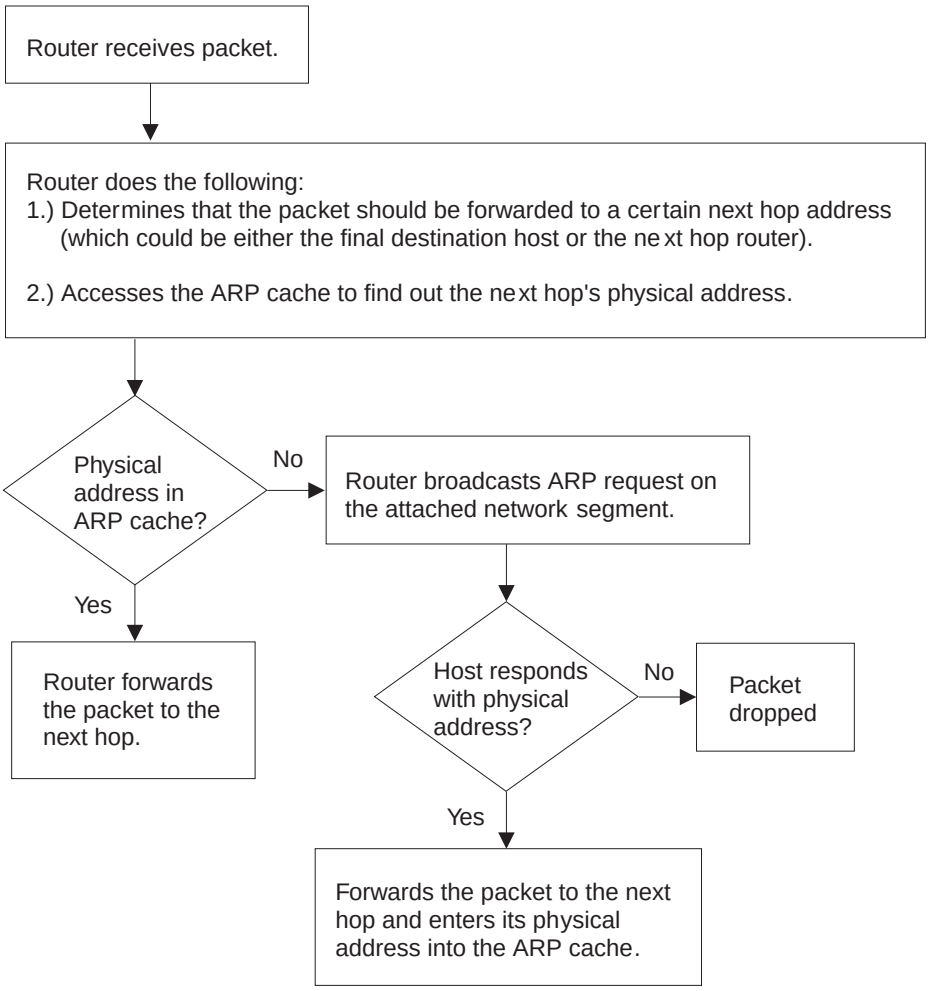

Figure 23-1. ARP Address Resolution Broadcast

When a router translates a network layer address to a physical address, the router accesses the ARP (translation) cache. The ARP cache contains the physical MAC address that corresponds to that network layer address. If the address is missing, the router broadcasts an ARP request to all hosts on the attached network segment to locate the correct physical MAC address. The node with the correct physical MAC address responds to the router. The router then sends the packet to the node and enters the physical MAC address into the translation cache for future use.

RFC 1577, Classical IP & ARP over ATM, extends the ARP protocol with a different packet format and with the addition of an entity known as the ARP Server as described in “Classical IP Components” on page 23-5.

Inverse ARP Overview

Inverse ARP, described in RFC 1293, was created for Frame Relay networks. This protocol defines a method for routers on a Frame Relay network to learn the protocol addresses of other routers in a way that very efficiently reduces traffic by eliminating the need to use broadcast ARP packets for address resolution. Inverse ARP discovers a protocol address by sending Inverse ARP request packets to the hardware address (for Frame Relay circuits the circuit identifier is the Frame Relay equivalent of a hardware address); for ATM, an ATM address is exchanged), as

soon as the circuit becomes active. The remote router responds with its protocol address and the resulting mapping is stored in the ARP cache.

In ATM, the inverse ARP packet has been extended to handle the variable-sized ATM addresses of the source and destination. Addresses learned by inverse ARP are aged out in the same way as those learned by ARP.

The protocol address-to-hardware address entries learned by Inverse ARP do not time out when the ARP refresh timer expires. The mappings do not age at all except when the Frame Relay circuit goes down. This means that the router does not need to transmit any ARP broadcasts to update the ARP cache. However, the router permits updates to an entry when the other (remote) router changes its protocol address.

Support for both ARP and Inverse ARP greatly enhances the router's interoperability with other vendors' routers over Frame Relay for dynamic mapping of protocol and hardware addresses. If other Frame Relay-attached routers support Inverse ARP, then the mappings are dynamically learned as described above. If the attached routers do not support Inverse ARP but support "traditional" ARP on Frame Relay, then the mappings still could be learned dynamically using ARP exchanges (see Figure 23-1 on page 23-2).

If needed, you can manually configure the protocol addresses of other routers using the Frame Relay configuration command **add protocol-address**. For additional information, see the chapter on configuring Frame Relay interfaces in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.

Classical IP and ARP Over ATM (RFC 1577)

The Internet Engineering Task Force (IETF) has standardized its solution for sending IP traffic over an ATM interface in RFC 1577, "Classical IP & ARP over ATM." This document, created by the IP over ATM working group of the IETF, strives to keep the ATM infrastructure transparent to IP. Most applications that run today in a LAN or WAN environment will see no difference in function; however, their performance and throughput gains may be substantial, as described in "Advantages of Classical IP" on page 23-4.

The IETF has proposed an update to RFC 1577 called 1577+ or Classic2. This update is an extension to RFC 1577 that changes the client registration mechanism and allows for multiple ATM ARP servers. The MSS Server supports both RFC 1577 and 1577+ behaviors.

For additional information on Classical IP & ARP over ATM, and for illustrations showing logical and physical network configurations, refer to *Multiprotocol Switched Services (MSS) Configuration and Operations Guide*

Classical IP (CIP) Logical IP Subnets (LIS)

In Classical IP (CIP), IP stations are grouped in Logical IP Subnets (LIS). Classical IP servers and clients are defined to support these subnets similar to the way that LAN Emulation servers and clients are defined to LAN Emulation Services as described in the "Using and Configuring LAN Emulation Services (LES)" chapter of

Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide

For many configuration commands, you will be prompted to answer questions that are identical to those for LAN Emulation Clients and Servers. Questions that require ATM address ESIs and selectors, for example, will be asked in a similar manner whether you are configuring Classical IP or LAN Emulation.

Each of these configuration questions is based on the client definition. A client is defined as an interface number (ATM only) and an IP address.

In its simplest form, the IP client has no server and can talk only to those that contact its *automatically*-assigned ATM address. If PVCs have been assigned, then they will be operational.

For a more detailed description of ATM, refer to the "Using, Configuring, and Monitoring ATM" chapter in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

Advantages of Classical IP

Classical IP has several advantages over conventional IP:

- Higher line speeds provided by ATM
- More efficient use of available bandwidth

  Classical IP requires less framing bytes than, for example, LANs (which contain source and destination MAC addresses), so less of the bandwidth is used for overhead and more is used for data.
- No broadcast traffic required for resolution of ARP frames

  In a broadcast environment, ARP traffic can adversely affect all stations. In Classical IP, the ARP traffic affects only the ARP Server and the client requesting the information. All other stations on the subnet are unaffected by this traffic.
- Independent conversation channels

  When IP is used over a shared medium such as token ring or Ethernet, frames transmitted between two stations preclude other stations on the same physical network from sending messages. This is true even when the traffic is nonbroadcast. In Classical IP, independent channels are established between hosts having the conversation. These channels can be established with traffic parameters that protect the conversation from being impacted by other conversations.
- Simpler method for adding, deleting, moving, or changing stations

  The same benefits of moves, adds, deletes, etc., described for LAN emulation over ATM also apply to the CIP Logical IP Subnet (LIS). Refer to "Using, Configuring, and Monitoring ATM" chapter in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

  Membership in a LIS is not based on physical location. Logically related stations may be grouped into the same LIS. The ease with which a client can register with the ARP Server makes additions and changes trivial. The deletion will occur naturally as the ARP Server ages its entries.

While all members of a LIS must support the Classical IP model, the MSS Server can easily route between CIP Logical IP Subnets (LIS) and emulated LAN subnets. Some equipment may be more adept at CIP while other equipment may be more adept at LAN emulation. The flexibility of the MSS Server allows you to place that equipment where it is most effective.

Classical IP Components

The Logical IP Subnet contains all of the properties of a normal IP subnet whether it is Ethernet, Token-Ring, or Frame Relay. However, because ATM is a Non-Broadcast Multiple Access (NBMA) network, the existing broadcast method for resolving addresses cannot be performed. To solve the addressing problem, RFC 1577 describes a registration/request procedure and introduces the notion of an ARP Server and ARP clients.

One ARP service is defined per LIS. The ARP service may be one ARP Server or several distributed ARP Servers per LIS. The service maintains the translation of IP addresses to ATM addresses. It allows CIP Clients to register by receiving incoming VCCs and querying the client for the appropriate information. The ARP service also responds to ATMARP requests for ATM addresses corresponding to IP addresses requested by the client. Finally, the ARP service manages and updates its tables through aging ARP entries and managing incoming VCCs.

The client is the entity that always places calls. A client, as it IMLs, will place a call to and register with an ARP Server. The call placed by the client to the server is called a control channel. When the client has traffic to transmit to another client on the LIS, the client sends an ARP request to the ARP Server with the target IP address. The server sends back either a reply (if the server has the information in its table) or a NAK (if no information is available). The client uses this ATM address to place a call to the target client (this call is referred to as a data channel). Once the call is established, IP datagrams may traverse the link at any time.

Within the CIP model, there are two forms of request/replies: ATM ARP request/replies (referred to as ARPs), and InATMARP request/replies. One could consider InATMARPs as gathering first-hand information. That is, InATMARP is used to query the other end of a VCC for its IP address and ATM address. InATMARP also informs the other end who it is (its IP address and ATM address). ATMARP could be considered surrogate information. A CIP client sends an ATMARP to the ARP Server to find the ATM address corresponding to the specified IP address. The Server replies with the requested information, or with a NAK if the information is not available. However, the RFC requires all clients and servers to respond to ARPs and InATMARPs with the appropriate response.

RFC 1577+ (Classic2) clients register with the ARP Server by sending an ARP request with the source and target protocol addresses set to the same value. The registration process is completed successfully when the clients receive an ARP reply for this request.

For each LIS, the device can appear as a client only, or can appear as both a client and an ARP Server on that LIS. The device does not support an ARP Server only as this goes against the recommendation of RFC 1577 that each ARP Server should contain an IP address.

Refer to the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide* for additional information about ATM Virtual Interfaces.

Timeouts and Refresh

Both the CIP client and ARP Server age their ARP entries. Once the timer for an ARP entry expires, that entry is deleted. If traffic is flowing when an ARP entry gets aged, that traffic will cease for a period until a new ARP entry is created. To avoid any interruption in service, the device provides an automatic refresh option. This option allows the client to transmit either an ARP request to the ARP Server or a positive InATMARP response only to the target client some time before the ARP entry expires. If the target replies, the timer of the ARP entry is reset. If the target does not, the entry is deleted. The ARP Server automatically sends out an InATMARP message before aging an entry in its table. The client and ARP Servers default to aging periods of 5 minutes and 20 minutes respectively. These times are configurable for each LIS (client or client/server pair).

Notes:

1. ARP entries are always refreshed if an ARP or InARP is received from that client.
2. The **Auto-refresh** defaults to *No* for a client and to *Yes* for a server.

RFC 1577+ clients are required to re-register with the ARP Server every 15 minutes by sending an ARP request for its own IP address. The refresh time is configurable, but RFC 1577+ specifies that 15 minutes is the re-registration interval.

RFC 1577+ servers are not required to refresh client entries using InARPs. It is the responsibility of the client to re-register. The default value for server **auto-refresh** remains *Yes* so that the server is compatible with RFC 1577 clients. If the LIS has only RFC 1577+ clients, **auto-refresh** can be set to *No* on the servers.

IP Addresses and CIP Components

IP addresses are key to IP routing. When configuring the device, the act of adding an IP address to an interface (ATM port), automatically creates a CIP client. The client is defined further by adding ATM ARP client information, but it is the adding of the IP address that creates the client.

Each server, since it contains an IP address, implicitly contains a client as well. When configuring the server, you must configure an IP address, automatically creating a client. The required databases are then created and maintained to service incoming requests.

The IP address configured does not necessarily imply that the device will act as a router. To act as a router, a higher level routing protocol such as OSPF must be configured. However, if the device is attached to multiple subnets, and if packets are sent to it from one subnet destined to a station on one of the other attached subnets, the device will forward that packet without having any routing protocol configured. Further, if a packet is sent to the device, but the destination of the packet is not the device, and the destination is on the same subnet as the source, the device will send an ICMP redirect message to the originator, and will forward the packet to the proper host.

ATM Addresses of CIP Components

Each client receives a unique ATM address. As described earlier, only NSAP addresses are supported. The End System Identifier (ESI) and the Selector can be chosen by the person configuring or it may be generated automatically during initialization time. If a device is configured as a client-only on a LIS, then configuring the ESI or Selector is not required (it is recommended that automatic generation be used). If a device is configured as a client/server pair, then it is strongly recommended that you do specify your own Selector, and if necessary, the ESI. (Note that the ESI will default to a burned-in 6-byte value that is unique.) A user will want to specify this information so that the specific ATM address comes up every time for that Server. Clients wishing to connect to this server can rely on the fact that the ATM address of the Server will not change.

If a server/client pair is configured for a specific LIS, then both the server and the client will use the same ATM address. The ATM addresses (ESI/Selector combination) for each CIP client should be unique.

Virtual Channel Connection (VCC)

A Virtual Channel Connection (VCC) is the lowest common denominator for data transmission. It can either be dynamically created in which case a VCC is a Switched Virtual Circuit (SVC), or it may be configured in the ATM Switch and end stations as a Permanent Virtual Circuit (PVC).

SVCs require a call setup or signalling protocol to establish the connection. Setting up an SVC is similar to placing a phone call. The user dials a phone number and waits for the phone to be answered before communicating to the answering party. If either end hangs up the phone, then the caller must redial the number before talking again. The same is true for ATM SVCs. The host sends out a setup message with a 20-byte ATM address (similar to a phone number), and waits for the other end to connect. Either host can hang-up the channel.

PVCs, on the other hand require no signalling protocol. Nor do they require matching levels of UNI. They are static, and are available to the host from initialization time until power down. The host does not need to take any actions to “set up” the connection. As such, PVCs are simpler and generally more reliable than SVCs.

The device's implementation of Classical IP supports both PVCs and SVCs. SVCs may be generated automatically through the address resolution process and subsequent call setup performed by the Classical IP code, or an SVC may be explicitly configured by the user. Automatic SVCs are brought up and torn down by the ARP subsystem as required for sending IP traffic. A configured SVC is brought up during initialization, and is kept up indefinitely. If the configured SVC does not connect, the device continues to retry the connection periodically until power is turned off.

PVCs and configured SVCs require no ARP Server definition. That is, a LIS could consist of hosts that were interconnected only by configured information. Optionally, the destination IP address of a configured PVC or SVC can be configured as well. If the IP address is not configured, InATMARP packets are used to determine what IP address sits at the opposite end of a VCC. For a network of any size, the amount of manual configuration would become prohibitive. Automatically generated

SVCs drastically reduce the amount of configured information, and provide maximum flexibility for adding and moving hosts.

Automatically generated VCCs can only exist with the assistance of an ARP Server. Each client must be configured with the ARP Server's ATM address. Immediately after initialization, the client will attempt to connect to the ARP server. This connection is referred to as a control channel. The principal use of a control channel is for sending ATMARP and InATMARP requests and replies, although if the ARP Server is also a client, the control channel also can be used for sending IP data. Automatic VCCs generated to send data from one host to another are referred to as data channels.

The attributes of both control and data channels can be tailored to the user's needs. The CIP configuration of the device allows for configuration of the Peak Cell Rate, Sustained Cell Rate, maximum SDU sizes and other characteristics of the control and data channels set up by the device. A user also can choose to limit the cell rates of incoming calls to avoid the problems caused by mismatches in bandwidths of the various ATM attachments.

When the ARP Client is also a MARS Client

The MARS client is an extension of the ARP Client. For information on configuring and monitoring MARS clients, see this chapter and Chapter 24, “Configuring and Monitoring ARP” on page 24-1. For more detail about MARS, see Chapter 26, “Using MARS and the MARS Server” on page 26-1 and Chapter 27, “Configuring and Monitoring the MARS Server” on page 27-1

Key Configuration Parameters for Classical IP

The simplicity of CIP is that very few configuration parameters are required. For a client-only, three pieces of information are required:

1. The IP address and Subnet mask. (**add address**)
2. The ATM address(es) of the ARP Server (or distributed ARP Servers). (**add arp-server**)
3. Configure the ARP client, and reply *No* when asked whether the client is also a server.

The IP address and subnet mask are required to give the client its unique IP identity so that it can send and receive IP datagrams. It also defines the subnet to which this CIP client belongs. The ATM address of the ARP Server is used by the client during initialization to establish a control channel with the ARP Server.

Multiple ARP Servers can be defined for a given LIS for backup purposes. If the primary ARP Server goes down, the client can switch to a backup ARP Server to avoid a single point of failure. The client will be able to switch back to its primary ARP Server as soon as the primary ARP Server resumes service. The first configured ARP Server ATM address will be chosen as the default primary ARP Server for a given LIS. You can change the primary ARP Server using the **reorder** command from the `ARP Config>` command prompt.

The configuration of the server is similarly simple. Essentially, the server needs to be defined with a fixed, well-known ATM address, and it needs to know which LIS it is serving. The server configuration requires the following:

1. The IP address and Subnet mask. (**add address**)

2. Answering “Yes” to the question about whether this client is also a server. (**add atm-arp-client-configuration**)
3. Specifying an explicit selector for the server's ATM address (answering “no” when asked if you wish to use the internally assigned selector). (**add atm-arp-client-configuration**)

The IP address and Subnet mask tell the server which LIS it is serving. The IP address also gives IP access to the server and routing function if desired (through the implicit client). Questions 2 and 3 are asked, among others, in the “add atm-client-configuration” Question 2 is required to enable the server function for that LIS. Question 3 is used to give the server a predictable ATM address.

Additional Configuration Considerations for MARS Clients

In addition to the key configuration parameters listed above, the following information needs to be specified for ATM ARP clients which are also MARS clients.

1. One primary MARS server must be specified and one backup MARS server may be identified during the MARS client configuration. However, it is usually preferable to specify backups in the MARS server configuration. Use the **add mars-server** command from the `ARP Config>` prompt to specify the ATM address(es) of the MARS Server(s).
2. MARS client-specific information is added using the **add multicast-support** command from the `ARP Config>` prompt.

How to Enter Addresses

Addresses are entered in two ways, depending on whether the address represents (1) an IP address, or (2) an ATM address, MAC address, or route descriptor, as follows:

1. IP address

   IP addresses are entered in dotted decimal format, a four-byte field represented by four decimal numbers (0 to 255) separated by periods (.).

   Example of IP Address:

   ```
   01.255.01.00
   ```

2. ATM or MAC address or route descriptor

   ATM addresses, MAC addresses, and route descriptors are entered as strings of hexadecimal characters with or without optional separator characters between bytes. Valid separator characters are dashes (–), periods (.), or colons (:).

   Examples of ATM address, MAC address or route descriptor:

```
A1FF010203

    or

A1–FF–01–02–03

     or

A1.FF.01.02.03

     or

39.84.0F.00.00.00.00.00.00.00.00.00.03.10.00.5A.00.DE.AD.C8

     or

A1:FF:01:02:03

    or even

A1–FF.01:0203
```

This applies to addresses entered for ATM, LAN emulation, and Classical IP & ARP over ATM.

Classical IP Redundancy Overview

The ARP Server redundancy has two devices. One serves as the primary ARP server and the other serves as the backup to the primary. Classical IP Redundancy allows you to specify in your configuration which device will act as the primary server, and which device will act as the secondary server (backup server). In this type of redundancy, the primary server is configured to service and route for a given LIS. When the primary fails, the backup registers using the primary's ATM address and takes over as the ARP Server. It can also act as the redundant default IP gateway, thereby taking over as the server and the router for that LIS. So, when everything is operational, the primary has two IP addresses on the LIS (a client IP address and a gateway IP address), and the backup has a single client IP address on the LIS. When the primary fails, the primary will obviously cease to have any appearance on the LIS, and the backup will have two IP addresses on the LIS (its original client IP address, and its newly obtained redundancy default IP gateway address). The backup will also assume the role of the ARP Server for that LIS (by taking over the ATM address of the primary).

ARP Server redundancy configuration will give you the capability to control which device acts as primary, and which one acts as the secondary. This allows you to effectively balance the load on your ARP Servers while providing backup. For example, you may want a device to be the primary ARP Server for six LISs and to be the secondary for six other LISs. And you may want a second device to be the secondary for the first six LISs and the primary for the other six LISs. The resulting configuration will have 12 LISs, six being served by one device, and six being served by the other. If either device goes down, the other device will take over the server role for all 12 LISs.

It should be noted that there will be two ATM addresses associated with the ATM endpoint. One ATM address will be the real ATM address, and the other will be a special redundancy ATM address, called the redundancy address. The redundancy address is always registered. The redundancy channel is established between the primary's and secondary's redundancy addresses. The redundancy addresses are used for redundancy activity only. The real addresses are used for the exchange of IP information.

In ARP Server redundancy, when configured as a primary, the primary entity will *always* try to register its real ATM address until it is successful. The primary will also attempt to place a call for the Redundancy channel to the secondary.

Notes:

1. The ARP Server redundancy requires that clients on the LIS be able to associate more than one IP address with a single VCC.
2. The primary and backup must be attached to the same ATM switch.

The following steps describe the ARP Server redundancy configuration process for a non-distributed ARP Server LIS:

1. Configure an ARP Client/Server pair on one device. This will be the primary ARP Server.
2. Configure an ARP Client only on the other device. This will provide the backup ARP Server function.
3. Use different ATM addresses and different IP addresses for the primary ARP Client/Server pair and the ARP Client providing the backup ARP Server function (both IP addresses must be on the same LIS)

Note: Please see the sample configuration provided in “Sample ARP Configurations” on page 24-27 for more detail.

ARP Server Redundancy provides the capability of a backup server for 1577 clients. 1577+ clients do not need ARP Server Redundancy because they are capable of switching to a backup ARP Server.

Distributed ARP Server Overview

The Distributed ARP Server allows you to maintain connectivity with a LIS in the event of an ARP Server failure. You can define as many distributed servers as you need per LIS (normally three to four are sufficient). The distributed servers can be located anywhere in your ATM network. They do not need to be meshed, but there must be some communication path from one to another.

An additional benefit of Distributed ARP Server is that the ATM ARP Service load can be distributed over many devices, allowing large LISs to be handled more efficiently.

Distributed ARP Servers on the same LIS must be configured with:

- The same Server Group ID (SGID)
- An ESI/Selector pair to be used to form the ATM address that other servers can use to contact this server to exchange ARP database information.
- The ATM addresses of the Directly Connected Servers (DCSs) with which the distributed ARP Server attempts to synchronize.

The Distributed ARP Server complies with the IETF draft "Server Cache Synchronization Protocol (SCSP) – NBMA." SCSP is the general-purpose protocol for distributing server databases over ATM networks.

ATM ARP clients must be able to recognize when their connection to the ARP Server is not operational and they must be able to switch to an alternate server. RFC 1577+ compliant clients satisfy this requirement.

Examples of Distributed ARP Servers

In Figure 23-2, two ARP Servers are defined on one LIS. These ARP Servers are configured so that they duplicate each other's ARP database. The SCSP in each device is configured with the SCSP ATM address of the other ARP Server. The ARP Servers establish a private session in order to exchange database information. The SCSPs in the device interact with the ARP Server in the same device to get and report cache changes.

The ATM ARP client is configured to have two ARP Servers, one as the primary and one as the backup in case of failure. If the client loses contact with the primary, it will register with the backup. The backup will have the full ARP resolution database and will provide ARP resolution service to the client.

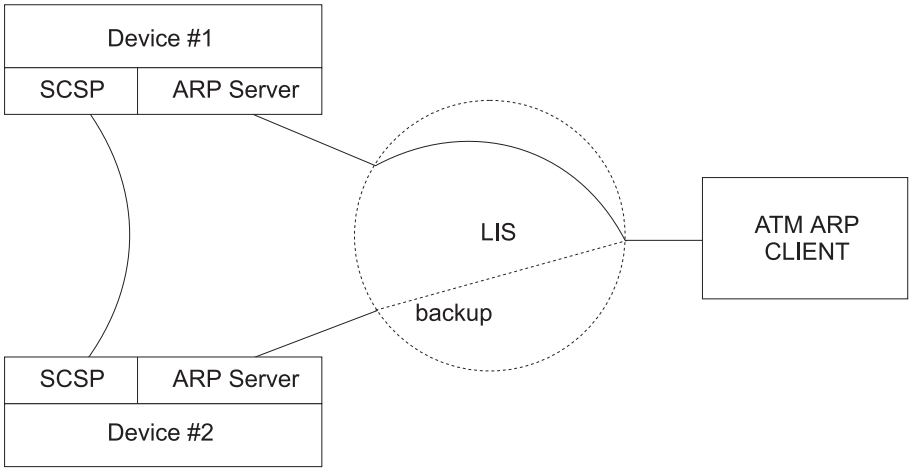

Figure 23-2. Simple Distributed ARP Server Configuration

In Figure 23-3 on page 23-13, three ARP Servers are configured on one LIS. Device 1 is configured with one Directly Connected Server (DCS), Device 2 is configured with two DCSs, and Device 3 is configured with one DCS.

Client 1 is configured with Device 1 as its ARP Server. Client 2 is configured with Device 3 as its primary server and Device 2 as its backup. With this configuration, Client 1 can get the address of Client 2 from Device 1 even though Client 2 is registered with Device 3. Likewise, Client 2 can get the address of Client 1 from Device 3.

If Device 3 fails, Client 2 can switch to Device 2 for ARP service with no loss of connectivity. If Device 1 fails, Client 1 will eventually lose connectivity with the LIS since it does not have a backup ARP Server configured. If Device 2 fails, redundancy is lost. In order for this configuration to retain full redundancy, the devices would need to be fully meshed.

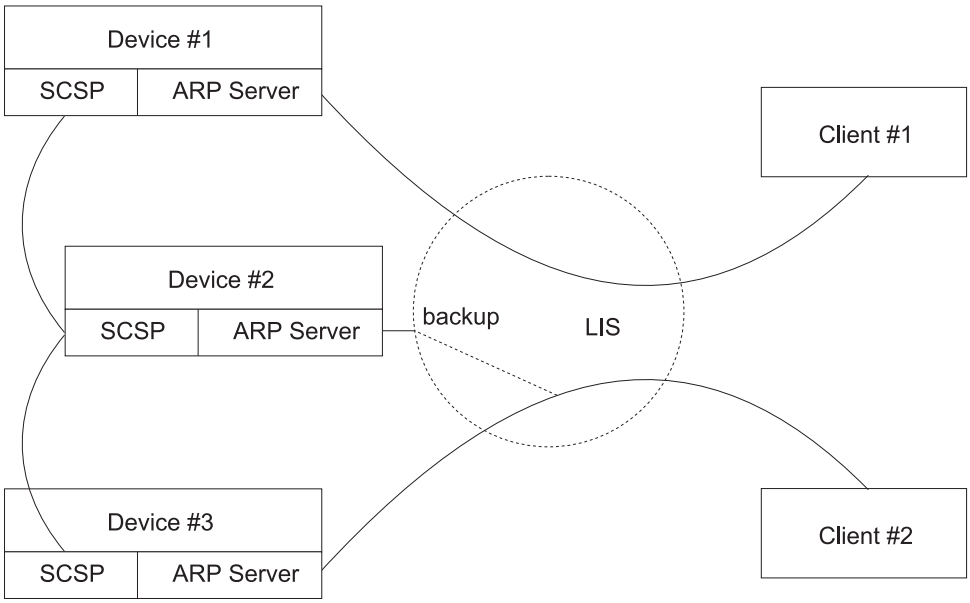

Figure 23-3. Distributed Configuration with Three ARP Servers

Peer Redundancy

The Distributed ARP Server allows you to provide alternate ARP server support for RFC 1577+ clients. ARP Server Redundancy allows you to define a backup ARP server for RFC 1577 clients. The redundancy function and the Distributed ARP Server function can be defined on the same device. In this configuration, both primary and backup are defined as servers with SCSP enabled. When both are operating, they act as ARP servers with the full ARP database available. When the primary fails, the backup takes over the ATM address of the primary (and also keeps its own). Furthermore, if the backup fails, the primary can take over the ATM address of the backup and hence support its 1577 clients. With peer redundancy, the distinction between primary and backup is removed and the servers become “peers.”

Note: Both primary and backup must be attached to the same ATM switch.

.

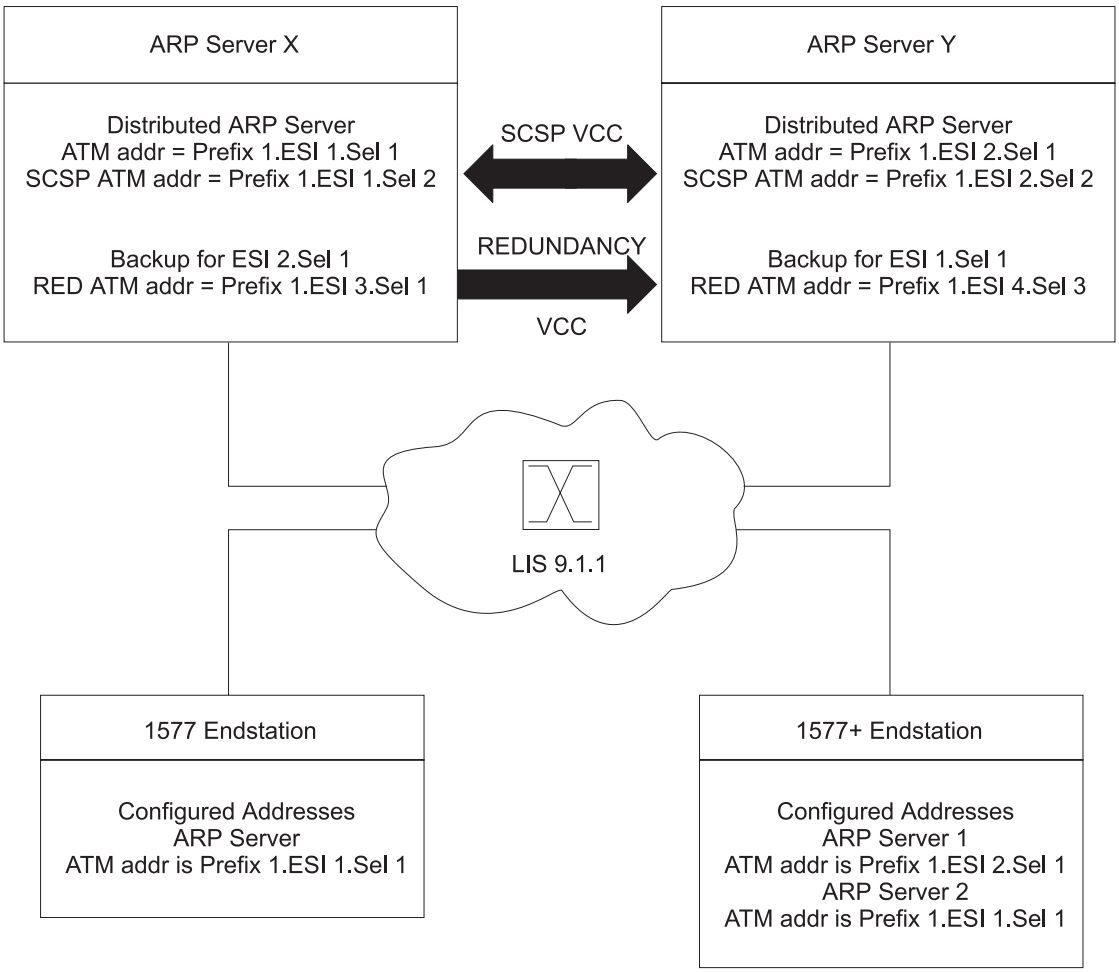

Figure 23-4. ARP Server Configuration with RFC 1577 and 1577+ Clients

A server can be configured as both a redundant server and a distributed server. In Figure 23-4, distributed ATMARP servers are used for LIS 9.1.1. Both Server X and Server Y are actively serving different sets of ATMARP clients on LIS 9.1.1. Server X is serving the RFC 1577 compliant client and Server Y is the first choice of the 1577+ client. The databases of the two ARP Servers are synchronized by the SCSP protocol. If Server Y were to fail, the 1577+ client would use the next entry on its list of ATMARP Server ATM addresses and connect to Server X.

In order to provide ARP Server redundancy for the 1577-compliant client, Server X is designated as the primary ARP Server for ATM address Prefix 1.ESI 1.Sel 1 and Server Y is designated as the backup ARP Server for ATM address Prefix 1.ESI 1.Sel 1. Likewise, Server Y is designated as the primary ARP Server for ATM address Prefix 1.ESI 2.Sel 1 and Server X is the backup for ATM address Prefix 1.ESI 2.Sel 1. Peer ARP Servers provide redundancy support. If Server X fails and Server Y takes over, Server Y will register the ATM address Prefix 1.ESI 1.Sel 1 in addition to its other ATM addresses. Thus Server Y will simultaneously represent ATM address Prefix 1.ESI 1.Sel 1 and ATM address Prefix 1.ESI 2.Sel 1. If Server X subsequently recovers and reestablishes the Redundancy VCC to Server Y, Server Y will deregister ATM address Prefix 1.ESI 1.Sel 1 so that Server X can resume its role as one of the active ARP Servers for the LIS. If Server Y fails, Server X takes over in a like manner.

Peer redundancy depends on the existence of the redundancy channel between the pair of Distributed ARP Servers configured for redundancy. The ATM client or server with the *bigger* redundancy ESI will initiate the redundancy channel with the partner. In this example, ESI 3 is greater than ESI 4, so Server X will initiate the call for the redundancy channel to Server Y.

Configuring Peer Redundancy

When creating a new configuration for ARP Server Redundancy, peer redundancy is automatically enabled if the ATM Classical IP client is configured as a distributed ARP Server.

When an existing configuration is used from a previous release, peer redundancy is not automatically enabled. In this case, in order to enable peer redundancy, use the **change redundancy** command to provide the partner server ESI and selector to each of the distributed ARP Servers and write the configuration to the device. Peer redundancy will then be enabled as long as the redundancy ARP Servers are distributed ARP Servers.

When distributed ARP Service for a client is disabled by changing the client configuration for a given IP address and there is a redundancy configuration, peer redundancy will be disabled. You will be prompted to verify the redundancy configuration for correctness when the distributed ARP service is disabled.

IPX and ARP Over ATM Overview (RFC 1483)

The MSS Server uses LLC/SNAP encapsulation as specified by RFC 1483 to carry IPX traffic over ATM. MSS Servers (and other routers that support RFC 1483 LLC/SNAP encapsulation on ATM) can be interconnected in full or partial meshes via manually configured RFC 1483 connections. Both PVCs and configured SVCs are supported. However, SVCs to IPX routers must be dedicated to IPX; they cannot be shared with other protocols, such as IP.

As with Classical IP, Quality of Server characteristics can be specified by configuring VCC traffic parameters such as Peak and Sustained Rates, and multiple circuits may be configured on a single ATM interface.

The MSS Server supports a single IPX network per ATM interface. This implies a single ATM ARP client per interface for IPX which must be explicitly configured. Therefore, all interconnected routers on the ATM interface must be part of the same IPX network.

IPX ATM addresses must be unique among all components using RFC 1483 encapsulation (which includes Classical IP components). The ESI and the selector portions of IPX ATM addresses are configured in the same manner as Classical IP ATM addresses. If the MSS Server is not initiating the SVC, then at least the selector should be explicitly specified in the current configuration to provide a fixed address that can be configured at the calling router.

IPX protocol addresses have two parts:

- 4-byte network number, and
- 6-byte host number (or host ID)

Network numbers must be unique within IPX routing domains, and host numbers must be unique within a given network. The IPX host number is set (by the MSS Server) to the ESI component of the associated ATM address. The ESI defaults to the MAC address burned into the ATM interface hardware in case that one is not explicitly configured by the user.

Destination IPX host numbers may be specified during VCC configuration or learned dynamically via InATMARP. You must manually configure the IPX host numbers of destination routers that do not support InATMARP. InATMARP is also used to periodically refresh the MSS Server's knowledge of a connected router's IPX host number.

Routers that are interconnected in a partial mesh and are providing intermediate routing between routers on the same ATM interface should disable IPX split-horizon on the ATM interface. This ensures RIP and SAP properly inform the interconnected routers of all available routes and services. Routers that are interconnected in a full mesh need not disable split-horizon.

Using the ATM Virtual Interface facility, IPX is no longer limited to one address per physical ATM interface. Several ATM Virtual Interfaces can be defined on a physical ATM interface and one IPX address can be configured on each ATM Virtual Interface.

Refer to the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide* for additional information about ATM Virtual Interfaces.

Note: Although the combination of RFC 1483 encapsulation and InATMARP has not been has not yet been standardized, the combination is specified for IPX over Frame Relay in RFC 1490 [9].

Bridging over ATM Overview (RFC 1483)

Although bridging does not use ARP support, the implementation of bridging over native ATM shares some internal structures with ARP. In this relationship, ATM client and channel records for bridge ports may be displayed and modified (client record only). Note that addition and deletion of these records is done automatically when a bridge port is added or deleted on an ATM interface.

For more details on RFC 1483 support for bridging over ATM, please see "RFC 1483 Support for Bridging" on page 3-10.

Chapter 24. Configuring and Monitoring ARP

This chapter describes how to configure and monitor ARP protocol activity and how to use the ARP monitoring commands. It includes the following sections:

- "Accessing the ARP Configuration Environment"
- "ARP and Inverse ARP Configuration Commands"
- "ARP Over ATM Configuration Commands" on page 24-5
- "Accessing the ARP Monitoring Environment" on page 24-31
- "ARP Monitoring Commands for Non-ATM Networks" on page 24-31
- "ARP Over ATM Monitoring Commands" on page 24-34

Accessing the ARP Configuration Environment

For information on how to access the ARP configuration environment, see "Getting Started (Introduction to the User Interface)" in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.

Use the following procedure to access the ARP *configuration* process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.) For example:

   ```
   * talk 6
   Config>
   ```

   After you enter the **talk 6** command, the CONFIG prompt (`Config>`) displays on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the CONFIG prompt, enter the **prot arp** command to get to the `ARP Config>` prompt.

ARP and Inverse ARP Configuration Commands

This section describes the ARP configuration commands for non-ATM networks. Table 24-1 on page 24-2 lists the ARP configuration commands. You can access ARP configuration commands at the `ARP config>` prompt.

Note: These commands are not used to configure ARP for Classical IP, IPX and Bridging on ATM interfaces. However, they can be used to configure ARP for ATM LAN Emulation clients.

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Table 24-1. ARP Configuration Commands for non-ATM Networks Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add Entry	Add a MAC address translation entry.
Change Entry	Change a MAC address translation entry.
Delete Entry	Deletes a MAC address translation entry.
Disable Auto-refresh	Disable ARP auto-refresh.
Enable Auto-refresh	Enable ARP auto-refresh.
List	List ARP configuration data in SRAM.
Set	Set the usage and refreshes timeout values.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add Entry

Use the **add entry** command to add a “static protocol-to-hardware address mapping” entry. This command is currently supported for IP addresses only.

Syntax:

add entry *ifc# prot-type prot-addr MAC-addr*

ifc# **Valid values**: Any defined interface

Default value: 0

prot-type **Valid values**: Any protocol that ARP supports.

Default value: IP

prot-addr **Valid Values**: Any valid IP address

Default Value: 0

MAC-addr

Valid Values: Any valid MAC address

Default Value: None

Example: **`add entry`**

```
Interface Number [0]?
Protocol [IP]?
IP Address [0.0.0.0]?
Mac Address []?
```

Change Entry

Use the **change entry** command to change a “static protocol-to-hardware address mapping” entry. This command is currently supported for IP addresses only. The hardware address parameter (MAC-addr) should be the address of the node being changed.

Syntax:

change entry *ifc# prot-type prot-addr MAC-addr*

ifc# **Valid values**: Any defined interface

Default value: 0

prot-type **Valid values**: Any protocol that ARP supports.

Default value: IP

prot-addr **Valid Values**: Any valid IP mask

Default Value: None

MAC-addr

Valid Values: Any valid MAC address

Default Value: None

Example: `change entry`

```
Interface Number [0]?
Protocol [IP]?
IP Address [0.0.0.0]?
Mac Address []?
```

Delete Entry

Use the **delete entry** command to delete a “static protocol-to-hardware address mapping” entry. This command is currently supported for IP addresses only.

Syntax:

delete entry *ifc# prot-type prot-addr*

ifc# **Valid values**: Any defined interface

Default value: 0

prot-type **Valid values**: *IP* or *IPX*

Default value: IP

prot-addr **Valid Values**: Any valid IP address

Default Value: 0.0.0.0

Example: `delete entry`

```
Interface Number [0]?
Protocol [IP]?
IP Address [0.0.0.0]?
```

Disable Auto-Refresh

Use the **disable auto-refresh** command to disable the auto-refresh function. The auto-refresh function is the router’s capability to send an ARP request based on the entry in the translation cache before the refresh timer expires. The request is sent directly to the hardware address in the current translation instead of a broadcast. If auto-refresh is disabled, no ‘preemptive’ ARP request is made, the refresh timer is allowed to expire, and the ARP translation is purged from the table. The next protocol packet to the destination protocol address will then cause a new ARP request to be broadcast on the network.

Syntax:

disable auto-refresh

Example: `disable auto-refresh`

Enable Auto-Refresh

Use the **enable auto-refresh** command to enable the auto-refresh function. The auto-refresh function is the router's capability to send an ARP request based on the entry in the translation cache before the refresh timer expires. The request is sent directly to the hardware address in the current translation instead of a broadcast.

Enabling auto-refresh could cause entries to be retained in the cache regardless of their usage. On networks with a large number of nodes, this can lead to an excessive number of entries in the cache, which might adversely affect router performance. However, on networks with a small number of nodes, this option is useful in reducing broadcast ARP traffic.

Syntax:

en**able**	auto-refresh

Example: `enable auto-refresh`

List

Use the **list** command to display the contents of the router's ARP configuration as stored in SRAM. The list command displays the current timeout settings for the refresh and usage timer.

Syntax:

list	all
	config
	entry

all Lists the ARP configuration followed by all of the ARP entries.

Example: `list all`

```
ARP configuration:

Refresh Timeout: 5 minutes
Auto Refresh: disabled

Mac address translation configuration
IF #           Prot #         Protocol --> Mac Address
 0               0           2.2.2.1 --> 0000C90932EF
```

config Lists the configuration for the different ARP parameters.

Example: `list config`

```
ARP configuration:

Refresh Timeout: 5 minutes
Auto refresh: disabled
```

entry Lists the ARP entries in SRAM.

Example: `list entry`

```
Mac address translation configuration

IF #           Prot #         Protocol --> Mac Address
 0               0           2.2.2.1 --> 0000C90932EF
```

Set

Use the **set** command to set an ARP configuration parameter.

Syntax:

set refresh-timer

refresh-timer *minutes*

Changes the timeout value for the refresh timer. To change the timeout value for the refresh timer, enter the timeout value in minutes. A setting of zero (0) turns off (disables) the refresh timer.

This timer is used in determining when an ARP translation cache entry is to be refreshed while auto-refresh is enabled, or purged while auto-refresh is disabled. Disabling the timer causes entries to be retained until a newly learned address translation causes entries to be removed, until entries are cleared manually with the ARP **clear** monitoring command, or until the router is restarted.

Valid Values: An integer number of minutes in the range of 0 to 65535

Default Value: 5 minutes

Example: `set refresh-timer 3`

ARP Over ATM Configuration Commands

This section describes the ARP Over ATM configuration commands. These commands apply to:

- Classical IP & ARP over ATM
- IPX over ATM
- 1483 bridging

Enter the commands at the `ARP Config>` prompt.

Effect on ARP Table Entries

These commands apply only to the physical ATM interface where the ARP entries reside for ARP over ATM. These commands will have no effect on a non-ATM interface such as an Emulated LAN.

Table 24-2. ARP Over ATM Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
List	Lists all (the current ARP over ATM configuration), lists ARP Servers (for IP only), or lists pvc-atm-arp-entries, svc-atm-arp-entries, atm-arp-client-configuration, mars-servers, and redundancy.
Add	Adds an arp-server, mars- server, multicast-support, atm-arp-client-configuration, pvc-atm-arp-entry, svc-atm-arp-entry or redundancy.
Change	Changes the atm-arp-client-configuration, multicast-support, or redundancy.
Delete	Deletes an arp-server, atm-arp-client-configuration, pvc-atm-arp-entry, svc-atm-arp-entry, mars-server, or redundancy.
Disable	Disables **auto-refresh** so that ARP entries will not be refreshed automatically.
Enable	Enables **auto-refresh** so that ARP entries will be refreshed automatically.
Set	Sets the **refresh-timer** for aging ARP entries.
Reorder	Selects the primary ARP Server from a given ARP Server list.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add an arp-server, MARS server, multicast support, atm-arp-client-configuration, svc-atm-arp-entry, or redundancy.

Syntax:

add
- arp-server
- mars-server
- multicast-support
- atm-arp-client-configuration
- pvc-atm-arp-entry
- svc-atm-arp-entry
- redundancy

arp-server private-nsapa *local-client-IP-address private-NSAP-address*

Adds an arp-server to the client specified or adds a Directly Connected Server (DCS) to an ARP Server.

If the IP address is a client only, the NSAP address is the address of a remote server. Multiple remote servers may be added per client. During initialization, the specified CIP client will place a call to an ARP Server and will use it as a mechanism for resolving IP addresses to ATM addresses.

If the IP address is a server, the NSAP address is the address of a DCS for the Distributed ARP Server. This address must match the SCSP

ATM address for the DCS (not the client ATM address). Use the **List Server-Groups** monitoring command at the SCSP> command prompt under **t 5** to determine the SCSP ATM address of a server. See Chapter 25, “Monitoring the Server Cache Synchronization Protocol (SCSP)” on page 25-1 for additional information.

local-client-IP-address

This value will specify the IP address of the client or server.

Valid Values: Any valid IP address

Default Value: None

private-nsap-address

This field is the Private Network Specified Access Point Address that is the addressing format specified in the UNI Versions 3.0 and 3.1. When configuring DCS, this value is the ATM address of the DCS.

The first byte of the *nsapa* defines the addressing format, as follows:

First Byte	*NSAP Address Format Specification*
0x39	DCC ATM Format
0x47	ICD ATM Format
0x45	E.164 ATM Format

Note: This setting corresponds to a client's (IP address/port number) pair.

Default value: None

Example:

```
ARP config> add arp-server private-nsapa
Local Client IP Address [0.0.0.0]? 2.2.3.100
Private NSAP Address: Specify 40 digits
ATM Address []? 39840f000000000000000000000410005a3345f3a0
```

mars-server private-nsapa *private-NSAP-address primary*

The NSAP address is the ATM address of the client's MARS Server.

private-nsap-address

This field is the Private Network Specified Access Point Address that is the addressing format specified in the UNI Versions 3.0 and 3.1.

The first byte of the *nsapa* defines the addressing format, as follows:

First Byte	*NSAP Address Format Specification*
0x39	DCC ATM Format
0x47	ICD ATM Format
0x45	E.164 ATM Format

Default value: None

See “MARS Configuration Example” on page 26-4 for an example.

Note: The ATM address of the MARS Server must be different from the ATM address of the ARP Server.

primary Specifies whether this is the primary MARS Server or a backup.

Valid values: Yes or No

Default value: If there is no primary server, the default is Yes. Otherwise, the default is No.

multicast-support

Adds multicast support to the specified client.

interface#

Specifies the interface number.

Valid values: Any interface on the device

Default value: 0

client Specifies the IP address of the client to which you want to add multicast support.

Valid values: Any valid client IP address

Default value: 0.0.0.0

Configure multicast support

Specifies whether multicast support should be enabled.

Valid values: Yes or No

Default value: No

Configure broadcast support

Specifies whether broadcast support should be enabled. This question is asked only if **configure multicast support** is *yes*.

Valid values: Yes or No

Default value: No

Redirect Timer value

Specifies the maximum time interval the MARS client should wait for MARS_REDIRECT_MAP messages. This question is asked only if **configure multicast support** is *yes*.

Valid values: 90 to 240 seconds

Default value: 90

Note: This value should be greater than the **cluster redirect timer** value specified in the MARS Server configuration.

Register Timer value

Specifies the time to wait for a response from the MARS Server before considering that a register attempt with the MARS server has failed. This question is asked only if **configure multicast support** is *yes*.

Valid values: 1 to 10 seconds

Default value: 10

Response Timer value
Specifies the time to wait for a response from the MARS Server before considering the request failed. This question is asked only if **configure multicast support** is *yes*.

Valid values: 1 to 240 seconds

Default value: 5

Maximum number of consecutive missed redirects
Specifies the maximum number of missed redirect messages from the MARS server before migrating to a new server. This question is asked only if **configure multicast support** is *yes*.

Valid values: 1 to 60

Default value: 4

Maximum Number of Consecutive Failed Register Attempts
Specifies the maximum number of consecutive Register attempts to make with a MARS Server before migrating to a new server. This question is asked only if **configure multicast support** is *yes*.

Valid values: 1 to 60

Default value: 3

Maximum Number of Consecutive Failed Response Timer Failures
Specifies the maximum number of consecutvie response timer attempts to make with a MARS Server before migrating to a new server. This question is asked only if **configure multicast support** is *yes*.

Valid values: 1 to 60

Default value: 3

Multicast VC Aging Timer
Specifies the maximum time that can elapse without data being sent or received on a point-to-multipoint connection before the connection is taken down. This question is asked only if **configure multicast support** is *yes*.

Valid values: 1 to 120 minutes

Default value: 20

See “MARS Configuration Example” on page 26-4 for an example.

atm-arp-client-configuration
Adds atm-arp-client-configuration.

You will be prompted to provide information about the characteristics of the VCCs that will be set up and received by this client or server, the refresh timeout and auto-refresh settings, how the ATM address for this client is determined, Distributed ARP Service parameters,and the frame size that this client can handle.

Note: Any bandwidth or cell parameter that equals zero will be treated as the line speed of the ATM interface.

Example for IP:

```
ARP config> add atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]?
Client IP Address [0.0.0.0]? 1.1.1.2
This client is also a server? [Yes] yes
Refresh timeout (in minutes) [20]?
Enable auto-refresh? [Yes]:
Refresh by InAtmArp? [Yes]:
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) 222222222222
  (  4) 121212121212
  (  5) AAAAAAAAAAAA
Select ESI [1]?2
Use internally assigned selector? [Yes]: no
Selector Only, Page 00..FF [00] ? 11
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Server for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Use Best Effort Server for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
Participate in Server Synchronization [No]? yes
Server Group ID [1]?
Do you want to accept sessions from non-configured DCSs [Yes]?
Hello Interval [3]
Dead Factor [3]?
(  1) Use burned in ESI
(  2) 111111111111
(  3) 222222222222
(  4) 121212121212
(  5) AAAAAAAAAAAA
Server Synchronization ESI [2]?
Server Synchronization selector, Range 00..FF [00]? 12
Server Synchronization Max SDU size (bytes) [9188]?
Re-registration time with Arp Server (in minutes) [15]?


To enable or change multicast support,
please issue the ADD or CHANGE MULTICAST-SUPPORT command.
```

Example for IPX:

```
ARP config> add atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]? IPX
Refresh timeout (in minutes) [5]?
Enable auto-refresh? [Yes]:
  (  1) Use burned in ESI
Select ESI [1]?
Use internally assigned selector? [Yes]:
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Server for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
```

Example for Bridging:

```
ARP config> add atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]? ASRT
Clients for this protocol can only be changed here.
Additions must be done under ASRT Config by adding a port.
```

Interface Number

Interface number assigned.

Valid values: Any interface on the device

Default value: 0

Protocol

Valid values: *IP*, *IPX*, **or** *ASRT*

Default value: IP

Client IP Address

Client IP Address (IP only). This should match the address configured using the **p IP** command.

Note: This value is also used for the LSID in the SCSP protocol.

Valid Values: Any valid IP address

Default value: 0.0.0.0

This client is also a server

Yes or No. If no, client is not a server. (IP only)

Refresh timeout (in minutes)

Refresh timeout value in minutes. ARP entries will age out after this number of minutes if they are not refreshed.

Valid Values: An integer number of minutes in the range of 0 to 65535

Default Value: 5 minutes

Enable auto-refresh

YES or NO.

If No, ARP entries will not be refreshed automatically.

Default Value: No for client, Yes for Server

Refresh by InAtmArp

YES or NO.

If YES, and if auto-refresh is enabled, then InAtmArp requests will be periodically transmitted to confirm the existence of the remote host.

If NO, and if auto-refresh is enabled, then AtmArp requests will be transmitted to the ARP Server to reconfirm the ARP entry.

Default Value: No for client, Yes for Server

Select ESI

Specifies whether a universally administered MAC address or a MAC address configured under the ATM interface configuration should be used as the End System Identifier component of the ATM address. This question is preceded by a list of valid ESIs from which the selection is to be made.

Valid Values: Any of the values listed in the menu preceding this question. Any 12 hexadecimal digits that have been defined as an ESI address using the **Add ESI** ATM Network configuration command.

Default Values: 1 (burned-in)

Use internally assigned selector

Use internally assigned selector.

Valid Values:Yes or No

Default Value: Yes

Selector This is the last byte of the client's ATM address.

Valid Values: Any single octet value that has not been previously used and is within the range defined for the device.

Default Value: 0

Validate PCR for best effort VCCs

TRUE or FALSE. When true, Best-Effort VCCs will be rejected if the signaled forward PCR exceeds the Maximum Reserved Bandwidth or the speed of the adapter. If false, Best-Effort PCRs will be accepted without regard to the signaled Peak Cell Rate.

Maximum Reserved Bandwidth for incoming VCCs (Kbps)

Defines the maximum acceptable Sustained Cell Rate (SCR) for an incoming VCC. If SCR is not specified on the incoming call, then this parameter defines the maximum acceptable Peak Cell Rate (PCR). Calls received with traffic parameters specifying higher rates will be released. This parameter is applied to both forward and backward Cell Rate parameters. The constraint imposed by this parameter is applicable to best effort connections (if “validate PCR” is yes) and is compared to the PCR on the incoming call.

Valid Values: Integer Kbps in the range of 0 to line speed. If you enter 0, the parameter is set to the line speed.

Default Value: None

Use Best Effort Service for Control VCCs

Specifies the type of traffic characteristics to be associated with Control VCCs. Bandwidth is not reserved for best effort traffic.

Valid Values: *Best Effort* or *Reserved Bandwidth*

Default Value: Best Effort

Peak Cell Rate of outbound control VCCs (Kbps)

Specifies the Peak Cell Rate (PCR) traffic parameter for the Control VCC. This PCR value is used for both the forward and backward PCR values of both best effort and reserved bandwidth VCCs.

Valid Values: An integer Kbps in the range of 0 to line speed of the ATM device. If you enter 0, the parameter is set to the line speed.

Default Value:

- If best effort, default is max data rate
- If reserved, there is no default

Sustained Cell Rate of outbound control VCCs (Kbps)

Specifies the bandwidth reserved by all VCCs on a given ATM device. (Sustained Cell Rate can be considered to reserved bandwidth.) This parameter is applicable only when Best Effort Service is not selected for Control VCCs.

Valid Values: An integer Kbps in the range of 0 to control VCC PCR. If you enter 0, the parameter is set to the line speed.

Default Value: none

Use Best Effort Server for Data VCCs

Yes or No. Specifies the type of traffic characteristics to be associated with Data VCCs. Bandwidth is not reserved for best effort traffic.

Peak Cell Rate of outbound Data VCCs (Kbps)

Specifies the Peak Cell Rate (PCR) traffic parameter for the Data VCCs. This PCR value is used for both the forward and backward PCR values of both best effort and reserved bandwidth VCCs.

Valid Values: An integer Kbps in the range of 0 to control VCC PCR. If you enter 0, the parameter is set to the line speed.

Default Value: 0

Sustained Cell Rate of outbound Data VCCs (Kbps)

Specifies the Sustained Cell Rate (SCR) traffic parameter for the Data VCCs. (Sustained Cell Rate can be considered to reserved bandwidth.) This parameter is applicable only when Best Effort Server is not selected for Data VCCs.

Valid Values: An integer Kbps in the range of 0 to PCR value for Data VCC. If you enter 0, the parameter is set to the line speed.

Default Value: none

Max SDU size (bytes)

Specifies the Maximum SDU size that will be specified when calls are placed from this client address. It also is used to verify incoming calls. This parameter cannot be set to a value greater than the Maximum SDU size for the physical ATM interface (port).

Valid Values: An integer in the range of 72 to Maximum interface SDU

Default Value: 9188

Participate in Server Synchronization

Specifies whether the ARP database for the LIS upon which this server resides will be distributed.

Valid Values: Yes or No

Default Value: No

Server Group ID

Specifies the value to identify this server group. This value must be unique for all Server Groups (of the ATMARP protocol type) within the ATM network. This value must be used for all servers in this server group (in this LIS).

Valid Values: 0 – 65535

Default Value:1

Accept sessions from non-configured DCS

Specifies whether this Local Server should accept connections from DCSs that are not explicitly configured.

Valid Values: Yes or No

Default Value: Yes

Hello Interval

Specifies the time in seconds between sending of Hello messages for this Local Server.

Valid Values: 0 to 65535

Default Value: 3

Dead Factor

Specifies the multiple of Hello Intervals after which this server should be considered down by directly connected servers (DCSs).

Valid Values: 0 to 65535

Default Value: 3

SCSP ESI

Specifies whether a universally administered MAC address or a MAC address configured under the ATM interface configuration should be be used as the End System Identifier component of the SCSP ATM address. This question is preceded by a list of valid ESIs from which the selection is to be made.

Valid Values: Any of the values listed in the menu preceding this question. Any 12 hexadecimal digits that have been defined as an ESI address using the **Add ESI** ATM Network configuration command.

Default Value: ESI of the Client/Server

SCSP Selector

Specifies the selector to be associated with this SCSP Local Server. If the ***SCSP ESI*** defaults to the ESI of the ARP Server, this selector value must be different from the ARP Server selector.

This is the last byte of the ATM address of this local server.

Note: The SCSP ATM address can be shared among the CIP clients on the same interface. The ATM address can also be shared with other protocols using the 1483 ATM LLC. Refer to the chapter entitled “Using and Configuring ATM” in the *Software User's Guide*. The SCSP ATM address cannot be shared with IP, IPX, or ASRT clients.

Valid Values: Any valid selector that has not been previously used and is within the range defined for the device.

Default Value: 0

Re-registration time with Arp Server (in minutes)

Specifies the time interval between registration requests from the client to the ARP Server.

Valid Values: An integer in the range of 0 to 65535

Default Value: 15

pvc-atm-arp-entry

Adds a PVC and optionally creates permanent ARP Entry if the destination protocol address is specified. For virtual ATM interfaces, you should check the configuration of the real ATM interface where the AVI sits and all the other AVIs configured on the real ATM interface. A new VPI/VCI pair is needed for a new PVC unless you specifically want to share the new PVC traffic with the traffic of an existing PVC.

Example for IP:

```
ARP config> add pvc-atm-arp-entry
Interface Number [0]?
Protocol [IP]?
Local client IP address [0.0.0.0]? 2.2.3.100
Specify destination protocol address? [Yes]: no
Permanent Virtual Circuit VPI, Range 00..FF [00]?
Permanent Virtual Circuit VCI, Range 0000..FFFF [0000]? 0029
```

Example for IPX:

```
ARP config> add pvc-atm-arp-entry
Interface Number [0]?
Protocol [IP]? IPX
Specify destination protocol address? [Yes]: no
Permanent Virtual Circuit VPI, Range 00..FF [00]?
Permanent Virtual Circuit VCI, Range 0000..FFFF [0000]? 0037
```

Example for Bridging:

```
ARP config> add pvc-atm-arp-entry
Interface Number [0]?
Protocol [IP]? ASRT
Channels for this protocol must be added under ASRT Config by adding
a port.
```

interface number

Valid values: The number of the interface assigned

Default value: 0

protocol Valid values: *IP*, *IPX*, *ASRT*

Default value: IP

local client IP address

Required for IP. This address associates this PVC with a client.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

destination protocol address

Valid Values: Any valid IP address. (For IPX, any valid 6-byte IPX host number.)

Default Value: 0.0.0.0

permanent virtual circuit VPI

Valid Values: any valid value in the range of 0 - 255

Default Value: 0

permanent virtual circuit VCI

Valid Values: any value in the range of 0 - 65535

Default Value: 0

svc-atm-arp-entry

Adds an SVC and optionally creates a permanent ARP Entry.

Example for IP:

```
ARP config> add svc-atm-arp-entry
Interface Number [0]?
Protocol [IP]?
Local client IP address [0.0.0.0]? 2.2.3.100
Specify destination protocol address? [Yes]: no
Destination ATM Address []? 39840f000000000000000000000210005a00dead03
```

Example for IPX:

```
ARP config> add svc-atm-arp-entry
Interface Number [0]?
Protocol [IP]? IPX
Specify destination protocol address? [Yes]: no
Destination ATM Address []? 39840f000000000000000000000210005a00dead03
```

Example for Bridging:

```
ARP config> add svc-atm-arp-entry
Interface Number [0]?
Protocol [IP]? ASRT
Channels for this protocol must be added under ASRT Config by adding
a port.
```

interface number

Valid values: The number of the interface assigned.

Default value: 0

protocol **Valid values:** *IP*, *IPX*, or *ASRT*

Default value: IP

local client IP address

Required for IP. This address associates this SVC with a client.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

destination protocol address

Valid Values: Any valid IP address. For IPX, any valid 6-byte IPX host number.

Default Value: 0.0.0.0

destination ATM address

Valid Values: Any valid ATM address

Default Value: None

Redundancy

Use this command to add a redundancy configuration.

ARP Server Redundancy Example

```
ARP config>add red
Interface Number [0]?
Protocol [IP]?
Local client IP Address [0.0.0.0]? 1.1.1.1
Note: Local Redundancy ESI must be different from the Primary Server ESI
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) AAAAAAAAAAA
  (  4) BBBBBBBBBBB
Select Local Redundancy ESI [1]? 3
Local Redundancy selector, Range 00..FF [00]? aa
Partner's (Redundancy) ATM Address, 40 Hex digits
 [0000000000000000000000000000000000000000]?
39840f00000000000000000001bbbbbbbbbbbbb  1
Redundancy default IP Gateway also ? [No]: yes
If Yes, Redundancy default IP Gateway protocol address [0.0.0.0]? 1.1.1.3
ARP config>

---------- Backup Server (client) -----------------

ARP config>add red
Interface Number [0]?
Protocol [IP]?
Local client IP Address [0.0.0.0]? 1.1.1.2
Note: Local Redundancy ESI must be different from the Primary Server ESI
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) AAAAAAAAAAA
  (  4) BBBBBBBBBBB
Select Local Redundancy ESI [1]? 4
Local Redundancy selector, Range 00..FF [00]? bb
Partner's (Redundancy) ATM Address, 40 Hex digits
 [0000000000000000000000000000000000000000]?
 39840f00000000000000000001aaaaaaaaaaaaa  1
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) AAAAAAAAAAA
  (  4) BBBBBBBBBBB
Partner Server ESI [1]? 2
Partner Server selector, Range 00..FF [00]? 11
Redundancy default IP Gateway also ? [No]: yes
If Yes, Redundancy default IP Gateway protocol address [0.0.0.0]? 1.1.1.3
ARP config>exit
Config>
```

Note: **1** This input should occur on the previous line. It is shown here on a separate line because of formatting.

Interface Number
Interface Number assigned

Protocol IP

Local Client IP Address
Associates this redundancy configuration with a client.

Valid Values: Any IP address

Default Values: 0.0.0.0

Select Redundancy ESI
Specifies whether the universally administered MAC address or a MAC address configured under the ATM interface configuration should be used as the End System Identifier component of the CIPC or CIPS ATM address. This question is preceded by a list of valid ESIs from which the selection is to be made.

Valid Values: The redundancy ESI must be different from all of the primary ARP client/server functional ESIs.

Default Value: 1

Choose Redundancy Selector

Identifies the selector byte for the Redundancy ATM address.

Valid Value: any single octet value that has not been previously used and is within the range defined for the device.

Default Value: 00

Partner's (Redundancy) ATM Address

Specifies the ATM address of the Redundancy ARP Server.

Valid Values: Only private NSAP addresses are valid. The first byte (Authority and Format Identifier) must contain a value of:

39 - Data Country Code ATM Format
47 - International Code Designator ATM Format
45 - E.164 ATM Format

Default Value: none

Partner Server ESI

Specifies the ESI component of the partner real ATM address.

Valid Values: Valid server ESI listed in the menu preceding this question.

Default Value: 1

Partner Server Selector

Specifies the selector component of the partner real ATM address.

Valid Values: Value defined for server selector

Default Value: 00

Redundancy's default IP gateway also?

Specifies whether this ARP entity will participate in the provision of default gateway redundancy support for the LIS.

Default Value: No

Redundancy's default IP gateway address

Specifies the IP address of the Redundancy default gateway for this LIS. This is the IP address configured at hosts using the server as their default router.

Default Value: 0.0.0.0

Change

Use the **change** command to change the ATM-ARP configuration.

Syntax:

ch**ange** entry

atm-arp-client-configuration

redundancy

multicast-support

atm-arp-client-configuration

Changes the atm-arp-client-configuration.

See page 24-9 for a description of the **Change** parameters.

Example for IP:

```
ARP config> change atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]?
Client IP Address [0.0.0.0]? 1.1.1.2
This client is also a server? [Yes] yes
Refresh timeout (in minutes) [20]?
Enable auto-refresh? [Yes]:
Refresh by InAtmArp? [Yes]:
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) 222222222222
  (  4) 121212121212
  (  5) AAAAAAAAAAAA
Select ESI [1]?2
Use internally assigned selector? [Yes]: no
Selector Only, Page 00..FF [00] ? 11
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Server for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Use Best Effort Server for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
Participate in Server Synchronization [No]? yes
Server Group ID [1]?
Do you want to accept sessions from non-configured DCSs [yes]?
Hello Interval [3]
Dead Factor [3]?
(  1) Use burned in ESI
(  2) 111111111111
(  3) 222222222222
(  4) 121212121212
(  5) AAAAAAAAAAAA
Server Synchronization ESI [2]?
Server Synchronization selector, Range 00..FF [00]? 12
Server Synchronization Max SDU size (bytes) [9188]?
Re-registration time with Arp Server (in minutes) [15]?


To enable or change multicast support,

please issue the ADD or CHANGE MULTICAST-SUPPORT command.
```

Example for IPX:

```
ARP config> change atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]? IPX
Refresh timeout (in minutes) [5]?
Enable auto-refresh? [Yes]:
  (  1) Use burned in ESI
Select ESI [1]?
Use internally assigned selector? [No]:
Selector Only, Range 00..FF [00]? 20
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Server for Data VCCs? [Yes]:
Peak Cell Rate of outbound data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
```

Since only one IPX ATM-ARP client configuration record exists for an ATM interface, you are not prompted to enter a protocol address.

Example for Bridging:

```
ARP config> change atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]? asrt
Client Address (Port Number) [0]? 2    1
  (  1) Use burned in ESI
Select ESI [1]?
Use internally assigned selector? [No]:
Selector Only, Range 00..FF [0A]?
Validate PCR for best effort VCCs? [No]:
Use Best Effort Service for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
```

Note: 1 In the case of Bridging, you are prompted for a port number instead of a protocol address.

Also, if using SVC support for a particular port, an internally assigned selector should not be used for the corresponding client. The selector must be specified by the user so that the ATM address for this client is definitively known for configuration at the other end.

Use of this command is required only if you wish to use values other than the defaults for the traffic parameters.

redundancy

Changes the redundancy configuration for a client.

See page 24-16 for a description of the parameters you can change.

multicast-support ***interface# client***

Changes multicast support to the specified client. See 24-8 for a description of parameters.

Delete

Use the **delete** command to delete an arp-server, atm-arp-client-configuration, pvc-atm-arp-entry, or svc-atm-arp-entry.

Syntax:

de**lete** arp-server

atm-arp-client-configuration

pvc-atm-arp-entry

svc-atm-arp-entry

redundancy

mars-server

arp-server

Deletes an arp-server or DCS.

Specify the address of the arp-server. This question is preceded by a list of valid arp-servers or DCSs from which the selection is to be made.

Valid Values: any of the values listed in the menu preceding this question.

Default Value: 0

Example for IP:

```
ARP config> del arp-server

ATM Arp Remote Server List:
   IP Address      Number       Address / Sub Address
        1.1.1.1     [ 1]       39.84.0F.00.00.00.00.00.00.00.00.00.02.
                                                  11.11.11.11.11.11.11
        1.1.1.1     [ 2]       39.84.0F.00.00.00.00.00.00.00.00.00.03.
                                                  AA.AA.AA.AA.AA.AA.AA

Number of the IP Address/Arp Server pair to be deleted
Default of 0 will delete nothing [0]? 1
```

atm-arp-client-configuration

Deletes an atm-arp-client-configuration for a client.

Specify the interface number, protocol, and Client IP address.

interface number

Valid values: any defined interface

Default value: 0

protocol **Valid values:** *IP*, *IPX*, **or** *ASRT*

Default value: IP

client IP address

Valid Values: any valid IP address

Default Value: 1.1.1.100

Example for IP:

```
ARP config> del atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]?
Client IP Address [1.1.1.100]? 2.2.3.100
ATM ARP Client Config record deleted
```

Example for IPX:

```
ARP config> del atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]? IPX
ATM ARP Client Config record deleted
```

Since only one IPX ATM-ARP client configuration record exists for an ATM interface, you are not prompted to enter a protocol address.

For field descriptions, refer to the preceding example for IP.

Example for Bridging:

```
ARP config> del atm-arp-client-configuration
Interface Number [0]?
Protocol [IP]? ASRT
Clients for this protocol can only be changed here.
Deletions must be done under ASRT Config by deleting a port.
```

pvc-atm-arp entry

Deletes a pvc-atm-arp-entry.

Specify the entry number for the pvc-atm-arp-entry you want deleted.

Example for IP and IPX:

```
ARP config> del pvc

ATM Arp Permanent Virtual Circuit Definitions
No. IF# Prot# P/S     Protocol     -> VPI / VCI
1    0    0    P         0.0.0.0   ->  00 / 0029
2    0    7    P 00.00.00.00.00.00 ->  00 / 0037
Which Arp entry do you want to delete [0]? 1
ATM Arp entry 1 being deleted
```

No. 1 is an IP PVC and No. 2 is an IPX PVC.

Example for Bridging:

```
ARP config> del pvc
ATM Arp Permanent Virtual Circuit Definitions
No. IF# Prot# P/S     Protocol     -> VPI / VCI    (Client Address)
1    0   23    P                   ->   0 / 87     (Port: 1)
Which Arp entry do you want to delete [0]? 1
Channels for this protocol must be deleted under ASRT Config by
deleting a port.
```

svc-atm-arp-entry

Deletes an svc-atm-arp-entry.

Specify the entry number for the svc-atm-arp-entry you want deleted.

Example for IP and IPX:

```
ARP config> del svc

ATM Arp Switched Virtual Circuit Definitions
No. IF# Prot# P/S     Protocol     -> Destination ATM Address
1    0    0    S         0.0.0.0   ->
                39.84.0F.00.00.00.00.00.00.00.00.02.10.00.5A.00.DE.AD.03
2    0    7    P 00.00.00.00.00.00 ->
                39.84.0F.00.00.00.00.00.00.00.00.02.11.00.B7.38.AA.BB.12

Which Arp entry do you want to delete [0]? 1
ATM Arp entry 1 being deleted
```

No. 1 is an IP SVC and No. 2 is an IPX SVC.

Example for Bridging:

```
ARP config>del svc
ATM Arp Switched Virtual Circuit Definitions
No. IF      Prot   P/S     Protocol     -> Destination ATM Address (Client)
2    0   23    S                    -> 39.11.22.33.44.55.66.77.88.99.00.11.22
                                    33.44.55.66.77.88.99 (Port: 2)
Which Arp entry do you want to delete [0]? 2
Channels for this protocol must be deleted under ASRT Config by deleting a port.
```

redundancy

Deletes the redundancy configuration for a client.

mars-server

Deletes the MARS Server specification for a client.

Disable

Use the **disable** command to disable auto-refresh of ARP entries.

The *auto-refresh* configuration value is overridden by the setting of *auto-refresh* at the atm-arp-client configuration. See 24-9 for information about atm-arp-client configuration parameters.

Syntax:

di**sable** auto-refresh

auto-refresh

Disables auto-refresh of an ARP entry.

Valid Values: Yes or No

Default Value: Yes for client, No for Server

Enable

Use the **enable** command to enable auto-refresh of ARP entries.

The *auto-refresh* configuration value is overridden by the setting of *auto-refresh* at the atm-arp-client configuration. See 24-9 for information about atm-arp-client configuration parameters.

Syntax:

enable auto-refresh

auto-refresh

Enables auto-refresh of an ARP entry.

Valid Values: Yes or No

Default Value: No for client, Yes for Server

List

Use the **list** command to display the contents of the router's ARP configuration as stored in SRAM. The list command also displays the current settings for the refresh and usage timer.

Syntax:

list entry

all

arp-servers

atm-arp-client-configuration

pvc-atm-arp-entry

svc-atm-arp-entry

redundancy

mars-servers

all Lists the ARP configuration followed by all of the ARP entries.

Example: `list all`

```
ARP config> list all
ARP configuration:

Refresh timeout: 5 minutes
Auto refresh: disabled

Mac address translation configuration

No arp entries defined

ATM Arp Server List:
  IP Address      Number       Address / Sub Address
 1.1.1.1     [ 1]       39.84.0F.00.00.00.00.00.00.00.00.00.02.
                                     11.11.11.11.11.11.11.11
 1.1.1.1     [ 2]       39.84.0F.00.00.00.00.00.00.00.00.00.03.
                                     AA.AA.AA.AA.AA.AA.AA.AA
```

arp-servers

Lists arp-servers. If this is a client-only configuration, this output lists the configured ARP Servers. If this is a Distributed ARP Server configuration, then configured Directly Connected Servers are listed.

See “Distributed ARP Server Overview” on page 23-11 for an explanation of communication between Distributed ARP Servers.

```
ARP config> list arp-servers

ATM Arp Remote Server List:
   IP Address      Number       Address / Sub Address
        1.1.1.1     [ 1]       39.84.0F.00.00.00.00.00.00.00.00.00.02.
                                          11.11.11.11.11.11.11.11
        1.1.1.1     [ 2]       39.84.0F.00.00.00.00.00.00.00.00.00.03.
                                          AA.AA.AA.AA.AA.AA.AA.AA
```

atm-arp-client-configuration

Lists the atm-arp-client-configuration.

```
ARP config> list atm

ATM Arp Clients:

--------------------------------------------------

If: 0  Prot: 0  Addr: 1.1.1.2          ESI: 11.11.11.11.11.11  Sel: 11
Server: yes  Refresh T/O: 20   AutoRefr: yes   By InArp: yes  Validate PCR: no
Use Best Effort: yes/yes  (Control/Data)   Max B/W(kbps):      0
Cell Rate(kbps):  Peak:      0/     0      Sustained:      0/     0
Max SDU(bytes):   9188
Server Synchronization: yes  SGID: 1       Secure DCSs: no
Hello Interval: 3    Dead Factor: 3
Server Synchronization ESI: 11.11.11.11.11.11   Selector: 12
Server Synchronization Max SDU(bytes):   9188
Arp Server Re-registration time in (minutes): 15
Multicast Support: no    Broadcast Support: no
```

See 24-9 for field descriptions.

redundancy

Lists the redundancy configurations and the gateway status.

```
ARP config>list red


ATMARP Clients with Redundancy Configured
-----------------------------------------

If:  0    Prot: IP    Addr: 1.1.1.2
Red. ESI: bb.bb.bb.bb.bb.bb   Red. SEL: bb   Pri/Secy: Secondary
Partner's (Red.) ATM Address:  39.84.0F.00.00.00.00.00.00.00.00.01.aa.aa.aa.aa.aa.aa.aa
Partner Server ESI: BB.BB.BB.BB.BB.BB.BB Partner Server SEL: AA
Redundancy Default IP Gateway Address: 1.1.1.3
-----------------------------------------

ARP config>list red


ATMARP Clients with Redundancy Configured
-----------------------------------------

If:  0    Prot: IP    Addr: 2.2.2.2
Red. ESI: aa.aa.aa.aa.aa.aa  Red. SEL: aa   Pri/Secy: Primary
Partner's (Red.) ATM Address:  39.84.0F.00.00.00.00.00.00.00.00.01.bb.bb.bb.bb.bb.bb.bb
Partner Server ESI: BB.BB.BB.BB.BB.BB.BB Partner Server SEL: AA
Redundancy Default IP Gateway Address: 1.1.1.3
-----------------------------------------
```

If: Interface Number

Prot: IP

Addr: IP Address

Red. ESI: Identifies the ESI portion of the redundancy ATM address:

Burned In - Specifies that the universally administered MAC address of the ATM adapter should be used as the End System Identifier (ESI) portion of the redundancy ATM address.

Locally administrated - Identifies a Locally Administered End System Identifier that is to be used as the ESI component of the redundancy ATM address.

Red. SEL:
Identifies the Selector portion of the redundancy ATM address.

Peer Redundancy/Primary/Secondary
Identifies the role of the client/server.

If primary, the client/server will place a call from its redundancy ATM address to the secondary's redundancy ATM address.

If secondary, this client/server will be idle as long as the redundancy VCC is established.

If peer, the server with the higher redundancy ATM address places the call.

Partner's (Red.) ATM Address:
Specifies the redundancy ATM address for the partner client/server.

Partner Server ESI:
Identifies a locally administered ESI that is to be used as the ESI component of the partner ARP Server ATM address when the ARP Server fails.

Partner Server SEL:
Identifies the Selector portion of the partner server ESI and selector configured on the partner server.

Redundancy Default IP Gateway Address:
Specifies the default IP gateway address. This is the default gateway address configured in the clients served by this ARP Server. Defining this address enables the ARP Server to provide routing function from one subnet to another subnet.

pvc-atm-arp-entry
Lists ARP PVCs.

```
ARP config> list pvc

ATM Arp Permanent Virtual Circuit Definitions


No. IF# Prot# P/S     Protocol     -> VPI / VCI
1    0    0    P         0.0.0.0   ->  00 / 0029
2    0   23    P                   ->  00 / 0068
```

No. VCC number

IF# Interface Number

Prot# Protocol number (Prot# 0 = IP, 7 = IPX, 23=ASRT)

P/S: P for PVC, S for SVC

Protocol IP Address (IPX host number if the protocol is IPX)

VPI/VCI The decimal value of the defined channel.

svc-atm-arp-entry
Lists ARP SVCs.

```
ARP config> list svc

ATM Arp Switched Virtual Circuit Definitions


No. IF# Prot# P/S     Protocol     -> Destination ATM Address
2    0    0    S        0.0.0.0   ->
                    39.84.0F.00.00.00.00.00.00.00.00.00.02.10.00.5A.00.DE.AD.03
```

No VCC number

IF# Interface Number

Prot# Protocol number (Prot# 0 = IP, 7 = IPX, 23=ASRT)

P/S: P for PVC, S for SVC

Protocol IP Address (IPX host number if protocol is IPX)

Destination ATM Address
Destination ATM Address

mars-servers
Lists information about configured MARS Servers.

```
ARP config>list mars-servers

ATM MARS Remote Server List:
   IP Address      Number   Prim/Bkup  Address / Sub Address
        8.5.5.5    [ 1]     Primary    39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01
```

Reorder

Use the **reorder** command to select the primary ARP Server from a list of ARP Servers. This command is useful for clients only.

Syntax:

reorder arp

Example: reorder arp

```
    ATM Arp Remote Server List:
       IP Address      Number       Address / Sub Address
            1.1.1.1     [ 1]       39.84.0F.00.00.00.00.00.00.00.00.00.02.
                                                 11.11.11.11.11.11.11
            1.1.1.1     [ 2]       39.84.0F.00.00.00.00.00.00.00.00.00.03.
                                                 AA.AA.AA.AA.AA.AA.AA
Number of the IP Address/Arp Server ATM Address pair to be made Primary
Default of 1 will change nothing [1]?
```

Set

Use the **Set** command to set the refresh timer value (in minutes). ARP entires will age out after this number of minutes if they are not refreshed.

Syntax:

set refresh-timer

refresh-timer
Specifies the value for the aging timer for ARP entries.

Valid Values: An integer number of minutes in the range of 0 to 65535

Default Value: 5

Sample ARP Configurations

Sample configurations show the complete sequence of events for that configuration.

ARP Server Redundancy Configuration in a Non-Distributed ARP Server LIS

Configuring a partner

The following sample shows configuring the a ARP Server for ARP Server Redundancy.

Notes:

1. Add the physical ATM device
2. Add locally administered ESIs
3. Add IP address to be used for server
4. Begin ARP Configuration
5. Define an ATM ARP client
6. Define the ARP Server
7. Use locally administered ESI
8. Begin redundancy configuration for IP address 1.1.1.1

```
Config (only)>add device atm        1
Device Slot #(0-3) [0]?
Adding CHARM ATM Adapter device in slot 0  port 1 as interface #0
Use "net 0" to configure CHARM ATM Adapter parameters
Config (only)>net
Network number [0]?
ATM user configuration
ATM Config>int
ATM interface configuration
ATM Interface Config>add esi   2
ESI in 00.00.00.00.00.00 form []? 11.11.11.11.11.11
ATM Interface Config>add esi
ESI in 00.00.00.00.00.00 form []? aa.aa.aa.aa.aa.aa
ATM Interface Config>exit
ATM Config>exit
Config (only)>p ip
Internet protocol user configuration
IP config>add addr    3
Which net is this address for [0]?
New address [0.0.0.0]? 1.1.1.1
Address mask [255.0.0.0]?
IP config>exit
```

```
Config (only)>p arp  4 .
ARP user configuration
ARP config>add atm  5
Interface Number [0]?
Protocol [IP]?
Client IP Address [0.0.0.0]? 1.1.1.1
This client is also a server? [No]: yes  6
Refresh timeout (in minutes) [20]?
Enable auto-refresh? [Yes]:
Refresh by InAtmArp? [Yes]:
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) AAAAAAAAAAAA
Select ESI [1]? 2      7
Use internally assigned selector? [Yes]: n
Selector Only, Range 00..FF [00]? 11
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Server for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Use Best Effort Server for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
Participate in Server Synchronization [N]?
Re-registration time with Arp Server (in minutes) [15]?
ARP config>add red      8
Interface Number [0]?
Protocol [IP]?
Local client IP Address [0.0.0.0]? 1.1.1.1
Note: Local Redundancy ESI must be different from the Primary Server ESI
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) AAAAAAAAAAAA
Select Local Redundancy ESI [1]? 3
Local Redundancy selector, Range 00..FF [00]? aa
Partner's (Redundancy) ATM Address, 40 Hex digits
[00000000000000000000000000000000000000000000]?
39.84.0F.00.00.00.00.00.00.00.00.01.bb.bb.bb.bb.bb.bb.bb

Redundancy default IP Gateway also ? [Yes]:
If Yes, Redundancy default IP Gateway protocol address [0.0.0.0]? 1.1.1.3
ARP config>exit
Config (only)>reload
Are you sure you want to reload the gateway? (Yes or [No]): yes
  EXIT, reload requested
```

Configuring the Partner

The following sample shows configuring the partner for ARP Server Redundancy.

Notes:

1. Add the physical ATM device
2. Add locally administered ESIs
3. Begin ARP Configuration
4. This is the client definition
5. When secondary, define as client only (if not is a Distributed ARP Server LIS). If Distributed ARP Server, the partner can be defined as a Distributed ARP Server LIS.
6. Use locally administered ESI
7. Define the ARP Server
8. Begin redundancy configuration for IP address 1.1.1.2
9. Defining the secondary

```
Config (only)>add device atm  1
Device Slot #(0-3) [0]?
Adding CHARM ATM Adapter device in slot 0  port 1 as interface #0
Use "net 0" to configure CHARM ATM Adapter parameters
Config (only)>net
Network number [0]?
ATM user configuration
ATM Config>int
ATM interface configuration
ATM Interface Config>add esi
ESI in 00.00.00.00.00.00 form []? 11.11.11.11.11.11
ATM Interface Config>add esi  2
ESI in 00.00.00.00.00.00 form []? bb.bb.bb.bb.bb.bb
ATM Interface Config>exit
ATM Config>exit
Config (only)>p ip
Internet protocol user configuration
IP config>add addr
Which net is this address for [0]?
New address [0.0.0.0]? 1.1.1.2
Address mask [255.0.0.0]?
IP config>exit
```

```
Config (only)>p arp  3
ARP user configuration
ARP config>add atm   4
Interface Number [0]?
Protocol [IP]?
Client IP Address [0.0.0.0]? 1.1.1.2
This client is also a server? [No]: no   5
Refresh timeout (in minutes) [5]?
Enable auto-refresh? [no]:
Refresh by InAtmArp? [no]:
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) BBBBBBBBBBB
Select ESI [1]? 1  6
Use internally assigned selector? [Yes]: y
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Server for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Use Best Effort Server for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Participate in Server Synchronization  (Y or N) [N]?    N
Max SDU size (bytes) [9188]?
Re-registration time with Arp Server (in minutes) [15]?
ARP config> add arp-server private-nsapa 7
Local Client IP Address [0.0.0.0]? 1.1.1.2
Private NSAP Address: Specify 40 digits
ATM Address []? 39840F000000000000000000000111111111111111
ARP config>add red   8
Interface Number [0]?
Protocol [IP]?
Local client IP Address [0.0.0.0]? 1.1.1.2
Note: Local Redundancy ESI must be different from the Primary Server ESI
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) BBBBBBBBBBB
Select Local Redundancy ESI [1]? 3
Local Redundancy selector, Range 00..FF [00]? bb
Partner's (Redundancy) ATM Address, 40 Hex digits
[0000000000000000000000000000000000000000]?
39.84.0F.00.00.00.00.00.00.00.00.01.aa.aa.aa.aa.aa.aa.aa    9
  (  1) Use burned in ESI
  (  2) 111111111111
  (  3) BBBBBBBBBBB
Select Partner Server ESI [1]? 2
Partner selector, Range 00..FF [00]? 11
Redundancy default IP Gateway also ? Yes
If Yes, Redundancy default IP Gateway protocol address [0.0.0.0]? 1.1.1.3
ARP config>exit
Config (only)>reload
Are you sure you want to reload the gateway? (Yes or [No]): yes
  EXIT, reload requested
```

Notes:

1. In a Distributed ARP Server LIS, both partners are Distributed ARP Servers.
2. Configuring ARP Server Redundancy is the same process for the Distributed ARP Server case as for the non-Distributed ARP Server case.

MARS Configuration

See “MARS Configuration Example” on page 26-4 for a sample configuration.

Accessing the ARP Monitoring Environment

Use the following procedure to access the ARP monitoring commands. This process gives you access to the ARP *monitoring* process.

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide.) For example:

   ```
   * talk 5
   +
   ```

   After you enter the **talk 5** command, the GWCON prompt (+) displays on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the + prompt, enter the **protocol arp** command to get you to the ARP> prompt.

   Example:

   ```
   + prot arp
   ARP>
   ```

ARP Monitoring Commands for Non-ATM Networks

This section describes the ARP monitoring commands for non-ATM nets. You can access ARP monitoring commands at the ARP> prompt.

Note: If the device's software load does not contain Asynchronous Transfer Mode (ATM), ATM-related commands are not valid and are not displayed at the ARP configuration and monitoring prompts.

Table 24-3 shows the commands.

Table 24-3. ARP monitoring Commands for non-ATM Networks Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Clear	Clear the cache for a specified interface.
Dump	Display the cache for a specified interface.
Hardware	List each ARP-configured network.
Ping	Verify connectivity between the device and the specified end station.
Protocol	List each ARP-configured protocol.
Statistics	Display ARP information.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Clear

Use the **clear** command to flush the ARP cache for a given network interface. The **clear** command can be used to force the deletion of bad transactions.

To clear a particular interface, enter the interface or network number as part of the command. To obtain the interface number, use the CONFIG **list devices** command.

Syntax:

c**lear** *interface#*

Example: `clear 1`

Dump

Use the **dump** command to display the ARP cache for a given network/protocol combination. To display the ARP cache for a particular interface, enter the interface or network number as part of the command. To obtain the interface number, use the CONFIG **list devices** command.

If there is more than one protocol on that network, the protocol number must also be given. This causes the monitoring to display the hardware address-to-protocol mappings stored in that database. If ARP is in use by only one protocol on the specified interface, then the protocol number is optional. To obtain the protocol number, use the CONFIG **protocol** command.

The **dump** command display shows the hardware address, the protocol address, and the refresh timer parameter for each mapping.

Syntax:

d**ump** *interface# protocol#*

Example: `dump 2 ip`

```
Hardware Address    IP Address      Refresh
02-07-01-00-00-01   192.9.1.2       Permanent
a1-b2-c3-4d-5e-6f   128.185.214.36  5
100                 128.185.123.51  Not Aging
16                  128.185.214.38  Not Aging
```

Valid refresh timer parameters are:

Permanent
: A statically configured mapping between hardware address and protocol address (entered using the ARP **add entry** command, or the frame-relay **add protocol** command, or the X25 **add address** command). These entries do not age and are not overwritten by dynamically learned mappings.

minutes to expire
: The number of minutes until this mapping expires due to aging or until this mapping is refreshed (if auto-refresh is enabled). This parameter is expressed as a numeric value.

Not Aging
: A fixed SVC or PVC mapping learned through Inverse ARP. It begins to age only when the circuit goes down. The mapping can be overwritten

by a newer learned address and can be cleared by the ARP **clear** monitoring command.

Hardware

Use the **hardware** command to display the networks registered with ARP. The **hardware** command lists each ARP-registered network, and displays each network's hardware address space (Hardware AS) and local hardware address.

Syntax:

hardware

Example: **hardware**

```
Network       Hardware AS    Hardware Address

 1 FR/0          000F            1023
 5 TKR/0         0006            00:00:C9:09:32:EF
 8 Eth/0         0001            AA-00-04-00-26-14
 9 IPPN/0        2048            128.185.214.38
10 BDG/0         0001            00-00-93-90-4C-F7
```

Note: The IPPN entry refers to IP Tunneling where the hardware address field indicates the IP address of the IP Tunnel.

Ping

Use the **ping** command to have the router send ICMP Echo Requests to a given destination. For more information on the **ping** command, see "Ping" on page 16-44.

Protocol

Use the **protocol** command to display (by network) the protocols that have addresses registered with ARP. This command displays the network, protocol name, protocol number, protocol address space (in hexadecimal), and local protocol addresses.

Syntax:

protocol

Example: **protocol**

```
Network  Protocol (num)  AS    Protocol Address(es)
5 TKR/0  IP       (00)   800    128.185.209.38
6 TKR/1  IP       (00)   800    10.1.181.38
8 Eth/0  IP       (00)   800    128.185.221.38
8 Eth/0  AP2      (22)   80F3   221/38
```

Note: SR entries refer to Source Routing - the protocol address is used to indicate the MAC address. Use the token-ring **dump** command to view actual RIF entries.

Statistics

Use the **statistics** command to display a variety of statistics about the operation of the ARP module.

Syntax:

statistics

Example: `statistics`

```
ARP input packet overflows
Net   Count
 PPP/0  0
 PPP/1  0
 TKR/0  0
IPPN/0  0
 BDG/0  0

ARP cache meters
Net Prot  Max Cur Cnt    Alloc  Refresh: Tot  Failure  TMOs: Refresh
0   0     1   1   1       17             0        0               13
0  22     1   0   0        6             0        0                6
1   0     1   1   2       27             0        0               25
1  16     3   3   7      291             0        0                0
2   0     1   0   0        2             0        0                2
2  16     1   0   0        1             0        0                0
8   0     1   1   1       11             0        0               10
```

ARP input packet overflows	Displays counters that represent the number of ARP packets discarded on input because the ARP layer was too busy. The counts shown are per network interface.
ARP cache meters	Consists of a variety of meters on the operation of the ARP cache. The counts shown are all per protocol, per interface.
Net	Displays the interface numbers.
Prot	Displays the protocol numbers.
Max	Displays the all-time maximum length hash chain.
Cur	Displays the current maximum length hash chain.
Cnt	Displays the count of entries currently active.
Alloc	Displays the count of entries created.
Rfrsh:Tot	Displays the number of refresh requests sent for this network interface and protocol.
Fail	Displays the number of auto-refresh attempt failures due to unavailability of internal resources. This count is not related to whether or not an entry was refreshed.
TMOs:Rfrsh	Displays the count of entries deleted due to a timeout of the refresh timer.

ARP Over ATM Monitoring Commands

This section describes the ARP over ATM (CIP) monitoring commands. It describes the monitoring commands for:

- Classical IP & ARP over ATM
- IPX over ATM
- 1483 bridging

The monitoring commands for IPX over ATM are essentially the same as those for Classical IP and ARP. The main difference is the format of protocol addresses:

- Protocol addresses for IP are specified as 4-byte fields in dotted-decimal notation.
- Protocol addresses for IPX are specified as 6-byte fields in hexadecimal characters.

Note: The **ping** command for IPX over ATM is different from that used for Classical IP and ARP. The IPX version of the **ping** command is available at the IPX monitoring. You can access ARP monitoring commands at the ARP> prompt. Table 24-4 on page 24-36 shows the commands.

For further information, refer to “Classical IP and ARP Over ATM (RFC 1577)” on page 23-3 and “IPX and ARP Over ATM Overview (RFC 1483)” on page 23-15. For additional information on ARP over ATM, and for illustrations showing logical and physical network configurations, refer to *Multiprotocol Switched Services (MSS) Configuration and Operations Guide*

Since bridging does not use ARP, the monitoring may only be used to check the status of a channel associated with a bridge port. Also, since bridging does not use protocol addresses, only the port number for the associated (local) port is displayed with a channel.

Table 24-4. ARP Over ATM monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Delete	Immediately bring down an active channel. A new channel may or may not be brought up to replace the old one depending on the conditions.
Display	Display all of the channels (VCCs) associated with a single ATM interface.
Dump	Show which ATM channels are being used for sending datagrams and show their corresponding IP addresses.
Hardware	List each ARP-configured network.
Ping	Verify connectivity between the device and the specified end station.
Protocol	List each ARP-configured protocol.
Redundancy-State	Display IP clients configured with Redundancy
Statistics	Display statistics of the ARP code over all of the network interfaces.
Mjoin	Makes the device to belong to one or more multicast groups. **Note:** This command is available only if MARS is enabled.
Mleave	Removes the device from membership in multicast groups. **Note:** This command is available only if MARS is enabled.
Mcache	Displays a list of currently active multicast forwarding cache entries. **Note:** This command is available only if MARS is enabled.
Mgroups	Displays the group membership of the device's attached interfaces. **Note:** This command is available only if MARS is enabled.
Mstats	Displays various multicast routing statistics. **Note:** This command is available only if MARS is enabled.
Grouplistrequest	Requests a multicast group list for a range of IP addresses. **Note:** This command is available only if MARS is enabled.
Joinrange	Issues a request to join a multicast group range. **Note:** This command is available only if MARS is enabled.
Leaverange	Issues a request to leave a multicast group range. **Note:** This command is available only if MARS is enabled.
Timers	Temporarily changes the Redirect, Register, and Response timer values. **Note:** This command is available only if MARS is enabled.
List-mars-clients	Lists of all the active MARS clients in this device. **Note:** This command is available only if MARS is enabled.
Mars-client-info	Displays information about one or more MARS clients. **Note:** This command is available only if MARS is enabled.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Delete

Use the **delete** command to immediately bring down an active channel. A new channel may or may not be brought up to replace the old one depending on the conditions.

Delete a specific channel off of the Active Channel List. One should use great care when invoking this option. The channel specified by the VPI/VCI is deleted if it is found on the active channel list. Before deletion, the channel is released with a normal hang-up cause code. All ARP entries that are dependent on this particular channel are also deleted.

Syntax:

de**lete**

Example: `delete`

```
ARP> del 0
VPI, Range 00..FF [00]?
VCI, Range 0000..FFFF [0000]? 0020
Channel found and deleted
```

Display

Use the **display** command to display all of the channels (VCCs) associated with a single ATM interface.

Syntax:

di**splay**

Example: `display`

```
ARP> display 0
Active Channel List : Net 0
   P/S FLAGS LIST  VPI/VCI    FwdPcr    FwdScr     MaxSDUsz Control P2P
  0) S   80    01   00/0020  155000000 155000000      9188      T     T
        Tgt Addr. 39.84.0F.00.00.00.00.00.00.00.00.02.10.00.5A.00.DE.AD.02
        Client Address (owner): 1.1.1.100
        Target Protocol Addresses: 1.1.1.2
New Channel List : Net 0
PVC Channel List : Net 0
   P/S FLAGS LIST  VPI/VCI    FwdPcr    FwdScr     MaxSDUsz Control P2P
  1) P  80   01    00/0068   155000000 155000000      9188      F     T
        Tgt Addr.:
        Client Address (owner): Port No. 1
  2) P  80   03    00/0048   155000000 155000000      9188      F     T
        Tgt Addr.:
        Client Address (owner): Port No. 1
```

P/S P means that this channel is a PVC. S means that this channel is an SVC. In the example, PVC #2 is for bridging.

List For internal use.

Flags For internal use.

VPI/VCI Virtual Path Identifier and Virtual Channel Identifier of the channel in use.

FwdPcr The Peak Cell Rate in bits per second.

FwdScr The Sustained Cell Rate in bits per second.

MaxSDUsz
The maximum SDU size for this channel. All packets transmitted or received on this interface must be less than or equal to this size less the 8-byte header prefix used by RFC 1483.

Control T if this is a control channel (channel to the ARP server). F if this is a data channel (channel to another client).

P2P T if this channel is point-to-point. F if this channel is point-to-multipoint.

Active Channel List
These channels are true connections with the remote party. Data can flow over these connections with the traffic parameters shown.

New Channel List
These channels are in the process of being connected with the other end. No data may flow over them until they are moved to the active list.

PVC Channel List
These are channels which have been specifically configured as PVCs. They take on the client characteristics for Data Channels as defined in the client configuration.

Client Address
This is the protocol address of the local client attached to this VCC.

Target Protocol Address
This is the protocol address of the remote client attached to this VCC.

Dump

Use the **dump** command to show which ATM channels are being used for sending datagrams, and their corresponding destination IP addresses.

This table represents the entire ARP table for a physical ATM network running Classical IP. The hardware address is the resultant VCC identifier (VPI/VCI) for an active channel. That is, all traffic that is to be sent to the IP address will be transmitted out on the associated channel (listed under Hardware Address).

Note: If the host on the other end of the channel sends either a request or reply with its own address, we will automatically reset the refresh time to its maximum value.

Syntax:

du**mp**

Example: dump

```
 ARP>du 0
Hardware Address  IP Address          Refresh      Origin Srvrid   Seq number
  0/0               1.1.1.1            19              1.1.1.1      868997267
  0/0               1.1.1.2            permanent       1.1.1.2      868997028
  0/0               1.1.1.3            permanent       1.1.1.2      868997028
  0/35              1.1.1.5            20              1.1.1.2      868997042
```

Under Refresh, the time specified is the approximate time before the ARP entry is aged out (in minutes). If autorefresh is turned on, then an ARP request or an InATMARP request will be sent out 30 seconds before the expiration. If a reply is received before expiration, the Refresh time is reset, and the ARP entry remains. If no reply is received, or if autorefresh is turned off, the ARP entry will be deleted when it expires. It will be recreated as required.

The following are valid Refresh states:

Hardware Address
Specifies the hardware addresses registered with the ARP. If “0/0” appears under the Hardware Address, there is no channel open for this ARP entry.

Refresh States

-
- If “resolve only” appears under Refresh, this ARP entry exists only for the purposes of resolving the ATM address of the given IP address. These entries are used for registering with the ARP server (1577+ registration).
- If “not aging” appears under Refresh, the entry will remain indefinitely.

Origin Server Id
The DCS ID (IP address for IBM products) of the server that originated this cache entry. It is possible that if a client registers with multiple servers, there will be more than one cache entry for that client's IP address. There will be one entry for each server with which the client registers, but each will have a different Origin ID.

Seq. Number
The current sequence number of the corresponding SCSP cache entry (in decimal). This number should match on all servers in the server group for this particular cache entry.

Hardware

Use the **hardware** command to list all of the ATM addresses associated with each configured IP client.

Syntax:

h**ardware**

Example: `hardware`

```
ARP> hardware
    Network         Hardware AS     Hardware Address
    0 ATM/0         0013            39.84.0F.00.00.00.00.00.00.00.00.00.01.
                                    10.00.5A.00.DE.AD.C8  (IP 1.1.1.100)
    1 IPPN/0        0800            1.1.1.100
```

Network: The physical network number.

Hardware AS:
The hardware type used in the ARP packets to classify this network. For ARP over ATM, the AS type is 0x13 (decimal 19).

Hardware Address:
The hardware address. Typically, this address is a MAC address for other networks, but for ATM, this address is the ATM address associated with a specific client. In the example, the IP client, `1.1.1.100`, is accessed by calling the corresponding ATM address `39.84.0F.00.00.00.00.00.00.00.00.00.01.10.00.5A.00.DE.AD.C8`.

Ping

Use the **ping** command to verify connectivity between the device and the specified end station.

Ping works exactly as it does over any of the other networks. It sends out an ICMP echo request every second, and displays statistics of the corresponding replies. Note that the source address in the request will contain the client's address that most closely matches the subnet of the destination.

Syntax:

p**ing**

Example: ping

```
ARP> ping 1.1.1.2
PING 1.1.1.100 -> 1.1.1.2: 56 data bytes, ttl=64, every 1 sec.
56 data bytes from 1.1.1.2: icmp_seq=0. ttl=64. time=19. ms
56 data bytes from 1.1.1.2: icmp_seq=1. ttl=64. time=11. ms

----1.1.1.2 PING Statistics----
2 packets transmitted, 2 packets received, 0% packet loss
round-trip min/avg/max = 11/15/19 ms
```

Protocol

Use the **protocol** command to list all the client addresses on each of the network interfaces. This is exactly the same as for other interfaces. For an ATM interface, the list of Protocol Addresses are all of the CIP clients configured on this interface.

Syntax:

p**rotocol**

Example: protocol

```
ARP> protocol
Network  Protocol (num)  AS     Protocol Address(es)
0 ATM/0  IP       ( 0)   0800   1.1.1.100
```

Redundancy-State

Use the **redundancy-state** command to display (by network) the IP clients that are configured with redundancy.

Syntax:

red**undancy-state**

The following example shows the Redundancy monitoring section on the primary ARP Server when the Redundancy channel is inactive.

```
CGW Operator monitoring
+p arp
ARP>red
Network number  [0]?
Protocol [IP]
If: 0 Prot: IP  Clients configured with Redundancy
-----------------------------------------------------------
Addr: 1.1.1.1   Place Redundancy Call: Yes  Real Esi: Up  Red. Esi: Up  Red. Chnl: Down
                    FLAGS: Real Client: C8  Red. Client: C8 RedFlags: C0
                    Red. Channel: 0/0
                     Red. Channel: Source ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.AA.AA.AA.AA.AA.AA.AA
                     Red. Channel: Target ATM address
39.84.0F.00.00.00.00.00.00.00.00.00.01.BB.BB.BB.BB.BB.BB.BB
                     Redundancy Status: Active
 Redundancy default IP Gateway protocol address: 1.1.1.3
```

The following example shows the Redundancy monitoring section on the primary Server when the Redundancy channel is active.

```
CGW Operator monitoring
+p arp
 ARP>red
 Network number  [0]?
 Protocol [IP]?
 If: 0 Prot: IP  Clients configured with Redundancy
 -----------------------------------------------------------
 Addr: 1.1.1.1   Place Redundancy Call: Yes  Real Esi: Up  Red. Esi: Up  Red. Chnl: Up
                     FLAGS: Real Client: C8  Red. Client: C8 RedFlags: D0
                     Red. Channel: (VPI/VCI)  0/32
                     Red. Channel: Source ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.AA.AA.AA.AA.AA.AA.AA
                     Red. Channel: Target ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.BB.BB.BB.BB.BB.BB.BB
                     Redundancy Status: Active
 Redundancy default IP Gateway protocol address: 1.1.1.3
 -----------------------------------------------------------
```

The following example shows the Redundancy monitoring section on the partner when the Redundancy channel is inactive and the partner is acting as the backup Arp Server.

```
ARP>red
 Network number  [0]?
 Protocol [IP]?
 If: 0 Prot: IP  Clients configured with Redundancy
 -----------------------------------------------------------
 Addr: 1.1.1.2   Place Redundancy Call: No  Real Esi: Up  Red. Esi: Up  Red. Chnl: Down
                     FLAGS: Real Client: C8  Red. Client: C8 RedFlags: 80
                     Red. Channel: 0/0
                    Red. Channel: Source ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.BB.BB.BB.BB.BB.BB.BB
                     Red. Channel: Target ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.AA.AA.AA.AA.AA.AA.AA
                     Redundancy Status: Active
 Partner Server ESI: 11.11.11.11.11.11, Partner Server SEL: 11, In backup Server mode
 Redundancy default IP Gateway Protocol address: 1.1.1.3
 -------------------------------------------
```

The following example shows the Redundancy monitoring section on the secondary when the Redundancy channel is active and the secondary is acting as client and not in backup ARP Server mode (Since Primary ARP server is active).

```
ARP>red
Network number  [0]?
 Protocol [IP]?
 If: 0 Prot: IP  Clients configured with Redundancy
 ------------------------------------------------------
Addr: 1.1.1.2   Place Redundancy Call: No  Real Esi: Down  Red. Esi: Up  Red. Chnl: Up
                     FLAGS: Real Client: C0  Red. Client: C8 RedFlags: 90
                     Red. Channel: (VPI/VCI)  0/32
                     Red. Channel: Source ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.BB.BB.BB.BB.BB.BB.BB
                    Red. Channel: Target ATM address
 39.84.0F.00.00.00.00.00.00.00.00.00.01.AA.AA.AA.AA.AA.AA.AA
                     Redundancy Status: Inactive, not trying ...
 Partner Server ESI: 11.11.11.11.11.11, Partner Server SEL: 11, Acting as a Client
 Redundancy default IP Gateway Protocol address: 1.1.1.3
 -------------------------------------------
 ARP>exit
```

The following fields are displayed from the Redundancy monitoring:

If: Specifies the interface number.

Prot: Specifies the protocol.

Addr: Specifies the IP Address of the client.

Place Redundancy Call
Indicates if the client will initiate the redundancy call. See page 23-15.

Real ESI: Indicates the state of the real ESI. If the state is Up, the client's ATM address registered successfully with the switch. If the state is Down, the client's attempt to register its ATM address with the switch was unsuccessful.

Red. ESI: Indicates the state of the Redundancy ESI. If the state is Up, the Redundancy channel ATM address registered successfully with the switch. If the state is Down, the Redundancy channel ATM address did not register successfully with the switch.

Red. Chnl:
Indicates the state of the of the Redundancy channel. If the state is Up, the Redundancy channel is set up between the primary and secondary. If the state is Down, the Redundancy channel is not set up between the primary and secondary.

Red Channel
Provides the VPI/VCI of the Redundancy channel.

Red. Channel Source ATM address:
Identifies the ATM address of the source Redundancy channel.

Red. Channel Target ATM address:
Identifies the ATM address of the target Redundancy channel.

Redundancy Status:
Identifies the status of redundancy.

Active Providing ARP Services.

Inactive Not providing ARP Services.

Partner Server ESI:
Identifies a locally administered ESI that is to be used as the ESI component of the partner ARP Server ATM address when the partner ARP Server fails.

Partner Server SEL:
Identifies the Selector portion of the ESI and selector configured on the partner device. This field is displayed for backup or peer ARP Server only.

Redundancy Default IP Gateway Address:
Specifies the default IP gateway address. This is the default gateway address configured in the clients served by this ARP Server. This address enables the ARP Server to provide routing function from one subnet to another subnet.

Statistics

Use the **statistics** command to display statistics of the ARP code over all of the network interfaces. These statistics are the same as the statistics in the ARP code over any of the other interfaces as described in “Statistics” on page 24-33.

Syntax:

s**tatistics**

Example: `statistics`

```
ARP> statistics

    ARP input packet overflows
        Net   Count
       ATM/0  0
      IPPN/0  0
       BDG/0  0

    ARP cache meters
    Net Prot  Max Cur Cnt    Alloc  Refresh: Tot  Failure  TMOs: Refresh
      0   0     1   1   1        1             0        0              0
```

Mjoin

Note: This command is available only if MARS is enabled.

Use the **mjoin** command to establish the device as a member of a multicast group.

Syntax:

mj**oin** *multicast-group-address*

```
ARP>mj
Multicast group to join [0.0.0.0]? 230.2.2.2
```

Mleave

Note: This command is available only if MARS is enabled.

Use the **mleave** command to remove a device's membership in a multicast group. This will keep the device from responding to pings and SNMP queries sent to the group address.

Syntax:

ml**eave** *multicast-group-address*

```
ARP>ml
Multicast group to leave [0.0.0.0]? 230.2.2.2
```

Mcache

Note: This command is available only if MARS is enabled.

Use the **mcache** command to display a list of currently active multicast cache entries. Multicast cache entries are built on demand, whenever the first matching multicast datagram is received. There is a separate cache entry (and therefore a separate route) for each datagram source network and destination group combination.

Cache entries are cleared on topology changes (e.g., a point-to-point line in the MOSPF system going up or down), and on group membership changes.

Syntax:

mc**ache**

```
ARP>mcache

        0: ATM/0           1: ATM/1           2: Internal

  Source          Destination     Count   Upst    Downstream
  8.0.0.0         226.6.6.6       26      1       2

ARP>
```

Mgroups

Note: This command is available only if MARS is enabled.

Use the **mgroups** command to display the group membership of the device's attached interfaces. Only the group membership for those interfaces on which the router is either designated router or backup designated router are displayed.

Syntax:

mg**roups**

```
ARP>mgroups

           Local Group Database
Group              Interface                Lifetime (secs)
224.1.1.1          ATM/0                     141
230.2.2.2          Internal
```

Mstats

Note: This command is available only if MARS is enabled.

Use the **mstats** command to display various multicast routing statistics. The command indicates whether multicast routing is enabled.

Syntax:

ms**tats**

```
ARP>mstats

               MOSPF forwarding:       Enabled
               Inter-area forwarding:          Enabled
               DVMRP forwarding:               Disabled

  Datagrams received:              0  Datagrams (ext source):           0
  Datagrams fwd (multicast):       0  Datagrams fwd (unicast):          0
  Locally delivered:               0  No matching rcv interface:        0
  Unreachable source:              0  Unallocated cache entries:        0
  Off multicast tree:              0  Unexpected DL multicast:          0
  Buffer alloc failure:            0  TTL scoping:                      0

  # DVMRP routing entries:         0  # DVMRP entries freed:            0
  # fwd cache alloc:               0  # fwd cache freed:                0
  # fwd cache GC:                  0  # local group DB alloc:           4
  # local group DB free:           2
```

Grouplistrequest

Note: This command is available only if MARS is enabled.

Use the **grouplistrequest** command to request a list of the multicast groups within the *<group-start-range - group-end-range>* block which have layer 3 members.

Syntax:

g**rouplistrequest** *network# group-start-range group-end-range*

```
ARP>grouplist
Network number [0]?
Start Range Group IP address [230.0.0.0]?
End Range Group IP address [239.255.255.255]?
Request for grouplist has been sent.
```

Joinrange

Note: This command is available only if MARS is enabled.

Use the **joinrange** command to request to join a specified group range.

Syntax:

j**oinrange** *interface# group-start-range*

```
ARP>joinrange 0
Start Range Group IP address [230.0.0.0]? 240.1.1.1
End Range Group IP address [239.255.255.255]? 239.1.1.1
Request to Join has been sent.
```

Leaverange

Note: This command is available only if MARS is enabled.

Use the **leaverange** command to request to leave a specified group range.

Syntax:

le**averange** *interface# group-start-range*

```
ARP>leaverange 0
Start Range Group IP address [230.0.0.0]? 240.1.1.1
End Range Group IP address [239.255.255.255]? 241.1.1.1
Request to Leave has been sent.
```

Timers

Note: This command is available only if MARS is enabled.

Use the **timers** command to change the configured values for the ***Redirect timer***, ***Register timer***, and ***Response timer***. See 24-8 for more information.

Syntax:

timers *interface#*

```
ARP>timers
Network number [0]? 1

You can change 3 timer values.

First timer value:
New Redirect Timer value (seconds) [90]? 99
The value of this timer has been changed temporarily.
THE NEW VALUE WILL BE LOST UPON REBOOT OR RESTART.
To permanently change this parameter please re-configure.

Second timer value:
New Register Timer value (seconds) [10]? 11
The value of this timer has been changed temporarily.
THE NEW VALUE WILL BE LOST UPON REBOOT OR RESTART.
To permanently change this parameter please re-configure.

Third timer value:
New Response Timer value (seconds) [5]? 8
The value of this timer has been changed temporarily.
THE NEW VALUE WILL BE LOST UPON REBOOT OR RESTART.
To permanently change this parameter please re-configure.
ARP>
```

Redirect Timer value

Specifies the maximum time interval the MARS client should wait for MARS_REDIRECT_MAP messages. The value of this timer will be changed temporarily. THE NEW VALUE WILL BE LOST UPON REBOOT OR RESTART. Use the `ARP config>`**change mcs** command in **t 6** to permanently change this parameter.

Valid values: 90 to 240 seconds

Default value: 90

Note: This value should be greater than the **cluster redirect timer** value specified in the MARS Server configuration.

Register Timer value

Specifies the time to wait for a response from the MARS Server before considering that a register attempt with the MARS server has failed. The value of this timer will be changed temporarily. THE NEW VALUE WILL BE LOST UPON REBOOT OR RESTART. Use the `ARP config>`**change mcs** command in **t 6** to permanently change this parameter.

Valid values: 1 to 10 seconds

Default value: 10

Response Timer value

Specifies the time to wait for a response from the MARS Server before considering the request failed. The value of this timer will be changed temporarily. THE NEW VALUE WILL BE LOST UPON REBOOT OR

RESTART. Use the `ARP config>`**change mcs** command in **t 6** to permanently change this parameter.

Valid values: 1 to 240 seconds

Default value: 5

List-mars-clients

Note: This command is available only if MARS is enabled.

Use the **list-mars-clients** command to get a list of all the active MARS clients in this device.

Syntax:

list-mars-clients

```
ARP>list-mars-clients
Net Number     Protocol Address     ATM Address

˚ 1˚           IP  8.2.2.2     39840F000000000000000000020202020202020202
```

Mars-Client-info

Note: This command is available only if MARS is enabled.

Use the **mars-client-info** command to display information about one or more MARS clients.

Syntax:

mars-client-info interface#

```
ARP>mars-client-info 1

 MARS Client: (Arpccb:  0x20559650)
   IP Address:  8.2.2.2
   ATM Address: 39840F0000000000000000000020202020202020202
   Broadcast:   enabled.

   Status: (0x100A)
      - Connected to MARS Server
      - Registered to MARS Server
      - Automatic registration

   Sequence Numbers:
      Client CMI:            1          LSN:        0
      Redirect seqxy:        0          CSN:        4
      Server HSN:            4

   Counters:
      Current Missed Redirects:        0    Total:        0
      Register attempts:               0

   Configured MARS servers:
      39840F00000000000000000001010101010101010  - Active Server Channel

   MARS servers learned via Redirect messages:
      39840F00000000000000000001010101010101010  - Active Server Channel

   Active Sender Group List:
        This list is empty.

   Inactive Sender Group List:
        This list is empty.

   Receiver Group List:
      <224.0.0.5, 224.0.0.5> (Loc: 0x20559B34)
      <224.0.0.0, 239.255.255.255> (Loc: 0x20559C6C)
      <224.0.0.1, 224.0.0.1> (Loc: 0x20559CBC)
      <224.0.0.6, 224.0.0.6> (Loc: 0x2055AE28)
      <255.255.255.255, 255.255.255.255> (Loc: 0x205597E0)

   Pending Join requests:
        This list is empty.

   Pending Leave requests:
        This list is empty.

   Pending Group List requests:
        This list is empty.
```

Chapter 25. Monitoring the Server Cache Synchronization Protocol (SCSP)

Use the SCSP monitoring function to monitoring the state of server synchronization.

Accessing the SCSP monitoring Environment

Use the following procedure to access the SCSP monitoring commands. This process gives you access to the SCSP *monitoring* process.

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to "The OPCON Process and Commands" in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*.) For example:

   ```
   * talk 5
   +
   ```

   After you enter the **talk 5** command, the GWCON prompt (+) is displayed on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the + prompt, enter the **protocol scsp** command to get you to the SCSP prompt.

   Example:

   ```
   + prot scsp
   SCSP>
   ```

SCSP Monitoring Commands

This section describes the SCSP monitoring commands. You can access SCSP monitoring commands at the SCSP> prompt. Table 25-1 shows the commands.

Table 25-1. SCSP Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
List	List SCSP monitoring information.
Statistics	Displays SCSP statistics for a Directly Connected Server.
Dump	Dumps SCSP cache for a server group.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

List

Use the **List** command to display information about the state of server synchronization. You can also enter a ? after a specific command name to list its options.

Syntax:

list dcs . . .
server-groups . . .

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dcs *interface sgid*

Lists the all DCSs within a server group.

interface — Specifies the interface number that the DCS is defined upon.

sgid — Specifies the server-group identifier of this DCS.

Example:

```
SCSP>li dcs
Network number [0]?
Server Group ID [0]?
      DCS Id      HFSM State  CAFSM State  M/S  CRL Len  ReTran Len
 03.04.02.00   Bidirectional      Aligned   S         0           0
```

DCS Id — The hex identifier of the DCS (on the other end of the VCC).

HFSM State — The state of the Hello Finite State Machine for this DCS session. The states are:

- Down_Inop — The channel to the DCS is down.
- Down — The channel to the DCS is down, but an open is in progress.
- Waiting — The Local Server (LS) has sent an Hello message to the DCS and it is waiting for a response.
- Unidirectional — The LS has received a Hello message from the DCS but it has not yet recongized this Local Server.
- Bidirectional — The LS and the Directly Connected Server recognize each other. This is the normal state.

CAFSM State — The state of the Cache Alignment Finite State Machine for this DCS session. The states are:

- Down — Cache alignment has not yet begun.
- MS_Neg — The LS and the DCS are negotiating for Master/Slave status.
- Summarize — The LS and DCS are exchanging cache summarization information.
- Update — The LS and DCS are exchanging full cache information.
- Aligned — The LS and DCS are synchronized. This is the normal state.

M/S — Indicates Master (M) or Secondary (S) status of this LS. This is significant only if the CAFSM is in Summarize, Update, or Aligned state.

CRL Len — Cache Length Request List length. This is the number of cache update records that remain to be sent during Update state.

ReTran Len — ReTransmit list length. This is the number of cache update records that remain to be acknowledged by the DCS.

server-groups *interface*

Lists information about all server groups.

interface network interface number

Example:

```
SCSP config> list ser
Network number [0]?
       SGID  Protocol      LSID  DCSs  ATM Addr
          1    ATMARP  04040100     0  39.84.0F.00.00.00.00.00.00.00.00.01.
                                       11.11.11.11.11.11.01
          0    ATMARP  03040100     1  39.84.0F.00.00.00.00.00.00.00.00.01.
                                       11.11.11.11.11.11.01
```

sgid Server Group Identifier. This is the configured identifier for the servers in this server group (LIS).

Protocol The type of database being exchanged.

lsid Hex value of the Local Server Identifier. This identifies this Server within the server group. For ATMARP, this is the client's IP address.

DCSs The number of Directly Connected Servers associated with this Local Server.

ATM address The ATM address of this Local Server. DCSs must use this to set up connections with this Local Server.

Statistics

Use this command to show statistics for a Directly Connected Server.

Use the **Statistics** command to display information about the state of server synchronization. You can also enter a ? after a specific command name to list its options.

Syntax:

statistics *interface server-group dcs-id*

interface Specifies the interface number that the DCS is defined upon.

Valid values: Any defined interface

Default value: 0

server-group

Specifies the server-group of this DCS.

Valid values: 0 - 65535

Default value: 0

dcs-id Specifies the hex identifier of the DCS (on the other end of the VCC).

Valid Values:

Default Value: 0

Example:

```
SCSP>stat 0 0
DCS ID (hex) [0]?
DCS with that ID not found, listing all DCS's.
-------------------------------------------
DCS ID: 03.04.02.00
HFSM State: Bidirectional   DCS Hello Interval(sec): 3   DCS Dead Factor: 3
CAFSM State: Aligned  Master/Slave: S   CA seq: 33D35204   CSUS seq: 33D351F1
Cache Summary List sent?: yes   Cache Summary List ACKed?: yes
Cache Request List Size: 0   Cache ReTransmit List Size: 0   Age(sec): 302
ATM Addr: 39.84.0F.00.00.00.00.00.00.00.00.00.04.12.12.12.12.12.12.01
VPI: 0  VCI: 32  Missed Hello Msgs: 0   RID doesn't match LSID: 0
Short Messages: 0   Sequence Mismatches: 0
```

DCS Id See page 25-2.

HFSM State
See page 25-2.

CAFSM State
See page 25-2.

Hello Interval
The interval in seconds that the DCS sends out Hello messages.

DCS Dead Factor
The number of Hello Intervals that must pass without receiving a Hello message after which this DCS is considered down.

Master/Slave
See page 25-2.

CA Seq The current Cache Alignment message sequence number.

CSUS Seq
The current Cache State Update Solicit message sequence number.

Cache Summary List Sent?
Yes if the Cache Summary List has been completely transmitted to the DCS (during cache alignment state).

Cache Summary List Acked?
Yes if the entire Cache Summary List has been acknowledged (during cache alignment state).

Cache Request List size
See page 25-2.

Cache ReTransmit List size
See page 25-2.

Age The number of seconds that this DCS has been intialized.

VPI, VCI The Virtual Path Identifier and Virtual Channel Identifier of the VCC to the DCS

Missed Hello Msgs
The number of Hello messages missed while in bidirectional state

RID doesn't match LSID
Number of messages received where the Receiver ID in the message does not match the LSID of the LS.

Short Messages
Number of badly formed (too short) SCSP messages.

Sequence Mismatches
Number of sequence number protocol violations.

Dump

Use the **Dump** command to dump the SCSP cache for a server group.

Syntax:

d**ump** *interface server-group*

interface Specifies the interface number that the DCS is defined upon.

Valid values: Any defined interface

Default value: 0

server-group
Specifies the server-group of this DCS.

Valid values: 0 - 65535

Default value: 0

Example:

```
SCSP> dump 0 0
Next key to assign = 33D351F1
Key           Origin ID              Seq. No.   Age   Paddr
03.04.02.00   03.04.02.00           869487085     0   03.04.02.00
03.04.01.00   03.04.01.00           869487090     0   03.04.01.00
SCSP>
```

Key The hex cache key value for this cache entry. For ATM ARP this corresponds to the server's IP address (in hex).

Origin ID The hex DCS ID of the server originating this cache entry. For ATM ARP, this corresponds to the server's IP address.

Age The number of minutes that this entry has existed without a matching server cache entry. Once 20 minutes is reached, this entry is aged.

Paddr The corresponding protocol address of this cache entry. If this is blank, there is no corresponding server cache entry (for example, ATM ARP cache entry).

Chapter 26. Using MARS and the MARS Server

This chapter describes how to use the Multicast Address Resolution Protocol (MARS) on your device. It includes the following sections:

- "Multicast Address Resolution Server"
- "MARS Configuration Steps" on page 26-3

Multicast Address Resolution Server

The Multicast Address Resolution Server (MARS) provides support for connectionless IP Multicast and Broadcast services over ATM networks.

MARS provides a mapping service between ATM addresses and an IP Multicast or Broadcast address. This service is similar to a Classical ARP Server (RFC 1577), but, while the ARP Server provides a one-to-one mapping between an IP Unicast address and an ATM address, the MARS Server provides a one-to-many mapping between an IP Multicast/Broadcast address and **n** ATM addresses, where **n** is the number of destinations that have joined a particular IP Multicast/Broadcast address.

IP Multicast and Broadcast addresses have a wide number of uses but the most well known is for sending audio/video information over the Mbone. While the Mbone is the most well known application, IP Multicast/Broadcast addresses are used by all of the major routing protocols (RIP, OSPF, BGP, etc..) and networking services such as BOOTP and DLS.

MARS provides the link-layer support for ATM networks required by IP Multicast/Broadcast enabled applications. This function adheres to RFC 2022.

The MARS model consists of:

- A MARS Server
- The set of endpoints (hosts and routers) which choose to be served by that MARS server. This set is called a cluster, and these endpoints are called MARS clients or cluster members.

  The MARS Client is an extension to the ARP Client.

  A cluster may not span multiple Logical IP Subnets (LISs).

Control Virtual Channel Connections

A MARS client communicates with its server via MARS control messages.

Private control messages are sent over a point-to-point VC called the Private Control VC. A client uses this VC to register the MARS Server, and then the client can dynamically join, leave, or send to a particular multicast group.

A separate point-to-multipoint VC called the Cluster Control VC (CCVC) is used by the MARS Server to update all cluster members of changes to multicast groups.

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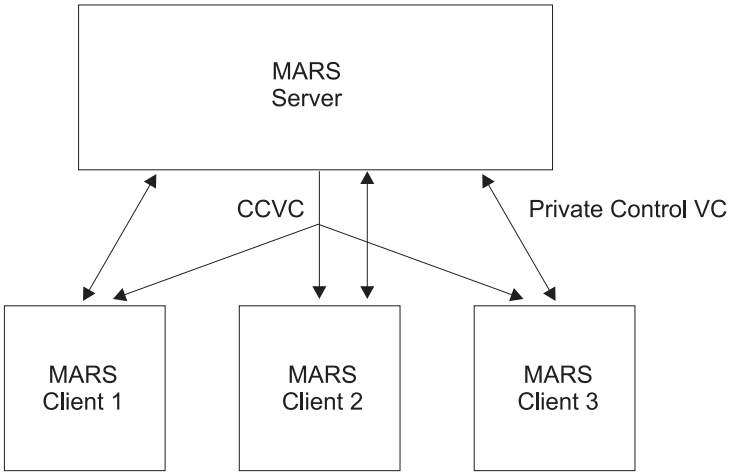

Figure 26-1. Cluster Control VC

Data Virtual Channel Connections

The VC mesh is used to achieve intra-cluster multicasting. Each multicast source establishes its own point-to-multipoint VC to all the members of the multicast group with whom it wishes to communicate.

In the VC mesh case, the MARS Server's role is to provide to the multicast source the list of all members of the multicast group. The MARS Server does not get involved with the multicast data path.

Alternatively, a multicast source can establish a VC to an intermediate node called a Multicast Server (MCS). The MCS establishes a point-to-multipoint VC to the actual destinations.

The MSS does not allow stand-alone MCSs, but the MARS server can be configured to act as both the server and an MCS, by issuing the **change mcs-support** command.

The use of an MCS is transparent to cluster members.

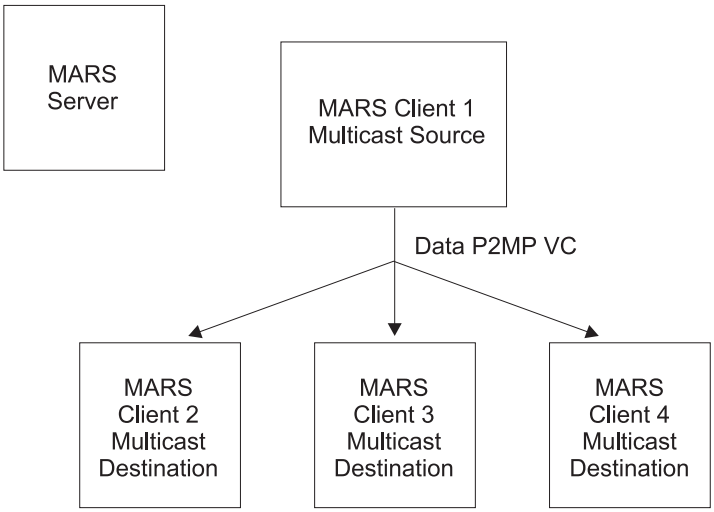

Figure 26-2. VC Mesh

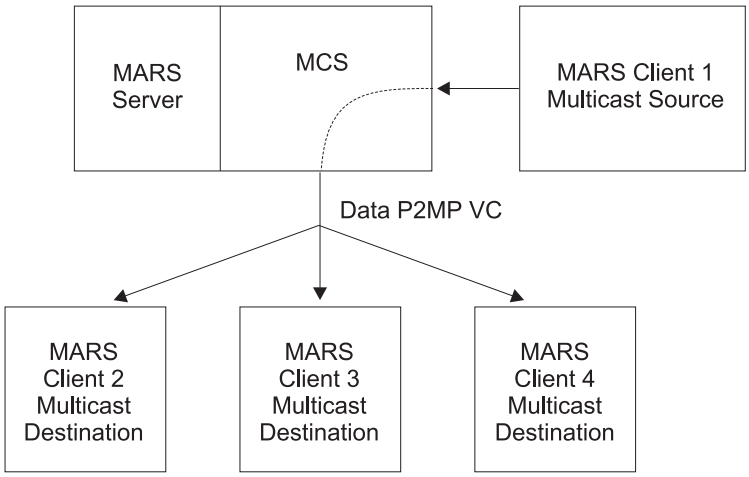

Figure 26-3. Use of Multicast Server

Backup/Redundant MARS Servers

A cluster member can be configured with a backup MARS server, or it can dynamically learn a list of backups via MARS_REDIRECT_MAP messages. These messages are sent by the MARS server periodically to its cluster, and they contain the default MARS server for the cluster to use, and a list of backup MARS servers.

The MARS_REDIRECT_MAP message can also be used to force cluster members to register with a different MARS server by changing the value of the default MARS server in the message.

The interval between MARS_REDIRECT_MAP messages is the **Cluster redirect timer** in the MARS Server configuration. It must be less than the **Redirect timer value** in the MARS client configuration.

MARS Client

The MARS Client is an extension to the ARP Client. Information about the MARS Client is available in Chapter 23, “Using ARP” on page 23-1 and Chapter 24, “Configuring and Monitoring ARP” on page 24-1.

MARS Configuration Steps

Use the following process to add MARS support to your configuration.

1. At the device where the MARS Server will reside:
   a. At the `Config>` prompt, enter the **p mars** command.
   b. At the `MARS config>` prompt, use the **add mars-server-configuration** command to configure the MARS server.
   c. Optionally, if Multicast Server (MCS) support is wanted, enter the **change mcs-support** command.
   d. Optionally, specify MARS backup servers with the **add mars-backup** command.
2. At the devices where the MARS clients will reside, for each MARS client:

a. Configure the ARP client and identify its ARP Server. (The ARP Server also must be configured at the device where it will reside. See Chapter 23, “Using ARP” on page 23-1 for information about configuring ARP clients and ARP Servers.)

b. Use **add multicast-support** to define multicast support.

c. Use **add mars-server** to identify its MARS Server.

MARS Configuration Example

The following sample shows configuring MARS.

Notes:

1 Define two ATM interfaces on the device that will contain the MARS Server and the ARP Server
2 Configure the MARS Server
3 Specify the ARP Server IP address (8.2.2.2) and mask
4 Configure the ATM ARP client as a MARS Server
5 Define an ATM interface on the device that will contain the MARS client
6 Define the client's IP address (8.3.3.3) and mask
7 Configure the ATM ARP client
8 Add multicast capability to the ARP client (MARS client)
9 Specify the ATM address of the client's ARP Server
10 Specify the ATM address of the client's MARS Server
11 Configure OSPF inter-area multicasting and non-broadcast

```
*------------------------------------------------------------------- *
* ------------------------------------------------------------------ *
*       CONFIGURATION OF THE MARS SERVER AND OF THE ARP SERVER:       *
* ------------------------------------------------------------------ *
* ------------------------------------------------------------------ *


Config (only)>add dev atm  1
Device Slot #(0-3) [0]? 0
Adding CHARM ATM device in slot 0  port 1 as interface #0
Use "net 0" to configure CHARM ATM parameters

Config (only)>net 0
ATM user configuration
ATM Config>interface
ATM interface configuration
ATM Interface Config>add esi
ESI in 00.00.00.00.00.00 form []? 01.01.01.01.01.01
ATM Interface Config>exit
ATM Config>exit

Config (only)>add dev atm
Device Slot #(0-3) [0]? 1
Adding CHARM ATM device in slot 1  port 1 as interface #1
Use "net 1" to configure CHARM ATM parameters

Config (only)>net 1
ATM user configuration
ATM Config>interface
ATM interface configuration
ATM Interface Config>add esi
ESI in 00.00.00.00.00.00 form []? 02.02.02.02.02.02
ATM Interface Config>exit
ATM Config>exit
```

```
Config (only)>p mars     2
MARS Configuration
MARS config>add mars-server-configuration private
Interface Number of MARS Server being created [0]? 0
Private NSAP Address: Specify unique 40 digits
ATM Address []? 39840f0000000000000000000010101010101010
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Service for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
Private Control VC Aging Timer (minutes) [20]?
Cluster Redirect Timer (seconds) [60]?
MARS Server Instance has been created

To enable MARS MCS support, select:  change mcs-support

MARS config>exit

Config (only)>p ip
Internet protocol user configuration
IP config>add addr      3
Which net is this address for [0]? 1
New address []? 8.2.2.2
Address mask [255.0.0.0]?
IP config>exit


Config (only)>p arp
ARP user configuration
ARP config>add atm-arp-client-configuration      4
Interface Number [0]? 1
Protocol [IP]?
Client IP Address [0.0.0.0]? 8.2.2.2
This client is also a server? [No]: yes
Refresh timeout (in minutes) [20]?
Enable auto-refresh? [Yes]:
Refresh by InAtmArp? [Yes]:
  (  1) Use burned in ESI
  (  2) 020202020202
Select ESI [1]? 2
Use internally assigned selector? [Yes]: no
Selector Only, Range 00..FF [00]? 02
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Service for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Use Best Effort Service for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
Participate in Server Synchronization ? [No]:
Re-registration time with Arp Server (in minutes) [15]?

To enable or change multicast support,
 please issue the ADD or CHANGE MULTICAST-SUPPORT command.

ARP config>exit
```

```
* ------------------------------------------------------------------ *
* ------------------------------------------------------------------ *
*             CONFIGURATION OF AN ARP/MARS CLIENT:                   *
* ------------------------------------------------------------------ *
* ------------------------------------------------------------------ *


Config (only)>add dev atm     5
Device Slot #(0-3) [0]? 0
Adding CHARM ATM device in slot 0  port 1 as interface #0
Use "net 0" to configure CHARM ATM parameters

Config (only)>net 0
ATM user configuration
ATM Config>interface
ATM interface configuration
ATM Interface Config>add esi
ESI in 00.00.00.00.00.00 form []? 03.03.03.03.03.03
ATM Interface Config>exit
ATM Config>exit

Config (only)>p ip   6
Internet protocol user configuration
IP config>add addr
Which net is this address for [0]? 0
New address []? 8.3.3.3
Address mask [255.0.0.0]?
IP config>exit

Config (only)>p arp
ARP user configuration
```

```
ARP config>add atm-arp-client-configuration     7
Interface Number [0]? 0
Protocol [IP]?
Client IP Address [0.0.0.0]? 8.3.3.3
This client is also a server? [No]: no
Refresh timeout (in minutes) [5]?
Enable auto-refresh? [No]:
Refresh by InAtmArp? [No]:
  (  1) Use burned in ESI
  (  2) 030303030303
Select ESI [1]? 2
Use internally assigned selector? [Yes]: no
Selector Only, Range 00..FF [00]? 03
Validate PCR for best effort VCCs? [No]:
Maximum Reserved Bandwidth for incoming VCCs (Kbps) [0]?
Use Best Effort Service for Control VCCs? [Yes]:
Peak Cell Rate of outbound control VCCs (Kbps) [0]?
Sustained Cell Rate of outbound control VCCs (Kbps) [0]?
Use Best Effort Service for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Max SDU size (bytes) [9188]?
Re-registration time with Arp Server (in minutes) [15]?

To enable or change multicast support,
 please issue the ADD or CHANGE MULTICAST-SUPPORT command.

ARP config>add multicast-support      8
Interface Number [0]? 0
Client IP Address [0.0.0.0]? 8.3.3.3
Configure multicast support? [No]: yes
Configure broadcast support? [No]: yes
Redirect Timer value (seconds) [90]?
Register Timer value (seconds) [10]?
Response Timer value (seconds) [5]?
Maximum number of consecutive missed Redirects [4]?
Maximum number of consecutive failed Register attempts [3]?
Maximum number of consecutive Response timer failures [3]?
Multicast VC Aging Timer (minutes) [20]?



ARP config>add arp-server private     9
Local Client IP Address [0.0.0.0]? 8.3.3.3
Private NSAP Address: Specify 40 digits
ATM Address []? 39840f0000000000000000000202020202020202

ARP config>add mars-server private    10
Local Client IP Address [0.0.0.0]? 8.3.3.3
Private NSAP Address: Specify 40 digits
ATM Address []? 39840f0000000000000000000101010101010101
Primary server? [Yes]: yes

ARP config>exit
```

```
Config (only)>p ospf    11
Open SPF-Based Routing Protocol configuration console

OSPF Config>enable mult
Inter-area multicasting enabled? [No]: yes

OSPF Config>enable ospf
Estimated # external routes [100]? 200
Estimated # OSPF routers [50]? 50
Maximum Size LSA [2048]?

OSPF Config>set area
Area number [0.0.0.0]?
Authentication Type [0]?

OSPF Config>set interface
Interface IP address [0.0.0.0]? 8.3.3.3
Attaches to area [0.0.0.0]?
Retransmission Interval (in seconds) [5]?
Transmission Delay (in seconds) [1]?
Router Priority [1]?
Hello Interval (in seconds) [10]?
Dead Router Interval (in seconds) [40]?
Type Of Service 0 cost [1]?
Demand Circuit (Yes or No)? [No]:
Authentication Key []?
Retype Auth. Key []?
Forward multicast datagrams? [Yes]:
Forward as data-link unicasts? [No]:
IGMP polling interval (in seconds) [60]?
IGMP timeout (in seconds)[180]?

OSPF Config>set non-b
Interface IP address [0.0.0.0]? 8.3.3.3
Poll Interval[120]?

OSPF Config>exit
```

Chapter 27. Configuring and Monitoring the MARS Server

This chapter describes how to use the MARS Server configuration and operating commands and includes the following sections:

- "Accessing the MARS Server Configuring Environment"
- "MARS Server Configuration Commands"
- "Accessing the MARS Server Monitoring Environment" on page 27-10
- "MARS Server Monitoring Commands" on page 27-10

Accessing the MARS Server Configuring Environment

For information on how to access the MARS configuring environment, see "Getting Started (Introduction to the User Interface)" in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.

Use the following procedure to access the MARS Server configuring process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.) For example:

   ```
   * talk 6
   Config>
   ```

   After you enter the **talk 6** command, the CONFIG prompt (`Config>`) displays on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the CONFIG prompt, enter the **prot mars** command to get to the `MARS Config>` prompt.

MARS Server Configuration Commands

To configure MARS, enter the commands at the `MARS Config>` prompt.

Table 27-1. MARS Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Add	Adds a MARS server configuration, a MARS backup server or mcs-support.
Change	Changes a MARS server configuration, a MARS backup server or mcs-support.
Delete	Deletes a MARS server configuration or a MARS backup server.
List	Lists all (the current MARS configurations), lists MARS Server configurations, or MARS backup servers.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

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Add

Use the **add** command to add a MARS server configuration or a MARS backup server.

Syntax:

add mars-server-configuration *private-nsapa*
mars-backup private-nsapa *instance-number*
mcs-support *instance-number*

mars-server-configuration private-nsapa . . .

Defines a MARS Server.

interface number

Specifies the interface number on which the MARS Server is to be defined.

Valid Values: 1 - maximum number of interfaces

Default Value: None

private-nsap-address

Specifies the full ATM address for the MARS Server. Private Network Specified Access Point Address (private-nsap-address) is the addressing format specified in the UNI Versions 3.0 and 3.1.

The first byte of the *nsapa* defines the addressing format, as follows:

First Byte	*NSAP Address Format Specification*
0x39	DCC ATM Format
0x47	ICD ATM Format
0x45	E.164 ATM Format

Valid Values: Any valid ATM address (40 hexadecimal characters)

Note: The selector portion of the ATM address must be less than the value of **max-config-selectors**. See the chapter entitled “Configuring ATM” in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide* for additional information about ATM addresses.

Default value: None

Validate PCR for best effort VCCs

When *yes*, Best-Effort VCCs will be rejected if the signaled forward PCR exceeds the Maximum Reserved Bandwidth or the speed of the adapter. If *no*, Best-Effort PCRs will be accepted without regard to the signaled Peak Cell Rate.

Valid Values: Yes or No

Default Value: No

Maximum Reserved Bandwidth for incoming VCCs (Kbps)

Defines the maximum acceptable Sustained Cell Rate (SCR) for an incoming VCC. If SCR is not specified on the incoming call, then this parameter defines the maximum acceptable

Peak Cell Rate (PCR). Calls received with traffic parameters specifying higher rates will be released. This parameter is applied to both forward and backward Cell Rate parameters. The constraint imposed by this parameter is applicable to best effort connections (if **validate PCR** is *yes*) and is compared to the PCR on the incoming call.

Valid Values: Integer Kbps in the range of 0 to line speed. If you enter 0, the parameter is set to the line speed.

Default Value: None

Use Best Effort Service for Control VCCs

Specifies the type of traffic characteristics to be associated with Control VCCs. Bandwidth is not reserved for best effort traffic.

Valid Values: Yes or No

Default Value: Yes

Peak Cell Rate of outbound control VCCs (Kbps)

Specifies the Peak Cell Rate (PCR) traffic parameter for the Control VCC. This PCR value is used for both the forward and backward PCR values of both best effort and reserved bandwidth VCCs.

Valid Values: An integer Kbps in the range of 0 to line speed of the ATM device. If you enter 0, the parameter is set to the line speed.

Default Value:

- If best effort, default is max data rate
- If reserved, there is no default

Sustained Cell Rate of outbound control VCCs (Kbps)

Specifies the bandwidth reserved by all VCCs on a given ATM device. (Sustained Cell Rate can be considered to reserved bandwidth.) This parameter is applicable only when Best Effort Server is not selected for Control VCCs.

Valid Values: An integer Kbps in the range of 0 to control VCC PCR. If you enter 0, the parameter is set to the line speed.

Default Value: none

Max SDU size (bytes)

Specifies the Maximum SDU size that will be specified when calls are placed. It also is used to verify incoming calls. This parameter cannot be set to a value greater than the Maximum SDU size for the physical ATM interface (port).

Valid Values: An integer in the range of 72 to Maximum interface SDU

Default Value: 9188

Cluster redirect timer

Specifies the transmission interval for mars-redirect-map messages.

Valid Values: An integer number of seconds in the range of 60 to 120

Default Value: 60

Private control VC Aging Timer

Specifies the aging timer associated with private control VCs.

Valid Values: An integer number of minutes in the range of 1 to 120

Default Value: 20

mars-backup private-nsapa

Identifies a MARS backup to the MARS being configured. Up to 8 backup servers can be specified.

instance-number

This value will specify the instance of MARS server.

Valid Values: Any defined interface

Default Value: None

ATM address

Specifies the full ATM address for the MARS backup server.

Valid Values: Any valid ATM address (40 hexadecimal characters). Up to 8 backup servers can be specified.

Default Value: None

```
MARS config>add mars-backup private
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance to which a backup is to be added
(Default of 0 will add nothing) [0]? 1
Backup Number     ATM Address/Sub Address
   [0]            39.84.0F.00.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08

   [1]            39.84.0F.00.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09


Enter the ATM Address of backup number [2]
Private NSAP Address: Specify unique 40 digits
ATM Address []? 39840f000000000000000000070707070707070707
Backup MARS Server has been added

MARS config>list mars-backups
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance whose backups are to be listed [1]? 1
Backup Number     ATM Address/Sub Address
   [0]            39.84.0F.00.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08

   [1]            39.84.0F.00.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09

   [2]            39.84.0F.00.00.00.00.00.00.00.00.00.07.07.07.07.07.07.07.07
```

mcs-support

Adds MCS support.

instance-number

Specifies the instance number on which multicast support is to be changed.

Valid values: Any instance on the device

Default value: None

Enable MCS support
Specifies whether MCS support is to be enabled.

Valid values: Yes or No

Default value: No

Support broadcast address
Specifies whether the broadcast address is supported. This question is asked only if the answer to **Enable MCS support** is *yes*.

Valid values: Yes or No

Default value: No

IP address of any device on the LIS
Specifies the IP address of any device on the LIS. This question is asked only if the answer to **Support broadcast address** is *yes*.

Valid values: Any valid IP address

Default value: 0.0.0.0

IP subnet mask for the LIS
Specifies the subnet mask for the LIS. This question is asked only if the answer to **Support broadcast address** is *yes*.

Valid values: Any valid IP subnet mask

Default value: 255.0.0.0

Support multicast address range
Specifies whether a multicast range is supported. This question is asked only if the answer to **Enable MCS support** is *yes*.

Valid values: Yes or No

Default value: No

Starting group address range
Specifies the minimum address of the group address range. This question is asked only if the answer to **Support multicast address range** is *yes*.

Valid values: Any valid group address ≤ the **Ending group address range**

Default value: 224.0.0.0

Ending group address range
Specifies the maximum address of the group address range. This question is asked only if the answer to **Support multicast address range** is *yes*.

Valid values: Any valid group address ≥ the **Starting group address range**

Default value: 239.255.255.255

Send all multicast/broadcast traffic over CCVC
Specifies whether multicast broadcast traffic should be sent over CCVC. This question is asked only if the answer to **Enable MCS support** is *yes*.

Valid values: Yes or No

Default value: No

Data VC aging timer
Specifies the aging time associated with a data VCC. This question is asked only if the answer to **Enable MCS support** is *yes* and the answer to **Send all multicast/broadcast traffic over CCVC** is *no*.

Valid values: 1 to 120 minutes

Default value: 20

Use Best Effort Service for Data VCCs
Yes or No. Specifies the type of traffic characteristics to be associated with Data VCCs. Bandwidth is not reserved for best effort traffic. This question is asked only if the answer to **Enable MCS support** is *yes*, and the answer to **send all multicast/broadcast traffic over CCVC** is *no*.

Valid values: Yes or No

Default value: Yes

Peak Cell Rate of outbound Data VCCs (Kbps)
Specifies the Peak Cell Rate (PCR) traffic parameter for the Data VCCs. This PCR value is used for both the forward and backward PCR values of both best effort and reserved bandwidth VCCs.This question is asked only if the answer to **Enable MCS support** is *yes*, and the answer to **send all multicast/broadcast traffic over CCVC** is *no*.

Valid Values: An integer Kbps in the range of 0 to control VCC PCR. If you enter 0, the parameter is set to the line speed.

Default Value: 0

Sustained Cell Rate of outbound Data VCCs (Kbps)
Specifies the Sustained Cell Rate (SCR) traffic parameter for the Data VCCs. (Sustained Cell Rate can be considered to reserved bandwidth.) This parameter is applicable only when Best Effort Service is not selected for Data VCCs. This question is asked only if the answer to **Enable MCS support** is *yes*, and the answer to **send all multicast/broadcast traffic over CCVC** is *no*.

Valid Values: An integer Kbps in the range of 0 to PCR value for Data VCC. If you enter 0, the parameter is set to the line speed.

Default Value: 0

Change

Use the **change** command to change the MARS server configuration.

Syntax:

change — mars-server-configuration private-nsapa *instance-number*
mars-backup private-nsapa *instance-number backup-number*
mcs-support *instance-number*

mars-server-configuration private-nsapa *instance-number*
Changes the MARS server configuration.

See 27-2 for a description of the **change** parameters.

mars-backup private-nsapa *instance-number backup-number*
Changes a MARS backup server.

See 27-4 for a description of the **change** parameters.

```
MARS config>change mars-backup private
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]*           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance which needs a backup change
(Default of 0 will change nothing) [0]? 1
Backup Number     ATM Address/Sub Address
   [0]            39.84.0F.00.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08
   [1]            39.84.0F.00.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09
   [2]            39.84.0F.00.00.00.00.00.00.00.00.00.07.07.07.07.07.07.07.07

Backup number to be changed [0]? 2
Private NSAP Address: Specify unique 40 digits
ATM Address [39.84.0F.00.00.00.00.00.00.00.00.00.07.07.07.07.07.07.07.07]?
39840f00000000000000000000606060606060606   1
Backup MARS Server has been changed

MARS config>list mars-backups
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance whose backups are to be listed [1]?
Backup Number     ATM Address/Sub Address
   [0]            39.84.0F.00.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08
   [1]            39.84.0F.00.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09
   [2]            39.84.0F.00.00.00.00.00.00.00.00.00.06.06.06.06.06.06.06.06
```

Note:

1 ATM address information is a response to previous question; it is shown as a separate line because of spacing.

mcs-support *instance-number*
Changes MCS support.

See 27-4 for a description of the **change** parameters.

```
MARS config>ch mcs
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance Number to be changed
(Default of 0 will change nothing) [0]? 1
Enable MARS MCS Support? [No]: yes
Support Broadcast address? [No]: yes
Support Multicast address Range? [No]: yes
IP address of any device on the LIS [0.0.0.0]? 8.1.1.1
IP Subnet mask for the LIS [255.0.0.0]?
Starting group address range [224.0.0.0]?
Ending group address range[239.255.255.255]˚? 230.255.255.255
Send all multicast/broadcast traffic over CCVC? [No]:
Use Best Effort Service for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Data VC Aging Timer (minutes) [20]?
MARS MCS Support has been changed.
```

Delete

Use the **delete** command to delete a MARS server configuration, or a MARS backup server.

Syntax:

delete mars-server-configuration *instance-number*
mars-backup *instance-number backup-number*

mars-server-configuration *instance-number*

Deletes a MARS server configuration.

instance-number

This value will specify the MARS instance to be deleted.

Valid Values: Any integer representing a MARS instance

Default Value: None

mars-backup *instance-number*

Deletes a MARS backup server.

instance-number

This value will specify the instance of MARS server.

Valid Values: Any integer representing a MARS instance

Default Value: None

backup-number

This value is the number of the backup to be deleted.

Valid Values: Any integer

Default Value: None

```
MARS config>delete mars-backup
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance for which a backup is to be deleted
(Default of 0 will delete nothing) [0]? 1
Backup Number     ATM Address/Sub Address
   [0]            39.84.0F.00.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08
   [1]            39.84.0F.00.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09
   [2]            39.84.0F.00.00.00.00.00.00.00.00.00.06.06.06.06.06.06.06.06

Backup number to be deleted [0]? 1
Backup MARS Server has been deleted

MARS config>list mars-backups
MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address
  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

Enter MARS Server Instance whose backups are to be listed "1"?
Backup Number     ATM Address/Sub Address
   [0]            39.84.0F.00.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08
   [1]            39.84.0F.00.00.00.00.00.00.00.00.00.06.06.06.06.06.06.06.06
```

List

Use the **list** command to display the information about MARS servers and MARS backups.

Syntax:

list all
config *instance-number*
mars-servers
mars-backup

all Lists the MARS server configurations.

```
MARS config>list all

MARS Server Configuration List:

 Mars Instance  Interface  ATM Address/Sub Address

  [1]           [0]        39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01

ATM MARS Server Configuration parameters:

MARS Server Instance Number [1]

If: 0  ESI: 01.01.01.01.01.01  Sel: 01

Validate PCR: no   Max B/W(kbps):      0
Control BE:   yes  Cell Rate(kbps): Peak:      0  Sustained:      0
Max SDU(bytes):   9188
Cluster Redirect Timer (sec): 60
Private VC idle  Timer (min): 20
MARS MCS Support:      no
   Support Broadcast Address: no
   Support Multicast Address Range: no
   Send all multicast/broadcast traffic over CCVC: no
      Use Best Effort Service for Data VCCs: yes
      Peak Cell Rate of outbound Data VCCs (Kbps):      0
      Sustained Cell Rate of outbound Data VCCs (Kbps):      0
      Data VC Aging Timer (minutes): 20
There are no backups yet for this MARS Server Instance.
MARS config>
```

config *instance-number*

This list option allows you to select the instance number of the MARS server you want to list.

mars-servers
This list option lists all MARS server instances.

mars-server-backups
This option lists all MARS backup instances.

See 27-4 and 27-2 for descriptions of the parameters displayed using the **list** command.

Accessing the MARS Server Monitoring Environment

Use the following procedure to access the MARS Server monitoring commands. This process gives you access to the MARS Server *monitoring* process.

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.) For example:

   ```
   * talk 5
   +
   ```

   After you enter the **talk 5** command, the GWCON prompt (+) displays on the monitoring. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the + prompt, enter the **p mars** command to get you to the MARS> prompt.

   Example:

   ```
   + p mars
   MARS>
   ```

MARS Server Monitoring Commands

This section describes the MARS Server monitoring commands.

For further information, refer to Chapter 26, "Using MARS and the MARS Server" on page 26-1.

Table 27-2. MARS Server Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Global-info	Display information common to all MARS Server instances.
Instance-info	Display information about a selected MARS Server.
Channels	Show which ATM channels are being used by the MARS Server.
Groups	Display information about MARS groups.
Nodes	Display information about MARS nodes.
Proto-info	List information about protocols using MARS.
Cg-redirect-timer	Temporarily change the redirect-timer value.
Redirect	Force a redirect.
List-instances	List all instances of MARS Servers.
Dump-hash-table	Display the MCS hash table.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Global-info

Use the **global-info** command to display MARS global information.

Syntax:

gl**obal-info**

Example:

```
MARS>global-info

Global Status Flags: 0x0000      Global Error Flags: 0x0000
Global # Queue Overflows:                        0
Global # Invalid Destinations:                   0
MARS Server # Input Packet Overflows:            0
MARS Server # Queued Input  Packets:             0
MARS Server # Queued Output Packets:             0
MARS Client # Input Packet Overflows:            0
MARS Client # Queued Input  Packets:             0
MARS Client # Queued Output Packets:             0
MCS # Input Packet Overflows:                    0
MCS # Queued Input  Packets:                     0
MCS # Queued Output Packets:                     0
MARS>
```

Instance-info

Use the **instance-info** command to display information about a selected MARS instance.

Syntax:

in**stance-info**

Example:

```
MARS>instance
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?

--------------------------------------------------
Instance: 0   Interface: 0     (Loc: 0x2050CA50)

MARS Server Instance Status Flags:   (0x015D)
          - Instance has been created
          - Instance has been configured
          - Instance has been activated
          - ATM Address has been activated
          - GET ATM Address by handle successful
          - ATM Open Call SAP successful
MARS Server Instance Failure Flags:  (0x0000)
          - NO failure flags have been set
MARS Server Instance ATM User Flags: (0xE0)
          - MARS Server Instance is registered to ATM Device Driver
          - Get MARS Server Instance UNI version successful
          - Open MARS Server Instance buffered frame SAP successful
```

Channels

Use the **channels** command to display which ATM channels are being used by the MARS Server.

Syntax:

ch**annels** *interface# instance#*

Example:

```
MARS>channels 0 0

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Active Channel List:

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  0) 00    01    0/32    154999984 154999984      9188      F        T
        ATM Address of remote side of channel:
                39.84.0F.00.00.00.00.00.00.00.00.00.03.03.03.03.03.03.03.03
                  No protocol addresses.

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  1) 00    01    0/38    155000000 155000000      9188      F        F
        Leaf Addressess:
                39.84.0F.00.00.00.00.00.00.00.00.00.05.05.05.05.05.05.05.05
                  No protocol addresses.
                39.84.0F.00.00.00.00.00.00.00.00.00.03.03.03.03.03.03.03.03
                  No protocol addresses.

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  2) 00    01    0/36    155000000 155000000      9188      F        F
        Leaf Addressess:
                39.84.0F.00.00.00.00.00.00.00.00.00.05.05.05.05.05.05.05.05
                  No protocol addresses.
                39.84.0F.00.00.00.00.00.00.00.00.00.03.03.03.03.03.03.03.03
                  No protocol addresses.

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  3) 00    01    0/35           0         0      9188      F        F
        Destination leaf.
        ATM Address of remote side of channel:
                39.84.0F.00.00.00.00.00.00.00.00.00.03.03.03.03.03.03.03.03

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  4) 00    01    0/33    155000000 155000000      9188      T        F
        Leaf Addressess:
                39.84.0F.00.00.00.00.00.00.00.00.00.05.05.05.05.05.05.05.05
                39.84.0F.00.00.00.00.00.00.00.00.00.03.03.03.03.03.03.03.03

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  5) 00    01    0/34    154999984 154999984      9188      F        T
        ATM Address of remote side of channel:
                39.84.0F.00.00.00.00.00.00.00.00.00.05.05.05.05.05.05.05.05
                  No protocol addresses.

     FLAGS LIST  VPI/VCI    FwdPcr    FwdScr      MaxSDUsz  Control  P2P
  6) 00    01    0/37           0         0      9188      F        F
        Destination leaf.
        ATM Address of remote side of channel:
                39.84.0F.00.00.00.00.00.00.00.00.00.05.05.05.05.05.05.05.05

New Channel List:
There is no channel of this type
```

FwdPcr The Peak Cell Rate in bits per second.

FwdScr The Sustained Cell Rate in bits per second.

MaxSDUsz
The maximum SDU size for this channel. All packets transmitted or received on this interface must be less than or equal to this size less the 8-byte header prefix used by RFC 1483.

Control T if this is a control channel. F if this is a data channel.

P2P T if this channel is point-to-point. F if this channel is point-to-multipoint.

Active Channel List

These channels are true connections with the remote party. Data or control messages can flow over these connections with the traffic parameters shown.

New Channel List

These channels are in the process of being connected with the other end. No data may flow over them until they are moved to the active list.

Groups

Use the **groups** command to display information about MARS groups.

Syntax:

gr**oups**	clusters
	servers

Example:

```
MARS>groups clusters
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?
For protocol 0x0800:

 Group <224.0.0.5, 224.0.0.5> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505

 Group <224.0.0.1, 224.0.0.1> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505

 Group <255.255.255.255, 255.255.255.255> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505

 Group <224.0.0.6, 224.0.0.6> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505


 Group <225.1.1.1, 225.1.1.1> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505

 Group <230.1.1.1, 230.1.1.1> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505

 Group <231.1.1.1, 231.1.1.1> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505

 Group <224.0.0.0, 239.255.255.255> has these members:
    Client: 39840F0000000000000000000030303030303030303
    Client: 39840F0000000000000000000050505050505050505



MARS>groups servers
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?
For protocol 0x0800:
There are currently no groups.
```

Nodes

Use the **nodes** command to display information about MARS nodes.

Syntax:

no**des**	clusters servers

Example:

```
MARS>nodes clusters
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?

 For protocol 0x0800 the number of current members is:     2
 For protocol 0x0800 the number of removed members is:     0

 Client ATM Addr: 39840F0000000000000000000030303030303030303
    Status: Active  CMI:     1  Protocol Address: 8.3.3.3
    Group Membership:
        <224.0.0.5, 224.0.0.5>
        <224.0.0.0, 239.255.255.255>
        <224.0.0.1, 224.0.0.1>
        <255.255.255.255, 255.255.255.255>
        <224.0.0.6, 224.0.0.6>
        <225.1.1.1, 225.1.1.1>
        <230.1.1.1, 230.1.1.1>
        <231.1.1.1, 231.1.1.1>

 Client ATM Addr: 39840F0000000000000000000050505050505050505
    Status: Active  CMI:     2  Protocol Address: 8.5.5.5
    Group Membership:
        <224.0.0.5, 224.0.0.5>
        <224.0.0.0, 239.255.255.255>
        <224.0.0.1, 224.0.0.1>
        <255.255.255.255, 255.255.255.255>
        <224.0.0.6, 224.0.0.6>
        <225.1.1.1, 225.1.1.1>
        <230.1.1.1, 230.1.1.1>
        <231.1.1.1, 231.1.1.1>


MARS>nodes servers
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?

 For protocol 0x0800 the number of current members is:     0
 For protocol 0x0800 the number of removed members is:     0
```

Proto-info

Use the **proto-info** command to list protocol information.

Syntax:

pr**oto-info**

Example:

```
MARS>proto-info
Network interface [0]?
Instance     ATM Address / Subaddress
[ 0]
Instance number [0]?
-------------------------------------------------------------------------------
Instance: 0   Interface: 0     (Loc: 0x206275E8)
Protocol: 0x0800     (mpp: 0x2063C954)
        # Pending Translations:          0       # Request Failures:              0
        Next Available CSN:              0       Next Available SSN:              0
        Next Available CMI:              0
        Cluster Control VC Information:     (mlp: 0x2063C424)
        # Active Members:                0       # Abnormally Dropped Members:    0
        # Added Members:                 0       # Failed Add Members:            0
        # Removed Members:               0       # Failed Remove Members:         0
        There is no Cluster Control VC.
        Server Control VC Information:      (mlp: 0x206234C4)
        # Active Members:                0       # Abnormally Dropped Members:    0
        # Added Members:                 0       # Failed Add Members:            0
        # Removed Members:               0       # Failed Remove Members:         0
```

Cg-redirect-timer

Use the **cg-redirect-timer** command to temporarily change the redirect timer value.

Syntax:

cg**-redirect-timer**

Example:

```
MARS>cg
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?
New Cluster Redirect Timer (seconds) [60]? 55
The value of the Cluster Redirect Timer has been changed temporarily.
THE NEW VALUE WILL BE LOST UPON REBOOT OR RESTART.
To permanently change this parameter please re-configure.
```

Redirect

Use the **redirect** command to force a redirect.

This command brings you into the Mars Redirect submenu. While in this submenu, you can add, change or delete a MARS server's list of backups. If you issue **apply-changes** after making these changes, the next Redirect message the MARS Server sends to its clients will instruct the latter to re-register with the MARS server at the top of the new backup list.

Table 27-3. MARS Redirect Command Summary

Command	Function
? (Help)	Display the MARS monitoring commands or lists the options associated with specific commands.
Which	Allows you to specify the network# and instance# of the MARS Server to which changes will apply.
Add-mars-backup	Adds another backup to the current list of backup servers.
Change-mars-backup	Changes a backup in the current list of backups.
Delete-mars-backup	Deletes a backup from the current list of backups.
List-mars-backups	Displays information about the current list of backups.
Apply-changes	Forces a redirect.
Quit	Quits without applying changes.
Exit	Exits the MARS Redirect monitoring. prompt.

Example:

```
MARS>redirect

Entering MARS Redirect sub-menu.

You can change the backup list, but changes do not go into effect
until you issue the APPLY-CHANGES command.

The first command you issue must be the WHICH command
to specify the interface and instance numbers of the
MARS server to which the redirect changes apply.

MARS Redirect>which
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]?
MARS Redirect> add pri
Enter the ATM Address of backup number [0]
Private NSAP Address: Specify unique 40 digits
ATM Address []? 39840f000000000000000000008080808080808080

Changes do not go into effect until you issue the APPLY-CHANGES command.

MARS Redirect> add pri
Instance 0 on interface 0:

Backup Number     ATM Address/Sub Address
   [0]             39.84.0F.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08

Enter the ATM Address of backup number [1]
Private NSAP Address: Specify unique 40 digits
ATM Address []? 39840f000000000000000000009090909090909090

Changes do not go into effect until you issue the APPLY-CHANGES command.

MARS Redirect> delete
Instance 0 on interface 0:

Backup Number     ATM Address/Sub Address
   [0]             39.84.0F.00.00.00.00.00.00.00.00.08.08.08.08.08.08.08.08
   [1]             39.84.0F.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09

Backup number to be deleted [0]?

Changes do not go into effect until you issue the APPLY-CHANGES command.

MARS Redirect>list
Instance 0 on interface 0:

Backup Number     ATM Address/Sub Address
   [0]             39.84.0F.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09

MARS Redirect> ch pri
Instance 0 on interface 0:

Backup Number     ATM Address/Sub Address
   [0]             39.84.0F.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09

Backup number to be changed [0]?
Private NSAP Address: Specify unique 40 digits
ATM Address [39.84.0F.00.00.00.00.00.00.00.00.09.09.09.09.09.09.09.09]?
39840f000000000000000000008080808080808080  1

Changes do not go into effect until you issue the APPLY-CHANGES command.

MARS Redirect> quit
MARS Redirect> exit
MARS>
```

Note:

1 ATM address information is a response to previous question; it is shown as a separate line because of spacing.

List-instances

Use the **list-instances** command to get a list of all MARS instances on this interface.

Syntax:

list-instances *interface#*

Example:

```
LIST-INSTANCES:
---------------

MARS> list 0

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01
             Loc: 0x2050CA50
```

Dump-hash-table

Use the **dump-hash-table** command to display the MCS hash table.

Syntax:

dump *interface#*

Example:

```
MARS> dump
Network interface [0]?

Instance     ATM Address / Subaddress

[ 0]         39.84.0F.00.00.00.00.00.00.00.00.00.01.01.01.01.01.01.01.01


Instance number [0]? 0

-----------------------------------------------------------------
Instance: 0   Interface: 0     Protocol: IP     (mpp: 0x2050CE0C)

Index [01]   VPI/VCI   0/38      mep 0x205127D8   231.1.1.1

Index [01]   VPI/VCI   0/36      mep 0x2051223C   230.1.1.1
```

Chapter 28. Using BGP4

This chapter describes how to use the Border Gateway Protocol (BGP) using the BGP configuration commands.

This chapter contains the following sections:

- "Border Gateway Protocol Overview"
- "How BGP4 Works"
- "Setting Up BGP4" on page 28-4
- "Sample Policy Definitions" on page 28-5

Border Gateway Protocol Overview

BGP is an exterior gateway routing protocol used to exchange network reachability information among autonomous systems. An AS is essentially a collection of routers and end nodes that operate under a single administrative organization. Within each AS, routers and end nodes share routing information using an interior gateway protocol. The interior gateway protocol may be either RIP or OSPF.

BGP was introduced in the Internet in the loop-free exchange of routing information between autonomous systems. Based on Classless Inter-Domain Routing (CIDR), BGP has since evolved to support the aggregation and reduction of routing information.

In essence, CIDR is a strategy designed to address the following problems:

- Exhaustion of Class B address space
- Routing table growth

CIDR eliminates the concept of address classes and provides a method for summarizing *n* different routes into single routes. This significantly reduces the amount of routing information that BGP routers must store and exchange.

Note: IBM only supports the latest version of BGP, BGP4, which is defined in RFC 1654. All references to BGP in this chapter and on the interface of IBM's routers are to BGP4, and do not apply to previous versions of BGP.

How BGP4 Works

BGP is an inter-autonomous system routing protocol. In essence, BGP routers selectively collect and advertise reachability information to and from BGP neighbors in their own and other autonomous systems. Reachability information consists of the sequences of AS numbers that form the paths to particular BGP speakers, and the list of IP networks that can be reached via each advertised path. An AS is an administrative group of networks and routers that share reachability information using one or more Interior Gateway Protocols (IGPs), such as RIP or OSPF.

Routers that run BGP are called BGP speakers. These routers function as servers with respect to their BGP neighbors (clients). Each BGP router opens a passive TCP connection on port 179, and listens for incoming connections from neighbors at this well-known address. The router also opens active TCP connections to enabled BGP neighbors. This TCP connection enables BGP routers to share and

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update reachability information with neighbors in the same or other autonomous systems.

Connections between BGP speakers in the same AS are called internal BGP (IBGP) connections, while connections between BGP speakers in different autonomous systems are external BGP (EBGP) connections.

A single AS may have one or many BGP connections to outside autonomous systems. Figure 28-1 shows two autonomous systems. The BGP speaker in AS1 is attempting to establish a TCP connection with its neighbor in AS2. Once this connection is established, the routers will be able to share reachability information.

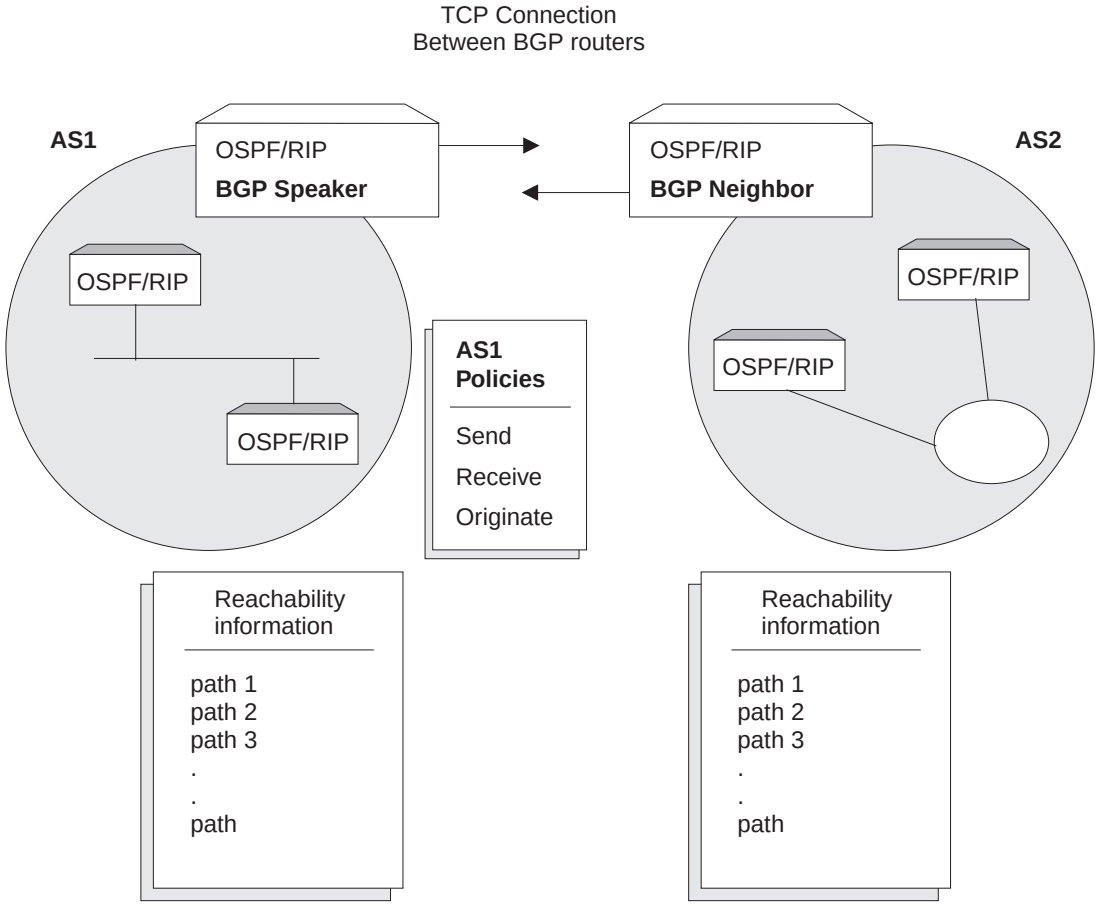

Figure 28-1. BGP Connections between Two Autonomous Systems. Once the BGP speaker in AS1 establishes a TCP connection with its BGP neighbor in AS2, the two routers can selectively exchange reachability information. The information each router sends or accepts is determined by policies defined for each router.

While the autonomous systems shown in Figure 28-1 have only one BGP router, each could have multiple connections to other autonomous systems. As an example of this, Figure 28-2 on page 28-3 shows three interconnected autonomous systems. AS1 has three BGP connections to outside autonomous systems: one to AS2, one to AS3 and one to ASx. Similarly, AS3 has connections to AS1, AS2 and to ASy.

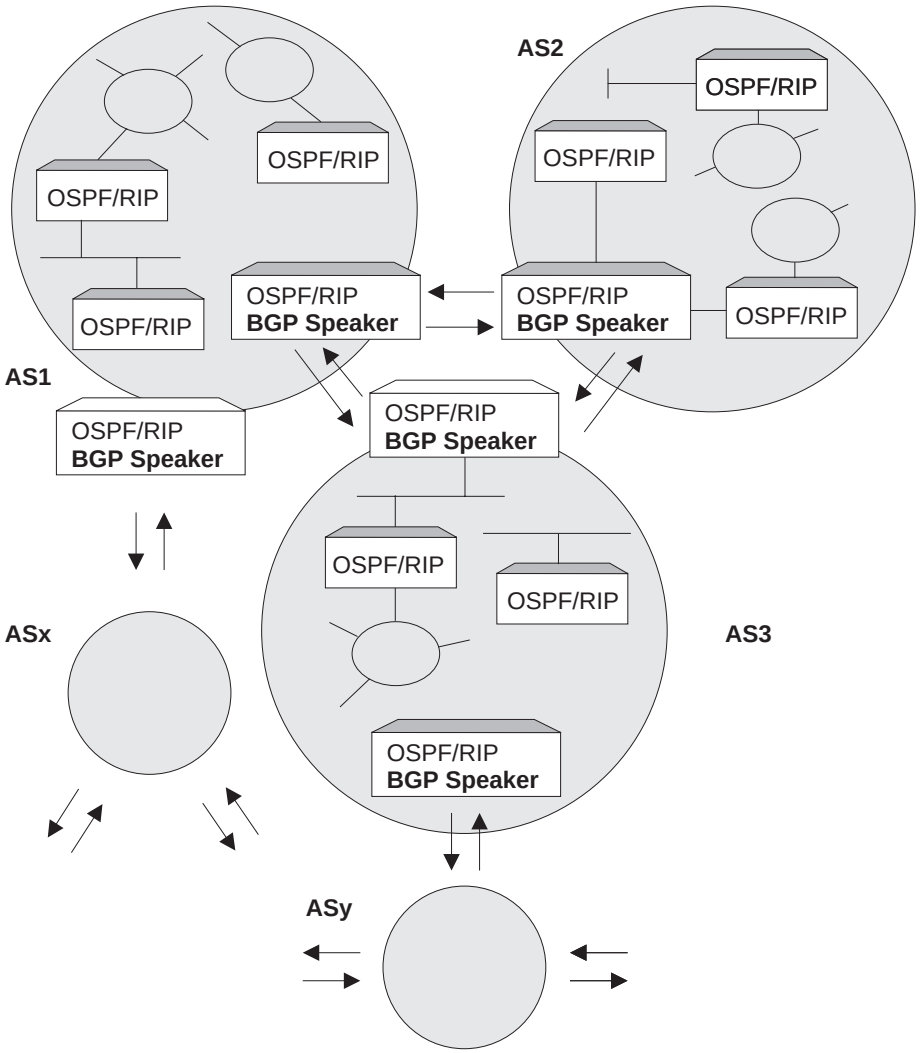

Figure 28-2. BGP Connections among Three Autonomous Systems. Note that AS1 and AS3 have two BGP speakers.

Originate, Send, and Receive Policies

Decisions on which reachability information to advertise (send), and which to accept (receive). are made on the basis of explicitly defined policy statements. IBM's BGP implementation supports three types of policy statements:

- Originate Policies
- Send Policies
- Receive Policies

Once a TCP connection is established, the BGP speaker shown in Figure 28-1 on page 28-2 can send its entire routing table to its BGP neighbor in AS2. However, for security or other reasons, it may not be desirable to send reachability information on each network to AS2. Similarly, it may not be desirable for AS2 to receive reachability information on each network in AS1.

BGP Messages

BGP routers use four kinds of messages to communicate with their neighbors: OPEN, KEEP ALIVE, UPDATE, and NOTIFICATION messages.

OPEN

Open messages are the first messages transmitted when a link to a BGP neighbor comes up and establishes a connection.

KEEP ALIVE

Keep alive messages are used by BGP routers to inform one another that a particular connection is alive and working.

UPDATE

Update messages contain the interior routing table information. BGP speakers send update messages only when there is a change in their routing tables.

NOTIFICATION

Notification messages are sent whenever a BGP speaker detects a condition that forces it to terminate an existing connection. These messages are advertised before the connection is transmitted.

Setting Up BGP4

Setting up BGP involves three basic steps:

1. "Enabling BGP."

   Enabling BGP requires you to specify the BGP router's unique AS Number. AS numbers are assigned by Stanford Research Institute Network Information Center.

2. "Defining BGP Neighbors" on page 28-5.

   BGP Neighbors are BGP routers with which a BGP speaker establishes a TCP connection. Once neighbors are defined, connections to them are established by default.

3. "Adding Policies" on page 28-5.

   The *policies* you establish determine which routes will be imported and exported by the BGP speaker. You can set up policies for different purposes. See "Sample Policy Definitions" on page 28-5 for more information.

Enabling BGP

You enable BGP using the **enable BGP speaker** command as shown.

```
BGP Config> enable BGP speaker
AS [0]? 167
TCP segment size [1024]?
```

The *AS number* must be in the range 0 to 65535. The *TCP segment* size must be in the range 1 to 65535. The default value for *TCP segment* is 1024. This number represents the maximum segment size BGP will use for passive TCP connections.

Defining BGP Neighbors

After enabling a BGP speaker, you must define its neighbors. BGP neighbors can be internal or external. Internal neighbors exist in the same AS and do not need to have a direct connection to one another. External neighbors exist in different autonomous systems. These must have a direct connection to one another.

To define internal or external BGP neighbors, use the **add neighbor** command. You must specify the IP address of the neighbor, and assign an AS number to the neighbor as shown below. Internal neighbors must have the same AS number as the BGP speaker.

```
BGP Config> add neighbor 192.0.190.178
AS [0]? 178
Init timer [12]? 30
Connect timer [120]?
Hold timer [90]? 30
TCP segment size [1024]? 512
```

Adding a BGP neighbor automatically enables it, causing the BGP speaker to send out a connection request to the neighbor.

Adding Policies

IBM's BGP implementation supports three policy commands:

- *Originate Policy*. This enables you to select the interior gateway protocol (IGP) networks to export.
- *Receive Policy*. This enables you to select the route information to import from BGP peers.
- *Send Policy*. This enables you to select the route information to export to peers. Note that exportable route information can include information collected from neighboring autonomous systems, as well as the routes that originate in the IGP.

Sample Policy Definitions

This section provides a set of examples of some specific policies you can set up for a BGP speaker. All policies are defined using the BGP **add** command. See "Add" on page 29-2 for the syntax of the **add** command.

Originate Policy Examples

Include All Routes for Advertisement

This example includes all routes in the BGP speaker's IGP routing table for advertisement. In this sense, you can view this command as the "default" originate policy statement for BGP.

Notice that the command specifies a range of addresses, rather than a single (exact) address.

```
BGP Config> add originate-policy inclusive
Network Prefix [0.0.0.0]?
Network Mask [0.0.0.0]?
Address Match (Exact/Range) [Exact]? range
Tag [0]?
```

Exclude a Range of Routes

This example also specifies a range, but in this case the goal is to prevent the BGP Speaker from advertising addresses in this range to its neighbors.

This example excludes all routes in the range 194.10.16.0 to 194.10.31.255 from the IGP routing table, which in turn prevents them from being advertised.

```
BGP Config> add originate-policy exclusive
Network Prefix [0.0.0.0]? 194.10.16.0
Network Mask [0.0.0.0]? 255.255.240.0
Address Match (Exact/Range) [Exact]? range
Tag [0]?
```

The tag is the received RIP information. You can select networks based on a particular tag value for advertisement. See the description of the **Set** command in "Using and Configuring IP" in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide* for information on setting the tag value.

By default, only classfull routes from the BGP speaker's IGP routing table will be selected for advertisement. To select a classless route for advertisement use the bgp-subnets **patch** command. For information about the **patch** see the chapter entitled The Configuration Process (Config) and Commands (Talk 6) in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

Receive Policy Examples

Import all Routes from All BGP Neighbors

This example ensures that the BGP speaker will import all routes from all of its neighbors into its IGP routing table.

```
BGP Config> add receive-policy inclusive
Network Prefix [0.0.0.0]?
Network Mask [0.0.0.0]?
Address Match (Exact/Range) [Exact]? range
Originating AS# [0]?
Adjacent AS# [0]?
IGP-metric [0]?
```

IGP-metric specifies the metric value with which the accepted routes are imported into the speaker's IGP routing table. You are only prompted to enter a value for IGP-metric only when setting up a policy for route inclusion.

If *IGP-metric* is -1, these routes will not be imported into IGP; thus, routes are not re-advertisable.

Block Specific Routes from a Transit AS

This example will prevent the BGP speaker from importing any routes originating at AS 168 from neighboring AS 165. You might use this command if you do not want the BGP speaker to receive any routes from AS 168 for security reasons.

```
BGP Config> add receive-policy exclusive
Network Prefix [0.0.0.0]?
Network Mask [0.0.0.0]?
Address Match (Exact/Range) [Exact]? range
Originating AS# [0]? 168
Adjacent AS# [0]? 165
```

Block Specific AS-path.

This example will prevent the BGP speaker from importing any route that has AS 175 in its AS-path list.

```
BGP Config> add no-receive
Enter AS: [0]? 175
```

Send Policy Examples

Restrict Route Advertisement to a Specific AS

This example restricts the BGP speaker. The speaker cannot advertise routes in the address range 143.116.0.0 to 143.116.255.255, that originate from AS 165, to autonomous system 168.

```
BGP Config> add send exclusive
Network Prefix [0.0.0.0]? 143.116.0.0
Network Mask [0.0.0.0]? 255.255.0.0
Address Match (Exact/Range) [Exact]? range
Tag [0]? 165
Adjacent AS# [0]? 168
```

Advertise All Known Routes

This example ensures that the BGP speaker will advertise all routes originated from its IGP, and all routes learned from its neighboring autonomous systems.

```
BGP Config> add send policy inclusive
Network Prefix [0.0.0.0]?
Network Mask [0.0.0.0]?
Address Match (Exact/Range) [Exact]? range
Tag [0]?
Adjacent AS# [0]?
```

Chapter 29. Configuring and Monitoring BGP4

This chapter describes the BGP configuring and monitoring commands and includes the following sections:

- "BGP4 Configuration Commands"
- "Accessing the BGP4 Configuration Environment"
- "Accessing the BGP Monitoring Environment" on page 29-12
- "BGP4 Monitoring Commands" on page 29-12

Accessing the BGP4 Configuration Environment

To access the BGP configuration environment, enter the following command at the `Config>` prompt:

```
Config> Protocol BGP
BGP Config>
```

BGP4 Configuration Commands

This section describes the BGP configuration commands. These commands allow you to modify the BGP protocol behavior to meet your specific requirements. Some amount of configuration is necessary to produce a fully functional BGP router. Enter BGP configuration commands at the `BGP config>` prompt.

Table 29-1. BGP Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Add	Add BGP neighbors.
Change	Modifies information that was originally entered with the **add** command.
Delete	Deletes BGP configuration information that had been entered with the **add** command.
Disable	Disables certain BGP features that have been turned on by the **enable** command.
Enable	Enables BGP speakers or BGP neighbors.
List	Displays BGP configuration items.
Move	Changes the order in which policies and aggregates are defined.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

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Add

Use the **add** command to add BGP information to your configuration.

Syntax:

add
- aggregate . . .
- neighbor . . .
- no-receive asnum . . .
- originate-policy . . .
- receive-policy . . .
- send-policy. . .

aggregate *network prefix network mask*

The **add aggregate** command causes the BGP speaker to aggregate a block of addresses, and advertise a single route to its BGP neighbors. You must specify the network prefix common to all the routes being aggregated and its mask. The following example illustrates how to aggregate a block of addresses from 194.10.16.0 through 194.10.31.255.

1. The *Network Prefix* is the addresses being affected. The prefix is the first address in a range of addresses specified in a BGP policy.

   Valid Values: Any valid IP address.
   Default Value: none

2. The *Network Mask* applies to the address specified in Network Prefix to generate an address used in a BGP policy.

   Valid Values: Any valid IP address.
   Default Value: none

Example: **`add aggregate`**

```
Network Prefix [0.0.0.0]? 194.10.16.0
Network Mask [0.0.0.0]? 255.255.240.0
```

When you add an aggregate definition, remember to define a policy to block the aggregated routes from being exported. If you do not, the router will advertise both the individual routes and the aggregate you have defined. This does not apply when you are aggregating the routes, which are originated from it's IGP routing table.

neighbor *neighbor IP address as# init timer connect timer hold timer keep alive timer tcp segment size*

Use the **add neighbor** command to define a BGP neighbor. The neighbor can be internal to the BGP speaker's AS, or external.

1. The IP address is the address of the neighbor you wish to peer with. It could be within your own autonomous system or in another autonomous system. If it is an external neighbor, both BGP speakers must share the same network. There is no such restriction for internal neighbors. The address has:

   Valid Values: Any valid IP address.
   Default Value: none

2. The AS number is your own autonomous system number for internal neighbor or neighbor's autonomous system number. The AS number of the neighbor has:

Valid Values: An integer in the range of 0 - 65535
Default Value: none

3. The *Init timer* to specifies the amount of time the BGP speaker waits to initialize resources and reinitiate transport connection with the neighbor in case the speaker has previously changed to IDLE state due to an error. If the error persists, this timer increases exponentially.

   Valid Values: 0 to 65535 seconds.
   Default Value: 12 seconds

4. The *Connect timer* specifies the amount of time the BGP speaker waits to reinitiate transport connection to its neighbor, if the TCP connection fails while in either CONNECT or ACTIVE state. In the mean time, the BGP speaker continues to listen for any connection that may be initiated by its neighbor.

   Valid Values: 0 to 65535 seconds.
   Default Value: 120 seconds

5. Enter the *Hold timer* to specify the length of time the BGP speaker waits before assuming that the neighbor is unreachable. Both neighbors exchange the configured information in OPEN message and choose the smaller of the two timers as their negotiated Hold Timer value.

   Once neighbors have established BGP connection, they exchange Keepalive messages at frequent intervals to ensure that the connection is still alive and the neighbors are reachable. The Keep-Alive timer interval is calculated to be one-third of the negotiated hold timer value. Hence the hold timer value must be either zero or at least three seconds.

   Note that on switched lines, you may wish to have the Hold Timer value of zero to save bandwidth by not sending Keepalives at frequent intervals.

   Valid Values: 0 to 65535 seconds.
   Default Value: 90 seconds

6. The *TCP segment size* specifies the maximum data size that may be exchanged on the TCP connection with a neighbor. This value is used for active TCP connection with the neighbor.

   Valid Values: 0 to 65535 bytes.
   Default Value: 1024 bytes

Example: **`add neighbor`**

```
Neighbor address [0.0.0.0]? 192.0.251.165
AS [0]? 165
Init timer [12]?
Connect timer [120]?
Hold timer [90]?
TCP segment size [1024]?
```

no-receive *asnum*

Use the **add no-receive asnum** to exclude AS-paths if the particular AS number appears anywhere inside the AS-path list.

The *AS number* has:

Valid Values: 0 to 65535
Default Value: none

Example: **add no-receive**

```
Enter AS: [0]? 178
```

originate-policy *(exclusive/ inclusive) network prefix network mask address match (Exact/Range) tag*

Use the **add originate-policy** command to create a policy that determines whether a specific address, or range of addresses, can be imported to the BGP speaker's routing table from the IGP routing table.

Exclusive	Exclusive policies prevent route information from being included in the BGP speaker's routing table.
Inclusive	Inclusive policies ensure that specific routes will be included in the BGP speaker's routing table.
Network prefix	The network prefix for the addresses being affected.
Address match	The address, or range of addresses, that will be affected by the policy statement.
Tag	The value that has been set for a particular AS. All tag values match that of the AS from which they were learned.

Exclusive policies prevent route information from being included in the BGP speaker's routing table.

1. The *Network Prefix* is the addresses being affected.

   Valid Values: Any valid IP address.
   Default Value: none

2. Enter the *Network Mask* to be applied to the address specified in Network Prefix to generate an address used in a BGP policy.

   Valid Values: Any valid IP address.
   Default Value: none

3. Select whether the *Address match* is to be a range of addresses or an exact address.

4. A *TAG* is the value that has been set for a particular AS. Tag values match that of the AS from which they were learned.

   Valid Values: 0 to 65535
   Default Value: none

The following example includes all routes in the BGP speaker's IGP routing table to be advertised.

Example: **add originate-policy exclusive**

```
Network Prefix [0.0.0.0]?
Network Mask [0.0.0.0]?
Address Match (Exact/Range) [Exact]? range
Tag [0]?
```

See "Originate Policy Examples" on page 28-5 for detailed examples of this policy command.

receive-policy *(exclusive/ inclusive) network prefix network mask address match originating as# adjacent as# igpmetric (inclusive only)*

Use the **add receive-policy** command to determine what routes will be imported to the BGP speaker's routing table.

Exclusive policies prevent route information from being included in the BGP speaker's routing table.

1. The *Network Prefix* is the addresses being affected.

   Valid Values: Any valid IP address.
   Default Value: none

2. The *Network Mask* applies to the address specified in Network Prefix to generate an address used in a BGP policy.

   Valid Values: Any valid IP mask.
   Default Value: none

3. The *Address match* is a range of addresses or an exact address.

4. An *Originating AS#* has:

   Valid Values: 0 to 65535
   Default Value: none

5. The *Adjacent AS#* to specifies the neighboring AS number.

   Valid Values: 0 to 65535
   Default Value: none

Example: **`add receive-policy exclusive`**

```
Network Prefix [0.0.0.0]? 10.0.0.0
Network Mask [0.0.0.0]?  255.0.0.0
Address Match (Exact/Range) [Exact]? range
Originating AS# [0]? 168
Adjacent AS# [0]? 165
```

See “Receive Policy Examples” on page 28-6 for detailed examples of this policy command.

send-policy *(exclusive/ inclusive) network prefix network mask address match tag adjacent as#*

Use the **add send-policy** command to create policies that determine which of the BGP speaker's learned routes will be readvertised. These routes could be internal or external to the BGP speaker's AS.

Exclusive policies prevent route information from being included in the BGP speaker's routing table.

1. The *Network Prefix* is for the addresses being affected.

   Valid Values: Any valid IP address.
   Default Value: none

2. The *Network Mask* applies to the address specified in Network Prefix to generate an address used in a BGP policy.

   Valid Values: Any valid IP address.
   Default Value: none

3. The *Address match* is a range of addresses or an exact address.

4. A *TAG*. is the value that has been set for a particular AS. Tag values match that of the AS from which they were learned.

   Valid Values: 0 to 65535
   Default Value: none

5. The *Adjacent AS#* specifies the neighboring AS number.

   Valid Values: 0 to 65535
   Default Value: none

Example: **`add send exclusive`**

```
Network Prefix [0.0.0.0]? 180.220.0.0
Network Mask [0.0.0.0]? 255.255.0.0
Address Match (Exact/Range) [Exact]? range
Tag [0]?
Adjacent AS# [0]? 25
```

See “Send Policy Examples” on page 28-7 for detailed examples of this policy command.

Change

Use the **change** command to change a BGP configuration item previously installed by the add command.

Syntax:

change aggregate . . .

neighbor . . .

originate-policy . . .

receive-policy . . .

send-policy. . .

aggregate *index# network prefix network mask*

This example changes the current aggregate (aggregate 1). The change causes aggregate 1 to use a different network prefix and mask to aggregate all routes in the address range from 128.185.0.0 to 128.185.255.255.

Example: **`change aggregate 1`**

```
Network Prefix [128.185.0.0]? 128.128.0.0
Network Mask [255.255.0.0]? 255.192.0.0
```

neighbor *neighbor IP address as# init timer connect timer hold timer keep alive timer tcp segment size*

The following example changes the value of the hold timer to zero for neighbor 192.0.251.165.

The *neighbor address* to be modified has:

Valid Values: Any valid IP address.
Default Value: none

Example: **`change neighbor 192.0.251.165`**

```
AS [165]?
Init timer [12]?
Connect timer [60]?
Hold timer [12]? 0
TCP segment size [1024]?
```

originate-policy *index# (exclusive/ inclusive) network prefix network mask address match tag*

Use the **change originate-policy** command to alter an existing originate policy definition.

This example alters the BGP speaker's originate policy. Rather than excluding networks with prefix 194.10.16.0 from the IGP routing table, the policy will now include all routes.

Example: **change originate-policy**

```
Enter index of originate-policy to be modified [1]?
Policy Type (Inclusive/Exclusive) [Exclusive]? inclusive
Network Prefix [194.10.16.0]? 0.0.0.0
Network Mask [255.255.240.0]? 0.0.0.0
Address Match (Exact/Range) [Range]?
Tag [0]?
```

receive-policy *index# (exclusive/inclusive) network prefix network mask address match originating as# adjacent as# igpmetric (inclusive only)*

Use the **change receive-policy** command to alter an existing receive policy definition.

This example adds a restriction to the BGP speaker's receive-policy. Rather than import route information from every BGP peer into its IGP routing table, it will now prevent routes from AS 165 from being imported.

Example: **change receive-policy**

```
Enter index of receive-policy to be modified [1]?
Policy Type (Inclusive/Exclusive) [Inclusive]? exclusive
Network Prefix [0.0.0.0]?
Network Mask [0.0.0.0]?
Address Match (Exact/Range) [Range]?
Originating AS# [0]?
Adjacent AS# [0]? 165
```

send-policy *index# (exclusive/ inclusive) network prefix network mask address match tag adjacent as#*

Use the **change send-policy** command to alter an existing send policy to one that is more inclusive, or more exclusive.

This example adds a restriction to the BGP speaker's send policy. The restriction ensures that all routes in the address range 194.10.16.0 to 194.10.31.255 will be excluded when advertising to autonomous system 165.

Example: **change send-policy**

```
Enter index of send-policy to be modified [1]?
Policy Type (Inclusive/Exclusive) [Inclusive]? exclusive
Network Prefix [0.0.0.0]? 194.10.16.0
Network Mask [0.0.0.0]? 255.255.240.0
Address Match (Exact/Range) [Range]?
Tag [0]?
Adjacent AS# [0]? 165
```

Delete

Use the **delete** command to delete a BGP configuration item previously installed by the **add** command.

Syntax:

delete aggregate . . .

neighbor . . .

no-receive . . .

originate-policy . . .

receive-policy . . .

send-policy. . .

aggregate *index#*

You must specify the index number of the aggregate you want to delete. The index number is equivalent to the AS number.

Example: `delete aggregate 1`

neighbor *neighbor IP address*

Use this command to delete a BGP neighbor. You must specify the neighbor's network address.

The *neighbor's network address to be deleted* has:

Valid Values: Any valid IP address.
Default Value: none

Example: `delete neighbor 192.0.251.165`

no-receive *as*

Use this command to delete the no-receive policy set up for a particular AS. You must specify the AS number.

The *AS number* has:

Valid Values: 0 to 65535
Default Value: none

Example: `delete no-receive 168`

originate-policy *index#*

Use this command to delete a specific originate policy. You must specify the index number associated with the policy.

Example: `delete originate-policy 2`

receive-policy *index#*

Use this command to delete a specific receive policy. You must specify the index number associated with the policy.

Example: `delete receive-policy`

```
Enter index of receive-policy to be deleted [1]?
```

send-policy *index#*

Use this command to delete a specific send policy. You must specify the index number associated with the policy.

Example: `delete send-policy 4`

Disable

Use the **disable** command to disable a previously enabled BGP neighbor or speaker. Note that neighbors are implicitly enabled whenever added with the **add** command.

Syntax:

disable BGP speaker

neighbor . . .

disable bgp speaker

Example: `disable bgp speaker`

disable neighbor *neighbor IP address*

The *neighbor address* has:

Valid Values: Any valid IP address.
Default Value: none

Example: `disable neighbor 192.0.190.178`

Enable

Use the **enable** command to activate the BGP features, capabilities, and information added to your BGP configuration.

Syntax:

enable BGP speaker

neighbor . . .

bgp speaker *as#* *tcp segment size*

Use the enable bgp speaker command to enable the BGP protocol.

Note: IBM only supports the latest version of BGP - BGP4, which is defined in RFC 1654.

1. The *AS number* is associated with this collection of routers and nodes.

   Valid Values: 0 to 65535
   Default Value: none

2. Enter the *TCP segment size* to specify the maximum segment size that BGP should use for passive TCP connections.

   Valid Values: 0 to 65535 bytes.
   Default Value: 1024 bytes

Example: **`enable bgp speaker`**

```
AS [0]? 165
TCP segment size [1024]?
```

neighbor *neighbor IP address*

Use this command to enable a BGP neighbor.

The *neighbor address* has:

Valid Values: Any valid IP address.
Default Value: none

Example: `enable neighbor 192.0.190.178`

List

Use the **list** command to display various pieces of the BGP configuration data, depending on the particular subcommand invoked.

Syntax:

list aggregate
all
BGP speaker
neighbor
no-receive
originate-policy
receive-policy
send-policy

aggregate

Use the **list aggregate** command to all aggregated routes defined with the **add aggregate** command.

Example: `list aggregate`

```
Aggregation:
Index    Prefix              Mask
1         194.10.16.0       255.255.240.0
```

all Use the **list all** command to list the BGP neighbors, policies, aggregated routes, and no-receive-as records in the current BGP configuration.

Example: `list all`

```
                BGP Protocol:          Enabled
                AS:                    167
                TCP-Segment Size:      1024
                Neighbors and their AS:

                                       Init    Conn    Hold    TCPSEG
Address           State     AS         Timer   Timer   Timer   Size
128.185.250.168   ENABLD    168    12      60      12      1024
192.0.251.165     ENABLD    165    12      60      12      1024

Receive-Policies:
Index  Type  Prefix       Mask      Match  OrgAS  AdjAS IGPmetric
1      INCL  0.0.0.0      0.0.0.0   Range  0      0      0

Send-Policies:
Index  Type  Prefix       Mask      Match  Tag    AdjAS
1      INCL  0.0.0.0      0.0.0.0   Range  0      0

Originate-Policies:
Index  Type  Prefix       Mask             Match  Tag
1      EXCL  194.10.16.0  255.255.240.0    Range  0

Aggregation:

Index  Prefix             Mask
1      194.10.16.0        255.255.240.0
No no-receive-AS records in configuration.
```

bgp speaker

Use the **list bgp speaker** command to derive information on the BGP speaker. The information provided is as follows:

Example: `list BGP speaker`

```
BGP Protocol:          Enabled
AS:                    165
TCP-Segment Size:      1024
```

neighbor Use the **list neighbor** command to derive information on BGP neighbors.

Example: `list neighbor`

```
Neighbors and their AS:

                                    Init    Conn    Hold    TCPSEG
Address            State     AS     Timer   Timer   Timer   Size

128.185.252.168    ENABLD    168    12      60      12      1024
192.0.190.178      DISBLD    178    12      60      12      1024
192.0.251.167      ENABLD    167    12      60      12      1024
```

no-receive

Use the **list no-receive** command to derive information on no-receive-AS definitions that have been added to the BGP configuration.

Example: `list no-receive`

```
AS-PATH with following autonomous systems will be discarded:
AS  178
AS  165
```

originate-policy *all index prefix*

Use the **list originate-policy** command to derive information on the originate policies that have been added to the BGP configuration.

Example: `list originate-policy`

```
Originate-Policies:
Index  Type  Prefix           Mask             Match  Tag
1      EXCL  194.10.16.0      255.255.240.0    Range  0
2      INCL  0.0.0.0          0.0.0.0          Range  0
```

receive-policy adj-as-number *all* **or** *index* **or** *prefix*

Use the **list receive-policy** command to derive information on the receive policies that have been added to the BGP configuration. You can display all receive policies defined for an AS, or display policies by index or prefix number.

Example: `list receive-policy`

```
Receive-Policies:
Index  Type  Prefix      Mask        Match  OrgAS  AdjAS  IGPmetric
1      EXCL  0.0.0.0     0.0.0.0     Range  178    165
2      INCL  0.0.0.0     0.0.0.0     Range  0      0      0
```

send-policy adj-as-number *all* **or** *index* **or** *prefix*

Use the **list send-policy** command to display information on send policies defined for specified autonomous systems. You can display all send policies defined for an AS, or display policies by index or prefix number.

Example: `list send-policy`

```
Send-Policies:
Index  Type  Prefix      Mask           Match Tag    AdjAS
1      EXCL  194.10.16.0 255.255.240.0  Range   0    165
2      INCL   0.0.0.0          0.0.0.0  Range   0    0
```

Move

Use the **move** command to change the order in which policies and aggregates have been defined. This changes the order in which the router applies existing policies to route information. Before using this command, it is advisable to use the **list** command to see what policies have been defined.

Syntax:

move *aggregate* or *originate-policy* or *receive-policy* or *send-policy*

Example: **move originate-policy**

```
Enter index of originate-policy to move [1]? 3
Move record AFTER record number [0]?
```

Accessing the BGP Monitoring Environment

To access the BGP configuration environment, enter the following command at the Config> prompt:

```
Config> Protocol BGP
BGP>
```

BGP4 Monitoring Commands

This section describes the BGP monitoring commands. These commands allow you to modify the BGP protocol behavior to meet your specific requirements. Some amount of configuration is necessary to produce a fully functional BGP router. Enter BGP monitoring commands at the BGP> monitoring prompt.

Table 29-2. BGP Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Destinations	Displays all entries in the BGP routing table.
Dump routing tables	Lists the contents of the IP routing table.
Neighbors	Displays currently active neighbors.
Paths	Displays all available paths in the database.
Ping	Sends ICMP Echo Requests to another host once a second and watch for a response. This command can be used to isolate trouble in an internetwork environment.
Traceroute	Displays the complete path (hop-by-hop) to a particular destination.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Destinations

Use the **destinations** command to dump all BGP routing table entries, or to display information on routes advertised to, or received from, specified BGP neighbor addresses (destinations).

Syntax:

destinations	*net address/net address net mask* advertised-to *network address* received-from *network address*

Example: `destinations`

```
Network         Mask       NextHop          MED AAG AGRAS ORG ASPath
128.185.0.0     FFFF0000   192.0.251.165    0   No  0     IGP
142.4.0.0       FFFF0000   192.0.190.178    0   No  0     IGP seq[178]
143.116.0.0     FFFF0000   128.185.252.168  0   No  0     IGP seq[168]
192.0.190.0     FFFFFF00   192.0.251.165    0   No  0     IGP
192.0.251.0     FFFFFF00   192.0.251.165    0   No  0     IGP
194.10.16.0     FFFFF000   192.0.251.167    0   No  167   IGP seq[167]
```

destinations *net address*

Displays detailed information on the specified route or destination network. The command shows how a specific route was learned, the best path to a specific destination, the metric associated with the route, and other information.

Example: `destinations 142.4.0.0`

```
Network         Mask     NextHop         MED AAG AGRAS ORG ASPath
142.4.0.0       FFFF0000 192.0.251.165   0   No  0     IGP
seq[165-178]Dest:142.4.0.0, Mask:FFFF0000, Age:180, Upd#:13,
LastSent:0001:53:32 Eligible paths: 2

PathID: 8  (Best Path)
        ASpath: seq[165-178]
        Origin: IGP, Pref: 507, LocalPref: 0
        Metric: 0, Weight: 0, MED: 0
        NextHop: 192.0.251.165, Neighbor: 192.0.251.165
        AtomicAggr: No

PathID: 21
        ASpath: seq[168-165-178]
        Origin: IGP, Pref: 505, LocalPref: 0
        Metric: 0, Weight: 0, MED: 0
        NextHop: 128.185.250.168, Neighbor: 128.185.250.168
        AtomicAggr: No
```

ASpath Enumeration of autonomous systems along the path.

- -seq: Sequence of autonomous systems in order in the path
- -set: Set of autonomous systems in the path.

Origin The originator of the destination. This is EGP, IGP, or Incomplete (originated by some other means not known).

LocalPref The originating router's degree of preference for the destination.

Metric The path metric with which the route is imported.

Weight The path weight.

MED A multi-exit discriminator value, used to discriminate among multiple entry/exit points to the same AS.

NextHop The address of the router to use as the forwarding address for destinations reachable via the given path.

AtomicAggr Indicates whether the router advertising the path has included the path in an atomic-aggregate.

destinations *net address net mask*

Displays detailed information on the specified route or destination network. The command shows how a specific route was learned, the best path to a specific destination, the metric associated with the route, and other information.

This command is useful in cases where multiple network addresses have the same prefix and different masks. In such cases, specifying the network mask narrows the scope of the information presented.

Example: destinations 194.10.16.0 255.255.240.0

```
Dest:194.10.16.0, Mask:FFFFF000, Age:0, Upd#:3, LastSent:0002:00:00

Eligible paths: 1
PathID: 0 - (Best Path)
        ASpath:
        Origin: IGP, Pref: 0, LocalPref: 0
        Metric: 0, Weight: 0, MED: 0
        NextHop: 194.10.16.167, Neighbor: 194.10.16.167
        AtomicAggr: No, Aggregator AS167/194.10.16.167
```

destinations advertised-to *net address*

Lists all routes advertised to the specified BGP neighbor.

Example: destinations advertised-to

```
BGP neighbor address [0.0.0.0]? 192.0.251.165

        Destinations advertised to BGP neighbor 192.0.251.165

Network       Mask     NextHop         MED AAG AGRAS ORG ASPath
194.10.16.0   FFFFF000 194.10.16.167   0   No  167   IGP
192.0.190.0   FFFFFF00 192.0.251.165   0   No  0     IGP seq [165]
142.4.0.0     FFFF0000 192.0.251.165   0   No  0     IGP seq [165-178]
143.116.0.0   FFFF0000 128.185.250.168 0   No  0     IGP seq [168]
```

destinations received-from *net address*

Lists all routes received from the specified BGP neighbor.

Example: destinations received-from

```
BGP neighbor address [0.0.0.0]? 128.185.250.167

        Destinations obtained from BGP neighbor 128.185.250.167

Network     Mask     NextHop         MED AAG AGRAS ORG ASPath
194.10.16.0 FFFFF000 128.185.250.167 0   No  167   IGP seq[167]
192.0.190.0 FFFFFF00 128.185.250.167 0   No  0     IGP seq[167-165]
142.4.0.0   FFFF0000 128.185.250.167 0   No  0     IGP seq[167-165-178]
```

Dump Routing Tables

For a complete explanation of the **dump routing tables** command, refer to “Dump Routing Table” in the “Monitoring IP” chapter of *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide*

Neighbors

Use the **neighbors** command to display information on all active BGP neighbors.

Syntax:

neighbors *internet address*

Example: **neighbors**

```
IP-Address       State        DAY-HH:MM:SS  BGPID           AS     Upd#

128.185.252.168  Established  00000:48:52  128.185.142.168  168     16
192.0.190.178    Established  00002:01:49  142.4.140.178    178     16
192.0.251.167    Established  00002:01:45  194.10.16.167    167     16
```

IP-Address
Specifies the IP address of the BGP neighbor.

State Specifies the state of the connection. Possible states are:

- **Connect** Waiting for the TCP connection to the neighbor to be completed.
- **Active** In the event of TCP connection failure, the state is changed to Active, and the attempt to acquire the neighbor continues.
- **OpenSent** In this state OPEN has been sent, and BGP waits for an OPEN message from the neighbor.
- **OpenConfirm** In this state a KEEPALIVE has been sent in response to neighbor's OPEN, and waits for a KEEPALIVE/NOTIFICATION from the neighbor.
- **Established** A BGP connection has been successfully established, and can now start to exchange UPDATE messages.

BGP-ID Specifies the neighbor's BGP Identification number.

AS Specifies the neighbor's AS number.

Upd# Specifies the sequence number of the last UPDATE message sent to the neighbor.

internet-address
Use the **neighbor** command to display detailed data on a particular BGP neighbor.

Example: **neighbor 192.0.251.167**

```
Active Conn: Sprt:1026  Dprt:179    State: Established KeepAlive/Hold
Time: 4/12
Passve Conn: None
TCP connection errors: 0          TCP state transitions: 0

BGP Messages:     Sent       Received                    Sent
Received
Open:             1          1          Update:          11         11
Notification:     0          0          KeepAlive:       1828       1830
Total Messages:   1840       1842

Msg Header Errs:  Sent       Received                    Sent
Received
Conn sync err:    0          0          Bad msg length:  0          0
Bad msg type:     0          0

Open Msg Errs:    Sent       Received                    Sent
Received
Unsupp versions:  0          0          Unsupp auth code: 0         0
Bad peer AS ident:0          0          Auth failure:    0          0
Bad BGP ident:    0          0          Bad hold time:   0          0

Update Msg Errs:  Sent       Received                    Sent
Received
Bad attr list:    0          0          AS routing loop:  0         0
Bad wlkn attr:    0          0          Bad NEXT_HOP atr: 0         0
Mssng wlkn attr:  0          0          Optional atr err: 0         0
Attr flags err:   0          0          Bad netwrk field: 0         0
Attr length err:  0          0          Bad AS_PATH attr: 0         0
Bad ORIGIN attr:  0          0

Total Errors:     Sent       Received                    Sent
Received
Msg Header Errs:  0          0          Hold Timer Exprd: 0         0
Open Msg Errs:    0          0          FSM Errs:        0          0
Update Msg Errs:  0          0          Cease:           0          0
```

Paths

Use the BGP **paths** command to display the paths stored in the path description data base.

Syntax:

paths

Example: **paths**

```
PathId   NextHop    MED  AAG   AGRAS  RefCnt   ORG   ASPath
0        10.2.0.3    0   No     0      2       IGP
4        192.2.0.2   0   No     0      2       IGP   seq[2]
5        192.2.0.2   0   No     2      1       IGP   seq[2]
6        192.2.0.2   0   No     0      1       IGP   seq[2-1]
7        10.2.0.168  0   No     0      4       IGP
8        192.3.0.1   0   No     0      2       IGP   seq[1]
9        192.2.0.2   0   No     2      1       IGP   seq[2]
10       10.2.0.3    0   No     0      1       IGP
```

PathId Path identifier

NextHop The address of the router to use as the forwarding address for the destinations that can be reached via the given path.

MED The multi-exit discriminator used to discriminate among multiple entry/exit points to the same AS.

AAG Indicates if the path has been atomic-aggregated that is the router that is advertising the given path has selected less specific route over the more specific one when presented with overlapping routes.

AGRAS Indicates the AS number of the BGP speaker that aggregated the routes.

RefCnt Indicates the number of path entities referring to the descriptor.

ORG Specifies the originator of the advertised destinations in the given path: either EGP, IGP, or Incomplete (originated by some other means not known).

AS Path Enumeration of autonomous systems along the path.

seq: Sequence of autonomous systems in order in the path.

set: Set of autonomous systems in the path.

Ping

For a complete explanation of the **ping** command, see "Ping" on page 16-44 .

Sizes

Use the BGP **sizes** command to display the number of entries stored in the various data bases.

Syntax:

sizes

Example: `sizes`

```
# Paths:                                11
# Path descriptors:                      7
Update sequence#:                       22
# Routing tbl entries (allocated):       6
# Current tbl entries (not imported):    0
# Current tbl entries (imported to IGP): 3
```

Paths Total number of eligible paths for all the routes in the BGP routing table.

Path descriptors
Total number of path descriptors in the database used to hold common path information.

Update sequence#
Indicates the current update sequence number.

Routing tbl entries (allocated)
Indicates the number of entries in BGP routing table.

Current tbl entries (not imported)
Indicates the number of BGP routes not imported into IGP.

Current tbl entries(imported to IGP)
Indicates the number of BGP routes imported into IGP.

Traceroute

For a complete explanation of the **traceroute** command, see its description in the "Monitoring IP" chapter of *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*.

Chapter 30. Using MultiProtocol Over ATM (MPOA)

This chapter describes how to use Multiprotocol over ATM (MPOA) and includes the following sections:

- "MPOA Overview"

MPOA Overview

The concept of virtual router, as shown in Figure 30-1, allows you to implement a conventional edge router function using MPOA servers, MPOA clients, and an ATM backbone network.

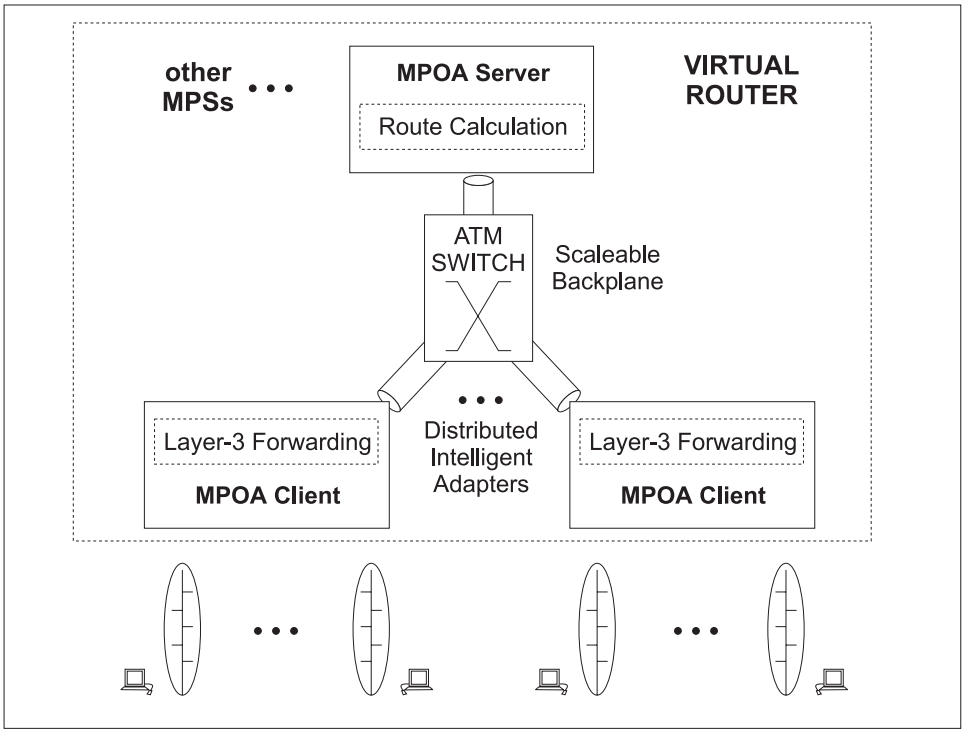

Figure 30-1. MPOA Virtual Router

MPOA uses networking technologies, such as bridging, LAN Emulation, and Next Hop Resolution Protocol, to implement the virtual router concept. As shown in Figure 30-2 on page 30-2, the virtual router model has:

- One router to manage
- One device participating in routing topology protocols, leading to simple edge devices
- Forwarding capacity of multiple devices

while a conventional edge router model has:

- Multiple routers to manage
- Multiple devices participating in routing topology protocols, leading to complex edge devices
- Forwarding capacity of multiple devices

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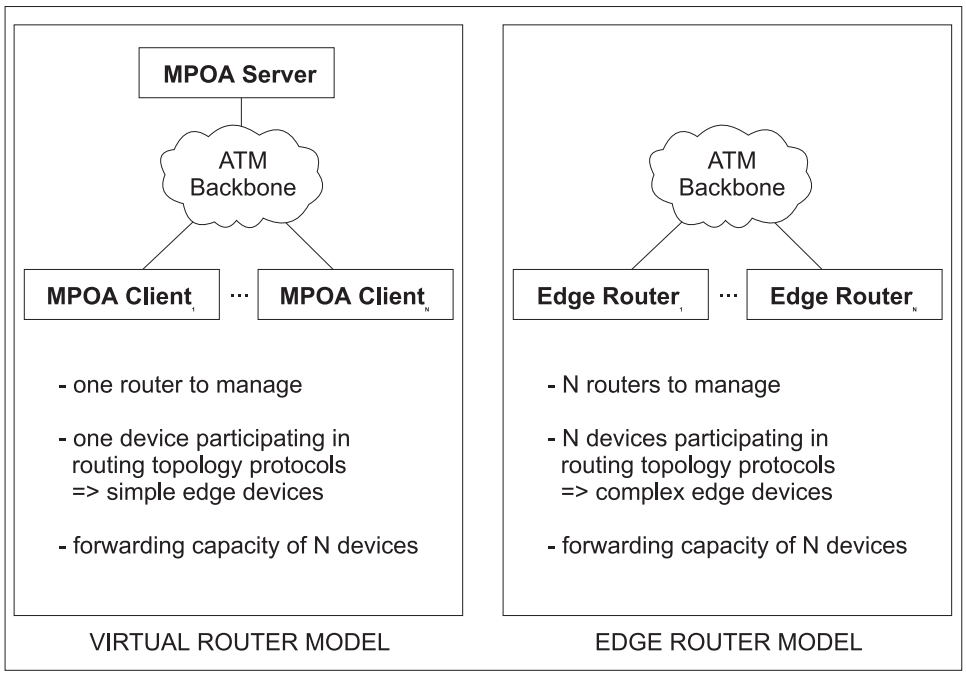

Figure 30-2. Comparison of Virtual Router and Edge Router Models

MPOA implements a virtual router with client/server protocols. MPOA clients (MPCs) issue requests to MPOA servers (MPSs). MPSs perform route calculations, while MPCs act as distributed intelligent adapters performing high-speed forwarding and the ATM network provides backplane throughput. MPSs are located with router functions and a NHRP server, while MPCs reside in MPOA hosts or MPOA edge devices, as shown in Figure 30-3 on page 30-3. The functions performed by a MPC in a MPOA host are very similar to those performed by a MPC in a MPOA edge device: establishing shortcut VCCs and forwarding intersubnet traffic over these VCCs to improve system performance. All MPOA devices include a LAN Emulation Client (LEC) that provides default path interconnection.

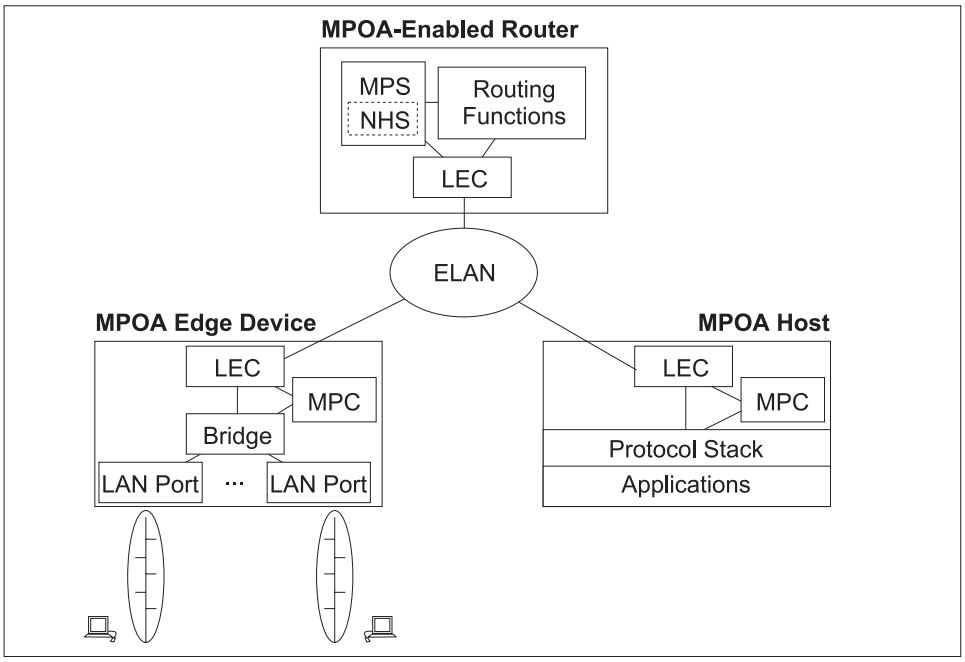

Figure 30-3. MPOA Components

MPOA and LAN Emulation

MPOA relies on LAN Emulation for three important functions:

- Auto-configuration
- Dynamic Device Discovery
- Intersubnet/default path connectivity

Auto-configuration allows MPOA configuration parameters to be stored and distributed from the LAN Emulation Configuration Server, or LECS. MPOA devices can obtain their configuration information from the LECS while they are being initialized, so that individual device configuration is reduced. See the chapter entitled “Configuring and Monitoring LAN Emulation Services” in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide* for additional information about configuring LECS.

MPOA devices dynamically learn about neighbor components through the discovery protocol. MPOA devices attach special TLVs to LAN Emulation control messages and then inspect received TLVs to identify MAC addresses associated with other MPOA devices. Refer to the chapter entitled “Overview of LAN Emulation” in the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide* for additional information about LAN Emulation TLVs.

MPOA clients bridge intrasubnet traffic over ELANs. Since most MPOA edge devices include LAN switching hardware capabilities, intrasubnet traffic is handled with end-to-end switching. This use of bridging, coupled with dynamic device discovery, enables the MPC to be independent of router topology while maintaining the change management benefits provided by VLANs. For example, a station can be moved from a segment behind one MPC to a segment behind another MPC without any reconfiguration.

MPOA and Shortcut Establishment

MPOA clients are responsible for initiating shortcut establishment. The MPC discovers the MAC addresses of the MPS routers and the corresponding ATM addresses. MPC then monitors traffic flow to these MAC addresses, and when the flow exceeds a configured threshold, MPC initiates shortcut establishment by sending a MPOA resolution request to the associated MPS.

MPOA Interoperability with NHRP

MPOA interoperates with NHRP by converting MPOA resolution requests to NHRP resolution requests. This conversion allows resolution requests and replies to be forwarded by intermediate non-MPOA NHRP servers that are on the routed path. This conversion also enables shortcuts between NHRP clients and MPCs.

IBM's MPOA implementation also supports LAN Emulation shortcut extensions. See “Next Hop Resolution Protocol (NHRP) Overview” on page 32-1 for additional information on LAN Emulation shortcut extensions.

The use of LAN Emulation shortcut extensions as well as other MSS enhancements allows the MPOA client to setup and use some additional types of shortcuts. The following is the list of the different types of shortcuts which can be used with the MPOA client on the MSS client.

- Bidirectional MPOA standard 1483 shortcuts with other MPOA standard MPCs (tagged format as well as native 1483 format data is supported).
- Bidirectional MPOA standard 1483 shortcuts with other standard NHCs.
- Enhanced bidirectional LANE shortcuts between two MSS client MPCs.
- Enhanced unidirectional LANE shortcuts can be received from NHCs supporting LANE extensions.
- Enhanced unidirectional LANE shortcuts can be setup to remote LAN emulation clients (requires an MSS to be the MPOA/NHRP server).
- Enhanced unidirectional 1483 shortcuts can be setup to remote Classical IP (RFC 1577) clients (requires an MSS to be the MPOA/NHRP server).

The use of these enhanced shortcut types can result in significantly increased packet throughput performance.

Chapter 31. Configuring and Monitoring MPOA

This chapter describes how to use the MPOA configuration and operating commands and includes the following sections:

- "Accessing the MPOA Configuration Environment"
- "MPS Configuration Commands" on page 31-2
- "MPC Configuration Commands" on page 31-6
- "Accessing the MPOA Monitoring Environment" on page 31-12
- "MPS Monitoring Commands" on page 31-13
- "MPC Monitoring Commands" on page 31-17

Accessing the MPOA Configuration Environment

Use the following procedure to access the MPOA configuration process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.)

   After you enter the **talk 6** command, the CONFIG prompt (`Config>`) displays on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the CONFIG prompt, enter the **prot mpoa** command to get to the `MPOA Config>` prompt.

MPOA Configuration Commands

The MPOA main menu includes the following commands.

Table 31-1. MPOA Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
NHRP	Enters the NHRP configuration environment. See Chapter 32, "Using NHRP" on page 32-1 for information about using NHRP and Chapter 33, "Configuring and Monitoring NHRP" on page 33-1 for NHRP configuration commands.
MPS	Enters the MPS configuration environment. See "MPS Configuration Commands" on page 31-2 for additional information.
MPC	Enters the MPC configuration environment. See "MPC Configuration Commands" on page 31-6 for additional information.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

Note: All three options may not be available on all platforms. For instance, on a route server platform such as the MSS server, the MPOA client function is

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not available, so only the **NHRP** and **MPS** commands will be available. Similarly on a platform which primarily serves as an MPOA edge device, only the **MPC** command will be available.

MPS Configuration Commands

At the `MPOA Config>` prompt, enter **mps** to get to the `MPS Configuration>` prompt. Enter the following commands at the `MPS Config>` prompt.

Table 31-2. MPS Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Enable	Enables an MPS.
Disable	Disables an MPS.
List	Lists the status of the MPS.
Set	Allows configuration of MPS parameters.
Advanced-Config	Allows configuration of advanced MPS physical interface parameters.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

Note: The MPS function is automatically enabled on the server if NHRP in enabled. See "NHRP Auto-Configuration" on page 32-10 for details. The MPS comes up with a set of default configuration parameters. If you do not want MPS to be enabled, use the **disable** command to disable it.

Enable

Use the **enable** command to enable the MPS.

Note: NHRP must be enabled. See "NHRP Configuration Commands" on page 33-1 for details.

Syntax:

en**able**

Disable

Use the **disable** command to disable an MPS.

Syntax:

d**isable**

Set

Use the **set** command to explicitly configure MPS parameters.

Syntax:

set	interval (for keep-alive messages) lifetime (of keep-alive messages) initial-retry-time maximum-retry-time giveup-time holding-time (NHS/MPS) accept-config-from-lecs

interval Sets the time between MPS keep-alive messages that are sent to MPCs.

Valid Values: 1 to 300 seconds

Default Value: 10

lifetime Sets the maximum time between MPS keep-alive messages. MPCs consider the MPS to have failed if they do not receive a keep-alive message within this time. This value must be at least three times the value of **interval**.

Valid Values: 3 - 1000 seconds

Default Value: 35

initial-retry-time
Specifies the initial value of the retry timer when the MPS sends a request. If a corresponding reply is not received before the expiration of the retry timer, the request is retried if the retry timer is less than ***maximum-retry-time*** and the retry timer is then doubled. This process will repeat until a reply is received or until the retry timer ≥ ***maximum-retry-time***.

Valid Values: 1 to 300 seconds

Default Value: 5

maximum-retry-time
Specifies the maximum value of the retry timer when the MPS sends a request. If a corresponding reply is not received before the expiration of the retry timer, the request is retried if the retry timer is less than this value and the retry timer is then doubled. This process will repeat until a reply is received or until the retry timer ≥ this value.

Valid Values: 10 to 300 seconds

Default Value: 40

giveup-time
Sets the minimum time to wait before giving up on a pending resolution request. This parameter is currently ignored by the MPS.

Valid Values: 5 to 300 seconds

Default Value: 40

holding-time
Sets the default holding time used in NHRP resolution replies. This value can also be set using NHRP. See page 33-9.

Valid Values: 1 to 120 minutes

Default Value: 20

accept-config-from-lecs

Specifies whether configuration parameters received from the LECS will be accepted by the MPS.

Valid Values: yes or no

Default Value: yes

List

Use the **list** command to display the MPS configuration.

Syntax:

list

Example:

```
                    Box Level MPS Configuration
                    ---------------------------
  Box Level MPS:           ENABLED
  Accept Config from LECS: YES
  Keep-Alive Time:       10 (sec)   Keep-Alive Lifetime:   35 (sec)
  Initial Retry Time:     5 (sec)   Maximum Retry Time:    40 (sec)
  Giveup Time:           40 (sec)   Holding Time:          20 (min)
  ------------------------------------------------------------------
  Physical Interface Net Number: 0
  ESI:         Using Burned In ESI
  Selector:                   06
  Desired PCR (Kbps):      155000        Line Speed (Mbps):  155
  ------------------------------------------------------------------
  Physical Interface Net Number: 2
  ESI:         Using Burned In ESI
  Selector:                   02
  Desired PCR (Kbps):      155000        Line Speed (Mbps):  155
  ------------------------------------------------------------------
  Physical Interface Net Number: 4
  ESI:         Using Burned In ESI
  Selector:                   02
  Desired PCR (Kbps):      155000        Line Speed (Mbps):  155
  ------------------------------------------------------------------
  Net:     0   ENABLED   Net:     2   ENABLED   Net:     4   ENABLED
  Net:     6   ENABLED   Net:     9   ENABLED
  ------------------------------------------------------------------
```

Advanced-Config

Use the **advanced-config** command to access the MPS interface configuration. You will be prompted to enter the *interface number* of the MPS.

Depending on the interface type, either the `MPS Physical Interface Config>` command prompt or the `MPS Net Interface Config>` command prompt is displayed.

Syntax:

advanced-config

To configure MPS physical interface parameters, enter the following commands at the `MPS Physical Interface Config>` prompt.

Table 31-3. MPS Physical Interface Configuration Command Summary	
Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Enable	Enables MPS on the physical interface.
Disable	Disables MPS on the physical interface.
List	Displays all the configuration information associated with the MPS interface.
Esi	Sets the ESI portion of the physical ATM address for MPS.
Selector	Sets the selector portion of the physical ATM address for MPS.
Desired-PCR	Sets the desired peak cell rate for the MPS interface.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

To configure MPS network interface parameters, enter the following commands at the `MPS Net Interface Config>` prompt.

Table 31-4. MPS Network Interface Configuration Command Summary	
Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Enable	Enables MPS on the interface.
Disable	Disables MPS on the interface.
List	Displays all the configuration information associated with the MPS interface.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Enable (MPS on Interface)

Use the **enable** command to enable the MPS on the interface.

Syntax:

en**able**

Disable (MPS on Interface)

Use the **disable** command to disable the MPS on the interface. Disabling the MPS on a physical interface causes it to be disabled on all the ELANs based on that physical interface.

Syntax:

di**sable**

List

Use the **list** command to display configuration information about the MPS interface.

Syntax:

list

```
MPS Configuration> list
   MPS Configuration on physical interface 0
   -----------------
   Net 0 status:                              ENABLED
   ESI:                                       Burned in ESI
   Selector:                                  09
   Desired Peak Cell Rate (Kbps):             155000
   Line Speed (Mbps):                         155
```

ESI

Use the **esi** command to configure the ESI portion of the ATM address for the MPS. You will be prompted to select the burned-in address of the interface adapter or a locally-administered ESI.

Syntax:

esi

Selector

Use the **selector** command to configure the selector portion of the ATM address for the MPS. The selector must be unique among all components using the same ESI.

Syntax:

selector

Desired-pcr

Use the **desired-pcr** command to configure the desired peak cell rate for MPS connections over this interface.

Syntax:

desired-pcr

MPC Configuration Commands

To access the MPC *configuration* process, enter **mpc** at the `MPOA Config>` prompt to access the `MPC Config>` prompt. Enter the commands at the `MPC Config>` prompt.

Table 31-5. MPC Configuration Command Summary	
Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds an MPC instance with default parameter values.
List	Lists the enabled/disabled status of the MPC instance.
Config	Allows explicit configuration of MPC parameters.
Remove	Removes a MPC configuration.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Note: The MPOA client does not have to be explicitly configured in order to start functioning at startup. If no explicit configuration of the MPC has been done under `talk 6`, an MPOA client is automatically created in the *enabled* state with a default set of parameter values and begins MPOA operation including shortcut initiation. You should explicitly configure any non-default configuration parameters. To prevent the MPOA client function from automatically being activated, you should use the **config** command to access the `MPC Configuration>` prompt and then use the **disable** command to create an MPC instance with a status of *disabled*.

Add

Use the **add** command to add a MPC instance with default parameters.

The **add** option requires that an ATM interface has been previously added. Only a single ATM interface is supported and the MPC is automatically associated with the ATM interface with the lowest interface number.

The added MPC defaults to ***enabled***.

Note: When an MPC is created, it is automatically associated with all LECs on the device that have a bridge port configured on them. There is no explicit configuration to associate particular LECs to the MPC. Further, this association is formed during startup time and not during configuration. Thus, even if no bridge ports have been defined at the time the MPC is added and configured, the MPC will still be associated with all LECs that have a bridge port associated with them at startup time. You cannot dynamically disable association of the MPC with a particular LEC at runtime.

Syntax:

add MPC

Remove

Use the **remove** command to remove a MPC configuration.

Syntax:

remove MPC

List

Use the **list** command to display the existing MPC instance.

Syntax:

list

Config

Use the **config** command to access the `MPC Configuration>` prompt and perform explicit configuration of the MPC parameters.

Syntax:

config

To configure MPC parameters explicitly, enter the following commands at the `MPC Configuration>` prompt.

Table 31-6. MPC Explicit Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Enable	Enables the MPC instance.
Disable	Disables the MPC instance. This command can also be used to create an MPC instance with a status of ***disabled***.
Set	Sets explicit values for MPC configuration parameters.
List	Displays all the configuration information associated with the MPC instance.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Enable

Use the **enable** command to enable an MPC instance.

Syntax:

enable

Disable

Use the **disable** command to disable an MPC instance.

This command can also be used to create an MPC instance with a status of ***disabled***.

Note: An MPC instance will be automatically created at startup, even if no MPC has been explicitly added. Use the **disable** command to disable this MPC instance if you do not want to configure MPC.

Syntax:

disable

Set

Use the **set** command to explicitly configure MPC parameters.

Syntax:

set
- frame-count
- frame-time
- initial-retry-time
- maximum-retry-time
- hold-down-time
- vcc-timeout-period
- accept-config-from-lecs
- fragmentation-mode
- esi
- selector
- pcr
- max-reserved-bandwidth
- shortcuts

frame-count Controls the rate of traffic required before the MPC will initiate a shortcut to a given protocol destination. The MPC will initiate a shortcut when at least this many frames are forwarded to the same protocol destination for a period of ***frame-time*** seconds.

Valid Values: 1 to 65535 frames

Default Value: 10

frame-time Controls the rate of traffic required before the MPC will initiate a shortcut to a given protocol destination. The MPC will initiate a shortcut when at least ***frame-count*** frames are forwarded to the same protocol destination for a period of this number of seconds.

Valid Values: 1 to 60 seconds

Default Value: 1

initial-retry-time Specifies the initial value of the retry timer when the MPC sends a request. If a corresponding reply is not received before the expiration of the retry timer, the request is retried if the retry timer is less than ***maximum-retry-time*** and the retry timer is then doubled. This process will repeat until a reply is received or until the retry timer ≥ ***maximum-retry-time***.

Valid Values: 1 to 300 seconds

Default Value: 5

maximum-retry-time Specifies the maximum value of the retry timer when the MPC sends a request. If a corresponding reply is not received before the expiration of the retry timer, the request is retried if the retry timer is less than this value and the retry timer is then doubled. This process will repeat until a reply is received or until the retry timer ≥ this value.

Valid Values: 10 to 300 seconds

Default Value: 40

hold-down-time Specifies the minimum time to wait before re-initiating a failed resolution request.

Valid Values: 30 to 1200 seconds

Default Value: 160

vcc-timeout-period Specifies the length of time after which either inactive control or inactive data connections will be cleared.

Valid Values: 1 to 10080 minutes

Default Value: 20

accept-config-from-lecs Specifies whether configuration parameters received from the LECS will be accepted by the MPC.

Valid Values: yes or no

Default Value: yes

fragmentation-mode Controls the manner that the ingress MPC hadles IP packet fragmentation.

When this parameter is set to ***maximize-shortcut-usage***, frames requiring fragmentation will be sent to the MPOA server, while smaller frames will be sent over the shortcut. A potential consequence of using ***maximize-shortcut-usage*** is that packets can get out of order.

When this parameter is set to ***maximize-inorder-usage***, usage of a particular shortcut will be suspended for the ***hold-down-time*** if a frame requiring fragmentation is received, causing all frames for the destination to be sent to the MPOA server.

Valid Values: maximize-shortcut-usage or maximize-inorder-packet-delivery

Default Value: maximize-shortcut-usage

esi Specifies the ESI that is to be used as the ESI component of the MPC's ATM address. The MPC implementation uses a single ATM address for control as well as data VCCs, so this ATM address refers to both the control and data ATM addresses of the MPC.

Valid Values:

- Burned-in
- One of the set of enabled ESI definitions for the MPC ATM device

Default Value: Burned-in

selector Specifies the selector value that is to be used in combination with the esi to create a value that is unique among all protocol components using the MPC ATM device.

Valid Values: any single valid octet value that has not already been used

Default Value:

pcr Specifies the desired peak cell rate for connections established by the MPC over the associated ATM device.

All connections established by the MPC are best-effort connections.

Valid Values: 0 - line speed of the ATM device (integer Kbps)

Default Value: line speed of the ATM device

max-reserved-bandwidth Specifies the maximum amount of reserved bandwidth acceptable on incoming calls received over the associated ATM device.

Valid Values: 0 - line speed of the ATM device (integer Kbps)

Default Value: 0

shortcuts Specifies whether the MPC should establish shortcuts to LANE devices over the associated ATM device.

Valid Values: yes or no

Default Value: yes

If the value of this parameter is *yes*, you will be prompted for the following additional information:

Choice of source address for LANE shortcuts Specifies what source MAC address is to be used in frames transmitted on LANE shortcut VCCs.

Valid Values:

- The MAC address burned into the MPC's ATM device
- A locally-administered MAC address
- The MAC address provided in the MPOA resolution reply

Default Value: Burned-in MAC address

If you choose to provide a locally-administered MAC address, you will be prompted for the value to be used.

Valid Values: 12 hexadecimal digits in the range of X'400000000000' and X'7FFFFFFFFFFF'.

Default Value: None

List

Use the **list** command to display configuration information about the existing MPC instance.

Syntax:

list

```
MPC Configuration> list
   MPC Configuration
   -----------------
   STATUS:                              ENABLED
   Shortcut Setup Frame Count:           1 (sec)
   Shortcut Setup Frame Time:            1 (sec)
   Initial Retry Time:                   10 (sec)
   Maximum Retry Time:                   40 (sec)
   Hold Down Time:                       300 (sec)
   VCC Timeout Period:                   120 (min)
   Accept Config Parms from LECS         YES
   Fragmentation Mode                    Maximize Shortcut Usage

   Interface:                            0
   ESI:                                  Burned In ESI
   Selector:                             3
   Desired PCR:                          155000 (Kbps)
   Maximum Reserved Bandwidth:           10000 (Kbps)
   Line Rate:                            155 Mbps
   Enable LANE Shortcuts:                Yes
   Source MAC Address for Shortcuts:     Burned In
```

Accessing the MPOA Monitoring Environment

Use the following procedure to access the MPOA monitoring commands. This gives you access to the MPOA *monitoring* process.

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide.)

   After you enter the **talk 5** command, the GWCON prompt (+) displays on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the + prompt, enter the **protocol MPOA** command to get you to the `MPOA>` prompt.

MPOA Monitoring Commands

The MPOA main menu includes the following commands.

Table 31-7. MPOA Monitoring Command Summary	
Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
NHRP	Enters the NHRP monitoring environment. See Chapter 33, “Configuring and Monitoring NHRP” on page 33-1 for information about NHRP monitoring commands.
MPS	Enters the MPS monitoring environment. See “MPS Monitoring Commands” on page 31-13 for additional information.
MPC	Enters the MPC monitoring environment. See “MPC Monitoring Commands” on page 31-17 for additional information.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Note: All three options may not be available on all platforms. For instance, on a route server platform such as the MSS server, the MPOA client function is not available, so only the **NHRP** and **MPS** commands will be available. Similarly on a platform which primarily serves as an MPOA edge device (such as the MSS client), only the **MPC** command will be available.

MPS Monitoring Commands

At the `MPOA>` prompt, enter **mps** to access the `MPS>` monitoring prompt. To monitor MPS, enter the commands at the `MPS >` prompt.

Table 31-8. MPS Monitoring Command Summary	
Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Configuration	Allows access to MPS configuration parameters.
Discovery	Displays the MPS discovery table.
Control-vccs	Displays control VCCs for the MPS
Imposition-cache	Displays imposition cache entries.
Server-purge-cache	Displays server purge cache entries.
Statistics	Displays statistics.
Reset	Resets the MPS interface or protocol.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Configuration

Use the **configuration** command to access the `MPS Config Parameters >` command prompt.

Syntax:

conf**iguration**

Table 31-9. MPS Monitoring Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Display	Displays the configured parameter values for the MPS.
Change	Changes the configuration parameter values for the MPS.
Reset	Resets the MPS configuration parameter values.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Display

Use the **display** command to display the configuration parameter values for the MPS interface.

Syntax:

d**isplay**

Change

Use the **change** command to modify the configuration parameter values for the current runtime.

Syntax:

change keep-alive-time
lifetime-keep-alive
initial-retry-time
maximum-retry-time
giveup-time
holding-time (NHS/MPS)

keep-alive-time

Sets the time between MPS keep-alive messages that are sent to MPCs.

Valid Values: 1 to 300 seconds

Default Value: 10

lifetime-keep-alive

Sets the lifetime for the keep-alive parameter. MPCs consider the MPS to have failed if they do not receive a keep-alive message within this time.

Valid Values: 3 - 1000 seconds

Default Value: 35

initial-retry-time

Specifies the initial value of the retry timer when the MPS sends a request. If a corresponding reply is not received before the expiration of the retry timer, the request is retried if the retry timer is less than ***maximum-retry-time*** and the retry timer is then doubled. This process will repeat until a reply is received or until the retry timer ≥ ***maximum-retry-time***.

Valid Values: 1 to 300 seconds

Default Value: 5

maximum-retry-time

Specifies the maximum value of the retry timer when the MPS sends a request.

Valid Values: 10 to 300 seconds

Default Value: 40

giveup-time

This parameter is currently ignored by the MPS.

Valid Values: 50 to 300 seconds

Default Value: 40

holding-time

Specifies the holding time to be returned in resolution replies.

Valid Values: 1 to 120 minutes

Default Value: 20

Reset

Use the **reset** command to reset the specified configuration parameter to the value in the static configuration.

Syntax:

reset keep-alive-time
lifetime-keep-alive
initial-retry-time
maximum-retry-time
giveup-time
holding-time (NHS/MPS)
accept-config-from-lecs

See the **change** command on page 31-14 for a description of these parameters.

Discovery

Use the **discovery** command to display the list of MPOA devices discovered by this MPS.

Syntax:

discovery

Control-VCCs

Use the **control-vccs** command to display control VCCs active for the MPS interface.

Syntax:

cont**rol-vccs**

Imposition-cache

Use the **imposition-cache** command to display the imposition cache for the MPS.

Syntax:

i**mposition-cache** list
entry *cache-id*

list Displays the list of current MPS imposition cache entries.

entry Displays detailed information about a particular MPS imposition cache entry. The cache entry is identified by the *cache-id*.

Server-purge-cache

Use the **server-purge-cache** command to display the server purge cache for the MPS. Each entry represents a destination protocol address and a client to which the server has provided authoritative shortcut information for that destination. Both NHRP server and MPOA server purge cache entries are listed.

Syntax:

s**erver-purge-cache**

Statistics

Use the **statistics** command to display statistics for the MPS.

Syntax:

st**atistics**

Reset

Use the **reset** command to reset an MPS interface or entire MPS. A reset causes the applicable static configuration values to be used.

Syntax:

reset interface *interface-number*
mps

interface Resets a particular MPS/NHRP interface.

mps Resets the entire MPS. This is equivalent to a cold start of MPS/NHRP.

MPS Packet Tracing and Event Logging

Use NHRP packet tracing and event logging for MPS. See “NHRP Packet Tracing” on page 33-18.

MPC Monitoring Commands

To access the MPC *monitoring* process, enter **mpc** at the MPOA> prompt to access the MPC Console> prompt. Enter these commands at the MPC Console> prompt.

Table 31-10. MPC Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
atm-interface	Accesses the MPC-ATM> command prompt from which information about the ATM interface can be displayed.
mpc-base	Accesses the MPC-BASE> command prompt from which information about the overall MPC status can be displayed.
neighbor-mps	Accesses the MPC-MPS> command prompt from which information about the MPOA servers (MPS) that have been discovered by the MPC can be displayed.
VCCs	Accesses the MPC VCC> command prompt from which information about the VCCs being used by the MPC can be displayed.
ingress-cache	Accesses the MPC Ingress> command prompt from which information about the MPC's ingress cache can be displayed.
egress-cache	Accesses the MPC egress> command prompt from which information about the MPC's egress cache can be displayed.
configure	Accesses the MPC Configure> command prompt from which MPC configuration parameters can be dynamically changed.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Monitoring Commands for the MPC ATM-Interface

Enter the following commands at the MPC-ATM> command prompt.

Table 31-11. MPC ATM-Interface Monitoring Command Summary	
Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
display-interface-state	Provides information about the state of the MPC's ATM interface and ATM address registration.
interface-statistics	Displays statistics about the ATM interface.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Display-Interface-State

Use the **display-interface-state** command to provide information about the state of the MPC's ATM interface and ATM address registration.

Syntax:

d**isplay-interface-state**

Example:

```
MPC ATM>display
  MPOA Client Configured on ATM Interface  0:
  ==========================================

  1. ATM Interface Up/Down ?:              UP
  2. ATM Address Activated By Switch ?:    TRUE
  3. LLC Call Sap Ready ?:                 TRUE
  4. LANE Call Sap Ready ?:                TRUE
  5. Local ATM address :
       39.84.0F.00.00.00.00.00.00.00.00.00.02.10.00.5A.01.9C.00.03
```

Interface-Statistics

Use the **interface-statistics** command to display statistics such as the total number of address activation attempts and the number of times the ATM interface has been down.

Syntax:

i**nterface-statistics**

Example:

```
MPC ATM>inter
      ATM Interface Statistics For This MPC:
      ------------------------------------
      Total Address Registration Timeouts:    0
      Total Address Registration Failures:    0
      Total Address Deactivations :           0
      Total Net Downs:                        0
```

MPC Base Monitoring Commands

Enter the following commands at the `MPC-BASE>` command prompt.

Table 31-12. MPC BASE Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
list-config	Displays the current MPC configuration parameters.
LECs	Displays a list of local LAN Emulation Clients that are currently associated with the MPC.
state	Displays the current state of the MPC and the time since the last state change.
mpc-statistics	Displays a set of statistics for the MPC as a whole.
Enable-mpc	Dynamically starts a disabled MPC instance.
Disable-mpc	Dynamically deactivates the MPC instance.
Create-mpc	Dynamically creates a new MPC instance.
Delete-mpc	Deletes the MPC instance.
clear-statistics	Resets all the statistics maintained for the MPC instance to their initial values.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

List-config

Use the **list-config** command to display the current configuration parameters of the MPC.

Syntax:

list-config

Example:

Note: This command displays the parameters that are configurable through `talk 6` as well as some parameters, such as the *ATM address packet trace filter* value that can only be configured through `talk 5` (in the CONFIGURE menu).

```
MPC Base>list
          MPOA Client Configuration:
          ==========================

     Status:                           ENABLED
     Shortcut Setup Frame Count:       1
     Shortcut Setup Frame Time:        1      (sec)
     Initial Retry Time:               5      (sec)
     Maximum Retry Time:               40     (sec)
     Hold Down Time:                   160    (sec)
     VCC Timeout Period:               20     (min)
     Accept Config From LECS:          Yes
     Fragmentation Mode:               Maximize Shortcut Usage
     Interface:                        0
     ESI:                              Burned In ESI
     Selector:                         3
     Desired PCR:                      155000   (kbps)
     Maximum Reserved Bandwidth:       155000   (kbps)
     Line Rate:                        155      (Mbps)
     Enable LANE Shortcuts:            TRUE
     Source MAC Address for Shortcuts: Burned In

          Packet Trace Filtering Parameters:
          ==================================

     ATM Address Pkt Trace Filter Value
      00000000000000000000000000000000000000000000
      ATM Address Pkt Trace Filter Mask
      00000000000000000000000000000000000000000000
     LAN Pkt Trace Filter Value
      000000000000
     LAN Pkt Trace Filter Mask
      000000000000
```

LECs

Use the **LECs** command to display a list of local LAN Emulation Clients (LECs) that are currently associated with the MPC. For each LEC, the interface number, ELAN ID, ELAN type, bridge port type and, if appropriate, the ring number are displayed.

Syntax:

le**cs**

Example:

```
          LECs Associated w/  MPOA Client (interface 0):
          ===============================================

     1) LEC Interface Number: 2
     ELAN Type: TOKEN RING      ELAN ID: x0
     Bridge Port Type: SRB PORT
     Ring (Seg.) Number: 1204    Route Desc. : x4B48

     Lan Destinations Registered by this LEC:
     ----------------------------------------
       1) Route Descriptor: x8b88
```

State

Use the **state** command to display the current state of the MPC and the time since the last state change.

Syntax:

s**tate**

Example:

```
MPC Base>state
           MPOA Client State:
           ==================

     ATM Interface Number:                 0
     State:                                MPC UP STATE
     Time Since Last State Change (h:m:s):  00:33:40
     Last (internal) error code:           0
```

MPC-Statistics

Use the **mpc-statistics** command to display aggregate statistics for the MPC instance.

Syntax:

m**pc-statistics**

Example:

Note: This command is basically a combination of the **statistics** commands in each of the other submenus.

```
MPC Base>mpc
           MPOA Client Statistics (interface 0):
           =====================================
       Ingress MPC Statistics For This MPC:
       ------------------------------------
     Frames forwarded to MPSs:               6
     Total Resolution Requests Sent:         7
     Total Refresh Res. Requests Sent:       6
     Total Res. Rqst Retransmissions:        1
     Total Res. Rqst Timeouts:               0
     Total Res. Reply Successes:             7
     Total Res. Reply NAKs:                  0
     Total Res. Replies Discarded:           0
     Total MPS Purges Recvd:                 0
     Total MPS Purged Mappings:              0
     Total MPS Purges Discarded:             0
     Total Triggers Recvd:                   0
     Total Triggers Discarded:               0
     Total Keep Alives Recvd:                218
     Total Inactive Mappings Deleted:        0
     Total Frames Forwarded On Shortcuts:    2174
     Total Octets Forwarded On Shortcuts:    217400
     Total Data Plane Purges Recvd:          0
     Total Data Plane Purged Mappings:       0
     Total Data Plane Purges Discarded:      0
     Total NHRP Purge Replies Transmitted:   0
```

```
  Egress MPC Statistics For This MPC:
  -----------------------------------
Total Imposition Requests Recvd:        8
Total Imposition Rqsts NAKed:           0
Total Imposition Updates Received:      7
Total Imposition Purges Received:       0
Total Imposition Purged Mappings:       0
Total E-MPC Purge Rqsts Sent To MPSs:   0
Total E-MPC Purge Rqst Retransmissions: 0
Total E-MPC Purge Rqst Timeouts:        0
Total Octets Recvd (Software Path):     228600
Tot. Frames Recvd & Fwded (Software):   2286
Total Recvd Frames Discarded:           0
Total Data Plane Purge Rqsts Sent:      0
Total Data Plane Purge Rqst Retransmits:0
Total Data Plane Purge Rqst Timeouts:   0
Total Egress Cache Entries Aged Out:    0


  VCC Statistics For This MPC:
  ----------------------------
Total Call Setup Failures:              0
Total Incoming Calls Rejected:          0
Total Connections Released Locally:     0
Total Calls Placed Successfully:        1
Total Calls Received Successfully:      1
Total Remote Hangups (Normal):          0
Total Remote Hangups (Error):           0


  ATM Interface Statistics For This MPC:
  --------------------------------------
Total Address Registration Timeouts:    0
Total Address Registration Failures:    0
Total Address Deactivations :           0
Total Net Downs:                        0


  Additional Misc. Stats
  ----------------------
Total Error Indication Frames Received: 0
Total Error Indication Frames Txmtd:    0
Total Invalid Frames Received:          0
Total Keep-Alives Discarded:            0
Total OAM Frames Received:              0
```

Enable-MPC

Use the **enable-mpc** command to dynamically start operation of a disabled MPC instance. When the MPC instance is enabled, existing configuration parameters are used, and the MPC statistics are not reset to their initial values. Use **create-mpc** to start an MPC instance using the configuration parameters saved in the SRAM and to reset all statistics.

Syntax:

enable-mpc

Disable-MPC

Use the **disable-mpc** command to dynamically deactivate the MPC instance. Once the MPC has been disabled, all packets follow the normal routed path and no shortcut data forwarding occurs.

Syntax:

di**sable-mpc**

Create-MPC

Use **create-mpc** to start an MPC instance using the configuration parameters saved in the SRAM and to reset all statistics.

Syntax:

cr**eate-mpc**

Delete-MPC

Use the **delete-mpc** command to delete an existing MPC instance. The MPC ceases operation immediately.

Syntax:

de**lete-mpc**

Clear-statistics

Use the **clear-statistics** command to reset all the statistics maintained for the MPC instance to their initial values.

Syntax:

cl**ear-statistics**

MPC Neighbor MPS Monitoring Commands

Enter the following commands at the `MPC-MPS>` command prompt.

Table 31-13. MPC Neighbor MPS Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
list	Displays a current list of all the MPSs that have been discovered by the MPC (all the MPSs for which the MPC may perform forwarding functions).
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

List

Use the **list** command to produce a current list of all the MPSs for which the MPC may perform forwarding functions. The displayed information includes a list of MAC addresses for which the MPC is performing flow detection, the interface number of the LEC associated with each MAC address, and the control ATM address of the MPS.

Note: In the case of source route bridged networks, the same MAC address may be associated with an MPS on different ELANs.

Syntax:

list

Example:

```
MPC MPS>list
           List of Neighbor MPSs for MPOA Client (interface 0):
           ====================================================
  1) Control ATM: 39.84.0F.00.00.00.00.00.00.00.00.01.10.00.5A.01.A4.00.05

      1 MAC Address(es) Learnt For This MPS:

        1) MAC Addr: x10.00.5A.01.A4.00   Associated LEC Intf #:  2
```

MPC VCC Monitoring Commands

Enter the following commands at the MPC-VCC> command prompt.

Table 31-14. MPC VCC Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
list	Displays all the VCCs that are currently associated with the MPC.
list-vcc	Displays detailed information about a particular MPC VCC.
delete-vcc	Deletes a VCC associated with the MPC.
vcc-statistics	Displays aggregated statistics related to all VCCs associated with the MPC, including VCCs that may no longer be active).
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

List

Use the **list** command to display all of the VCCs that are currently associated with the MPC. This display includes fully operational VCCs and those that are not completely operational.

Syntax:

list

Example:

```
MPC VCC>list
           SVCs For MPC On ATM Interface 0 (total    2):
           ============================================
    1) VPI/VCI 0/38    State: OPERATIONAL
      Remote ATM: 39.84.0F.00.00.00.00.00.00.00.00.01.10.00.5A.01.A4.00.05
    2) VPI/VCI 0/39    State: OPERATIONAL
      Remote ATM: 39.84.0F.00.00.00.00.00.00.00.00.03.10.00.5A.01.9A.00.04
```

List-VCC

Use the **list-vcc** command to display detailed information about a particular MPC VCC.

Syntax:

list-v**cc** *vpi vci*

Example:

```
MPC VCC>list-v
VPI, Range 0..255 [0]?
VCI, Range 0..65535 [0]? 39

  VPI/VCI: 0/39     State: OPERATIONAL    Calling Party: FALSE
  Hold Down Cause:  N/A   Cause Code: N/A   Fwd/Bak SDU:4388/4388
  Remote ATM Addr: 39.84.0F.00.00.00.00.00.00.00.00.00.03.10.00.5A.01.9A.00.04
  Conn Type: P2P     VCC Type: B. EFFORT     Encaps. Type: LLC 1483
  H/W Path Valid: FALSE    Ref. Frame Cnt: 4810
  Frames Tx/Rx: 2754/2754     Bytes Tx/Rx: 275400/275400


      (Direct) Shortcut Routes Using This VCC:
      ----------------------------------------
     1) Address/Mask: 3.4.1.8/255.255.255.255    Shortcut State: RESOLVED
```

Delete-VCC

Use the **delete-vcc** command to delete a VCC associated with the MPC. ATM signalling closes the VCC. Because of on-going traffic, the VCC may be re-established shortly after deletion, giving the appearance that it was never deleted.

Syntax:

d**elete-vcc** *vpi vci*

VCC-Statistics

Use the **vcc-statistics** command to display aggregated statistics related to all VCCs associated with the MPC, including VCCs that may no longer be active.

Syntax:

v**cc-statistics**

Example:

```
MPC VCC>vcc
           VCC Statistics For This MPC:
           ----------------------------
      Total Call Setup Failures:              0
      Total Incoming Calls Rejected:          0
      Total Connections Released Locally:     0
      Total Calls Placed Successfully:        1
      Total Calls Received Successfully:      1
      Total Remote Hangups (Normal):          0
      Total Remote Hangups (Error):           0
```

MPC Ingress Cache Monitoring Commands

Enter the following commands at the `MPC-Ingress>` command prompt.

Table 31-15. MPC Ingress Cache Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
list	Displays all the entries in the MPC's ingress cache.
list-entries	Displays detailed information about specific ingress cache entries.
delete-entries	Deletes specified ingress cache entries.
ingress-statistics	Displays aggregated statistics for all of the MPC's ingress cache entries.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

List

Use the **list** command to display a list of all the entries in the MPC ingress cache. Use **list-entries** to display more detailed information.

Syntax:

list

Example:

```
MPC INGRESS>list
           Ingress Cache For MPC on ATM Interface 0
           ========================================


           Ingress Cache Entries for Direct Host Routes:
           ---------------------------------------------
     1)  Protocol Address: 3.4.1.8    Shortcut State: RESOLVED

           Ingress Cache Entries for Direct Network Routes:
           ------------------------------------------------

           Ingress Cache Entries for Derived Host Routes:
           ----------------------------------------------
```

List-entries

Use **list-entries** to display more detailed information.

You will be prompted for a destination protocol address and address mask. Detailed information is displayed for all entries in the MPC's ingress cache which match the specified address/mask combination. The information displayed for each destination includes:

- State of the entry
- Destination ATM address (if resolved)
- Statistics on frames sent to the MPS and those sent over the shortcut
- Remaining age values

- MTU of the destination
- Shortcut VCC being used for this entry, if any, and the type of encapsulation being used on the VCC
- Whether this is a local shortcut
- Data link layer header information returned in the resolution reply
- Control ATM address of the MPS which provided the address resolution.

Syntax:

list-**entries** *destination-protocol-address mask*

Example:

```
MPC INGRESS>list-en
Destination Protocol Address [0.0.0.0]? 3.4.1.8
Destination Protocol Address Mask [255.255.255.255]?
      Host Route Entries matching 3.4.1.8/255.255.255.255
      ---------------------------


            Direct Host Routes :

1) Address: 3.4.1.8  Shortcut State: RESOLVED
      Hold Down Cause: N/A   CIE Code: x0
      Dest ATM: 39.84.0F.00.00.00.00.00.00.00.00.03.10.00.5A.01.9A.00.04
      Frames Sent To MPS: 6  Frames Sent Over Shortcut: 3507
      Remaining Age (mins:secs): 3:12      Last Request ID: xB
      Destn MTU: 4376       Encaps. Type: TAGGED
      LANE Encaps. Hdr: xN/A
      Tag Value: x1
      Shortcut VCC (VPI/VCI):    0/  39   Local Shortcut ?: FALSE
      MPS: 39.84.0F.00.00.00.00.00.00.00.00.01.10.00.5A.01.A4.00.05

            Derived Host Routes :

      Network Route Entries matching 3.4.1.8/255.255.255.255
      ------------------------------

None found!
```

Delete-entries

Use the **delete-entries** command to delete specific ingress cache entries.

Syntax:

d**elete-entries** *destination-protocol-address mask*

You will be prompted for a destination protocol address and address mask. All ingress cache entries which match this address/mask combination are then deleted.

Note: Because of ongoing traffic, an ingress cache entry for a particular destination may immediately get recreated after it has been deleted using this command, giving the appearance that the entry had not been deleted.

Ingress-statistics

Use the **ingress-statistics** command to display aggregated statistics for all the MPC's ingress cache entries.

Syntax:

ingress-statistics

Example:

```
MPC INGRESS>ingress
           Ingress MPC Statistics For This MPC:
           ------------------------------------
     Frames forwarded to MPSs:               6
     Total Resolution Requests Sent:         14
     Total Refresh Res. Requests Sent:       13
     Total Res. Rqst Retransmissions:        1
     Total Res. Rqst Timeouts:               0
     Total Res. Reply Successes:             14
     Total Res. Reply NAKs:                  0
     Total Res. Replies Discarded:           0
     Total MPS Purges Recvd:                 0
     Total MPS Purged Mappings:              0
     Total MPS Purges Discarded:             0
     Total Triggers Recvd:                   0
     Total Triggers Discarded:               0
     Total Keep Alives Recvd:                443
     Total Inactive Mappings Deleted:        0
     Total Frames Forwarded On Shortcuts:    4414
     Total Octets Forwarded On Shortcuts:    441400
     Total Data Plane Purges Recvd:          0
     Total Data Plane Purged Mappings:       0
     Total Data Plane Purges Discarded:      0
     Total NHRP Purge Replies Transmitted:   0
```

MPC Egress Cache Monitoring Commands

Enter the following commands at the `MPC-Egress>` command prompt.

Table 31-16. MPC Egress Cache Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
list	Displays all the entries in the MPC's egress cache.
list-entries	Displays detailed information about specific egress cache entries.
purge-entries	Purges specified egress cache entries.
egress-statistics	Displays aggregated statistics for all of the MPC's egress cache entries.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

List

Use the **list** command to display a list of all the entries in the MPC egress cache. Use **list-entries** to display more detailed information.

Syntax:

list

Example:

```
MPC EGRESS>list
           Egress Cache For MPC on ATM Interface 0
           =======================================

     Egress Cache Entries w/ MPOA-Tag Encapsulation:
     -----------------------------------------------

    1) Protocol Address/Mask: 5.4.1.5/255.255.255.255     State:     ACTIVE


     Egress Cache Entries w/ Native 1483 Encapsulation (Host Routes):
     ----------------------------------------------------------------


     Egress Cache Entries w/ Native 1483 Encapsulation (Netwk Routes):
     ----------------------------------------------------------------
```

List-entries

Use **list-entries** to display detailed information about all the entries in the MPC egress cache.

You will be prompted for a destination protocol address and mask. Detailed information is then displayed for all egress cache entries which match this address/mask combination. The information includes:

- ATM addresses of the source and the imposing MPS
- Type of the entry
- Identity of the egress LEC corresponding to the imposition request
- Cache ID of the entry
- Its remaining age
- Statistics on received data packets
- Tag value, if applicable
- Data link layer header information
- Information on the different types of LANE extensions returned in the last MPOA Cache Imposition reply for this entry

Syntax:

list-**entries** *destination-protocol-address mask*

Example:

```
MPC EGRESS>list-en
Destination Protocol Address [0.0.0.0]? 5.4.1.5
Destination Protocol Address Mask [255.255.255.255]?

      Egress Cache Entries matching 5.4.1.5/255.255.255.255 :

 1) Address/Mask: 5.4.1.5/255.255.255.255   Entry Type: TAG
    LEC #:  2    Cache ID: x1   State: ACTIVE
    MPS: 39.84.0F.00.00.00.00.00.00.00.00.01.10.00.5A.01.A4.00.05
    Source: 39.84.0F.00.00.00.00.00.00.00.00.03.10.00.5A.01.9A.00.04
    Remaining Age (mins:secs): 13:37
    Recvd Octets: 463900
    Recvd Frames Forwarded: 4639
    Recvd Frames Discarded: 0
    Tag Value: x1       Local Shortcut: FALSE
    DLL Header: x0040000000019f0090005a01a40006a08b884b40aaaa030000000800
    LANE Extensions in last Imposition reply:  None
```

Purge-entries

Use the **purge-entries** command to purge specified egress cache entries.

You will be prompted for a destination protocol address and mask. All egress cache entries which match this address/mask combination are purged. This is done using the MPOA e-MPC initiated egress cache purge request.

Note: Because of ongoing traffic, an egress cache entry for a destination may immediately get recreated after it has been purged, giving the appearance that the purge command may not have been successful.

Syntax:

p**urge-entries** *destination-protocol-address mask*

Egress-statistics

Use the **egress-statistics** command to display aggregated statistics for all the MPC's egress cache entries.

Syntax:

egr**ess-statistics**

Example:

```
MPC EGRESS>egr
           Egress MPC Statistics For This MPC:
           -----------------------------------
     Total Imposition Requests Recvd:        18
     Total Imposition Rqsts NAKed:           0
     Total Imposition Updates Received:      17
     Total Imposition Purges Received:       0
     Total Imposition Purged Mappings:       0
     Total E-MPC Purge Rqsts Sent To MPSs:   0
     Total E-MPC Purge Rqst Retransmissions: 0
     Total E-MPC Purge Rqst Timeouts:        0
     Total Octets Recvd (Software Path):     551000
     Tot. Frames Recvd & Fwded (Software):   5510
     Total Recvd Frames Discarded:           0
     Total Data Plane Purge Rqsts Sent:      0
     Total Data Plane Purge Rqst Retransmits:0
     Total Data Plane Purge Rqst Timeouts:   0
     Total Egress Cache Entries Aged Out:    0
```

MPC Configure Monitoring Commands

Enter the following commands at the MPC-Configure> command prompt to dynamically change values of the MPC configuration parameters. The changes occur immediately and are temporary. The changes are applied to the running MPC instance and are not saved.

The commands for setting various configuration parameters are very similar to the corresponding commands using talk 6. Under talk 5, however, there are separate explicit commands for setting each parameter that can be dynamically configured, while under talk 6, all parameters are configured under the **set** command.

Note: Dynamic enabling/ disabling or creation/deletion of an MPOA client can also be done and the commands are under the MPC-BASE menu.

Two additional sets of configuration parameters available using the talk 5 **config** that do not have any talk 6 counterparts are the **atm-packet-trace-filter** and **lan-packet-trace-filter** commands. You can configure a mask for an ATM address or MAC address respectively. MPOA client packets are only traced if the remote ATM address of the VCC on which the packet is being sent or received or the destination MAC address of the packet if on a legacy LAN interface matches the configured mask.

The first example will result in only those MPOA client packets being traced on the ATM interface that are being sent/received over VCCs to a remote ATM address with the last two bytes being 05'.

Example:

```
MPC CONFIGURE>atm
    ATM Address Pkt Trace Filter Value (40 hex digits)
     [0000000000000000000000000000000000000000]?
     0000000000000000000000000000000000000005
    ATM Address Pkt Trace Filter Mask (40 hex digits)
     [0000000000000000000000000000000000000000]?
     00000000000000000000000000000000000000ff
```

The following example will result in MPOA client packet tracing on the legacy LAN interfaces of only those packets for which the destination MAC address has a 40' as the first byte.

Example:

```
MPC CONFIGURE>lan
    LAN Pkt Trace Filter Value (12 hex digits)
     [000000000000]? 400000000000
    LAN Pkt Trace Filter Mask (12 hex digits)
     [000000000000]? ff0000000000
```

See page 31-9 for a description of each command.

Table 31-17 (Page 1 of 2). MPC Configure Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.

Table 31-17 (Page 2 of 2). MPC Configure Monitoring Command Summary

Command	Function
list	Displays the current values of all the dynamically configurable parameters.
reset	Resets all the dynamically configurable parameters to the values configured at the `talk 6` prompt. See "MPC Configuration Commands" on page 31-6 for more information.
pcr	Dynamically sets the peak cell rate for the MPC instance.
max-reserved-bandwidth	Dynamically sets the maximum reserved bandwidth for the MPC instance.
enable-lane-shortcuts	Dynamically enables LANE shortcuts for the MPC instance.
lane-shortcuts-src-mac	Dynamically sets the source MAC address to be used in frames transmitted on LANE shortcut VCCs.
configured-src-mac	Dynamically sets locally administered MAC address to be used as the source MAC address in frames transmitted on LANE shortcut VCCs..
frame-count	Dynamically sets the frame count used to control the rate of traffic required before the MPC will initiate a shortcut to a given protocol destination.
frame-time	Dynamically sets frame time used to control the rate of traffic required before the MPC will initiate a shortcut to a given protocol destination.
init-retry-time	Dynamically sets the value of the retry timer used to determine if a request is to be retried when there is no response in a specified amount of time.
max-retry-time	Dynamically sets the maximum value of the retry timer used to determine if a request is to be retried when there is no response in a specified amount of time.
hold-down-time	Dynamically sets the minimum time to wait before reinitiating a failed resolution attempt.
vcc-timeout	Dynamically sets the time after which VCCs will be cleared when there has been no activity.
accept-config-from-lecs	Dynamically specifies whether any configuration parameters received from the LECS will be accepted by the MPC.
fragmentation-mode	Dynamically controls the manner that the ingress MPC handles IP packet fragmentation.
atm-packet-trace-filter	Allows the user to restrict packet tracing to specific VCCs.
lan-packet-trace-filter	Allows the user to restrict packet tracing to and from LAN ports.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

MPC Packet Tracing

MPOA client packet traces can be activated from the Event Logging System (ELS) which is an integral part of the router operating system. See the chapter entitled "Using the Event Logging System" and the chapter entitled "Configuring and Monitoring the Event Logging System" in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide* for additional information about ELS.

Note: Packet tracing for the MPOA server function is separate from that of the MPOA client function and is accessed as part of NHRP packet tracing.

For MPOA client packet tracing, use the MPOA ELS subsystem. MPOA client packet tracing supports the **set trace decode on** option. This option enables the MPOA output to be interpreted for viewing. For details on using the trace facility, see the description of the trace command in the chapter entitled "Configuring and Monitoring the Event Logging System" in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

MPOA client packets are identified by three different events under the MPOA ELS subsystem.

- Event 61 traces all MPOA client control frames
- Event 62 traces all MPOA client data frames
- Event 63 traces all MPOA client frames on legacy LAN interfaces.

Sample Trace Output 1:

```
#1 Dir:INCOMING  Time:2.10.16.85  Trap:7611
Comp:MPOA  Type:UNKNOWN  Port:0  Circuit:0x000000  Size:245
----------------------------------------------------------------
** MPC MPOA/NHRP Frame on 1483 VCC **
AddressFamily:ATM_NSAP  ProtocolType:IPv4  HopCount:64  PacketSize:237
Checksum:0x6F02  ExtensionOffset:0x0044  Version:1
PktType:MpoaCacheImpositionR
equest
SrcAddrTL:20  SrcSubAddrTL:0  SrcProtoLen:4  DstProtoLen:4
ReqID:26
Src NBMA:39840F000000000000000000310005A019A0004
Src Protocol Addr: 5.4.2.0  Dest Protocol Addr: 5.4.1.5
0040: 00 FF 00 00 11 18 03 C0  00 00 00 00 10 01 00 00    | ................ |
0050: 10 02 00 04 D0 00 00 5A  00 08 00 08 08 00 5A 00    | .......Z......Z. |
0060: 00 01 00 06 00 08 00 1C  08 00 5A 00 00 01 00 0A    | ..........Z..... |
0070: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00    | ................ |
0080: 00 00 00 00 00 08 00 34  08 00 5A 00 00 01 00 0C    | .......4..Z..... |
0090: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00    | ................ |
00A0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00    | ................ |
00B0: 00 00 00 00 00 00 00 00  00 00 00 00 00 08 00 08    | ................ |
00C0: 08 00 5A 00 00 01 00 10  90 00 00 25 00 00 00 02    | ..Z........%.... |
00D0: 00 00 00 00 1C 00 40 00  00 00 01 9F 00 90 00 5A    | ......@........Z |
00E0: 01 A4 00 06 20 4B 48 8B  80 AA AA 03 00 00 00 08    | .... KH......... |
00F0: 00 80 00 00 00
```

Sample Trace Output 2:

```
#3 Dir:OUTGOING  Time:2.10.16.85  Trap:7611
Comp:MPOA  Type:UNKNOWN  Port:0  Circuit:0x000000  Size:269
----------------------------------------------------------------
** MPC MPOA/NHRP Frame on 1483 VCC **
AddressFamily:ATM_NSAP  ProtocolType:IPv4  HopCount:255  PacketSize:261
Checksum:0x0DBE  ExtensionOffset:0x0058  Version:1
PktType:MpoaCacheImpositionR
eply
SrcAddrTL:20  SrcSubAddrTL:0  SrcProtoLen:4  DstProtoLen:4
ReqID:26
Src NBMA:39840F000000000000000000000310005A019A0004
Src Protocol Addr: 5.4.2.0  Dest Protocol Addr: 5.4.1.5
0040: 00 20 00 00 11 18 03 C0  14 00 00 FF 39 84 0F 00    | . ..........9... |
0050: 00 00 00 00 00 00 00 00  02 10 00 5A 01 9C 00 03    | ...........Z.... |
0060: 10 01 00 04 00 00 00 01  10 02 00 04 00 00 D0 00    | ................ |
0070: 00 08 00 08 08 00 5A 00  00 01 00 06 00 08 00 1C    | ......Z......... |
0080: 08 00 5A 00 00 01 00 0A  00 00 00 00 00 00 00 00    | ..Z............. |
0090: 00 00 00 00 00 00 00 00  00 00 00 00 00 08 00 34    | ..............4 |
00A0: 08 00 5A 00 00 01 00 0C  00 00 00 00 00 00 00 00    | ..Z............. |
00B0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00    | ................ |
00C0: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00    | ................ |
00D0: 00 00 00 00 00 08 00 08  08 00 5A 00 00 01 00 10    | ..........Z..... |
00E0: 90 00 00 25 00 00 00 02  00 00 00 00 1C 00 40 00    | ...%..........@. |
00F0: 00 00 01 9F 00 90 00 5A  01 A4 00 06 20 4B 48 8B    | .......Z.... KH. |
```

Sample Configuration

Example Configuration of an MPOA client

Notes:

1 Enter the MPOA client configuration menus.

2 First add an MPC.

3 Confirm that an MPC has been added, then go into the config option for configuring this MPC.

4 List the current configuration. Since we just added the MPC, all the configuration parameters have been set to the default values.

4a Some of the parameters displayed cannot be configured but are displayed simply for convenience. For instance the interface indicated refers to the ATM interface number on which the MPC is being configured. The ATM interface number with the lowest interface number is automatically selected and cannot be configured. Similarly the line rate refers to that of the ATM interface and cannot be configured in the MPC configuration menus.

5 If we would like the MPC to be in disabled state on bringup, use the disable'' command. The MPC can be dynamically activated from the monitoring console (talk 5).

6 Use the **set** command to configure various MPC parameters. Check the list of parameters which can be set using this command as shown below.

7 The *frame-count*parameter can be configured as shown (setting it to 1 will effectively result in the MPC making shortcut attempts to every destination for which a packet is encountered, while setting it to a very large value will result in shortcuts only to destinations to which extremely heavy traffic is being sent).

8 Configure the ESI portion of the ATM address of the MPC (the MPC uses a single ATM address as both its control and data ATM address). Two ESIs have already been administered under the ATM interface configuration menus.

9 Configure the selector byte to be used along with the ESI as part of the MPC's ATM address.

10 Configure parameters related to the use of LAN emulation shortcuts.

Note: If LANE shortcuts are enabled, you are prompted for the choice of source MAC address to be used in the layer 2 header of LANE shortcut packets. Further, if option 2 (*locally configured MAC address* is chosen, then you are also prompted for the MAC address desired.

11 Confirm the new configuration using the **list** command.

```
MOS Operator Control

*t 6
Gateway user configuration
Config>p mpoa        1
Next Hop Resolution Protocol/Multi Protocol Over ATM user configuration
MPOA config>mpc

MPOA Client user configuration
MPC >?
ADD
LIST
CONFIG
REMOVE
EXIT

MPC >add         2

     MPC added on interface 0
MPC >list        3
      LIST OF CONFIGURED MPOA CLIENTS
        ---------------------------------
        Interface                  Status
        ---------------------------------
            0                       ENABLED

MPC >config

MPC Configuration> ?
ENABLE
DISABLE
SET
LIST
EXIT
```

```
MPC Configuration> list        4

   MPC Configuration
   -----------------
   STATUS: ENABLED
   Shortcut Setup Frame Count:       10    (frames)
   Shortcut Setup Frame Time:        1     (sec)
   Initial Retry Time:               5     (sec)
   Maximum Retry Time:               40    (sec)
   Hold Down Time:                   160   (sec)
   VCC Timeout Period:               20    (min)
   Accept Config From LECS:          Yes
   Fragmentation Mode:               Maximize Shortcut Usage

   Interface:                        0
   ESI:                              Burned In ESI
   Selector:                         0x 2
   Desired PCR:                      155000 (kbps)
   Maximum Reserved Bandwidth:       155000 (kbps)
   Line Rate:                        155 (Mbps)
   Enable LANE Shortcuts:            TRUE
   Source MAC Address for Shortcuts: Burned In
```

4a

```
MPC Configuration> disable        5
Disable MPC?  [Yes]?y
    MPC set to DISABLED

MPC Configuration> set ?      6
FRAME-COUNT (FOR SHORTCUTS)
FRAME-TIME (FOR SHORTCUTS)
INITIAL-RETRY-TIME
MAXIMUM-RETRY-TIME
HOLD-DOWN-TIME
VCC-TIMEOUT-PERIOD
ACCEPT-CONFIG-FROM-LECS
FRAGMENTATION-MODE
ESI
SELECTOR
PCR
MAX-RESERVED-BANDWIDTH
SHORTCUTS
```

```
MPC Configuration> set frame-count    7
Frame Count for Shortcut Setup (in frames):  [10]? 1

MPC Configuration> set esi       8
     [1] Burned in ESI
     [2] 12.34.56.78.9A.BC
     [3] 12.12.12.12.12.12
 ESI:  [1]? 2

MPC Configuration> set selector      9
Selector Byte (in hex) [2]? 10
MPC Configuration> set short    10
Enable LANE Shortcuts?  [Yes]? y

  Choices for Source MAC Address for LANE Shortcuts:
     [1] Burned in ESI
     [2] Locally Configured MAC Address
     [3] MAC Address from the Resolution Reply

MAC Address Type for LANE Shortcuts:  [1]? 2
MAC Address for LANE Shortcuts:  [00.00.00.00.00.00]?42.42.42.42.42.42

MPC Configuration> list       11

     MPC Configuration
     -----------------
     STATUS: DISABLED
     Shortcut Setup Frame Count:       1     (frames)
     Shortcut Setup Frame Time:        1     (sec)
     Initial Retry Time:               5     (sec)
     Maximum Retry Time:               40    (sec)
     Hold Down Time:                   160   (sec)
     VCC Timeout Period:               10    (min)
     Accept Config From LECS:          Yes
     Fragmentation Mode:               Maximize Shortcut Usage

     Interface:                        0
     ESI:                              12.34.56.78.9A.BC
     Selector:                         0x10
     Desired PCR:                      155000 (kbps)
     Maximum Reserved Bandwidth:       155000 (kbps)
     Line Rate:                        155 (Mbps)
     Enable LANE Shortcuts:            TRUE
     Source MAC Address for Shortcuts: Locally Configured
                                 42.42.42.42.42.42
```

Chapter 32. Using NHRP

This chapter describes how to use:

- Next Hop Resolution Protocol (NHRP) as specified in Internet Draft Version 13, which has been submitted for RFC status
- Route Switching, which extends the benefits of NHRP to LAN-attached end-stations.

Next Hop Resolution Protocol (NHRP) Overview

The Next Hop Resolution Protocol (NHRP) defines a method for a source station to determine the Non-Broadcast Multi-Access (NBMA) address of the “next hop” towards a destination. The NBMA next hop may be the destination itself or the egress router from the NBMA network that is “nearest” to the destination station. This “next hop” information is called a “cut-through” route or VC in the NHRP specification; the router uses the term “shortcut” instead of “cut-through.” The source station can then establish an NBMA virtual circuit directly with the destination or the egress router and reduce the number of hops through the network.

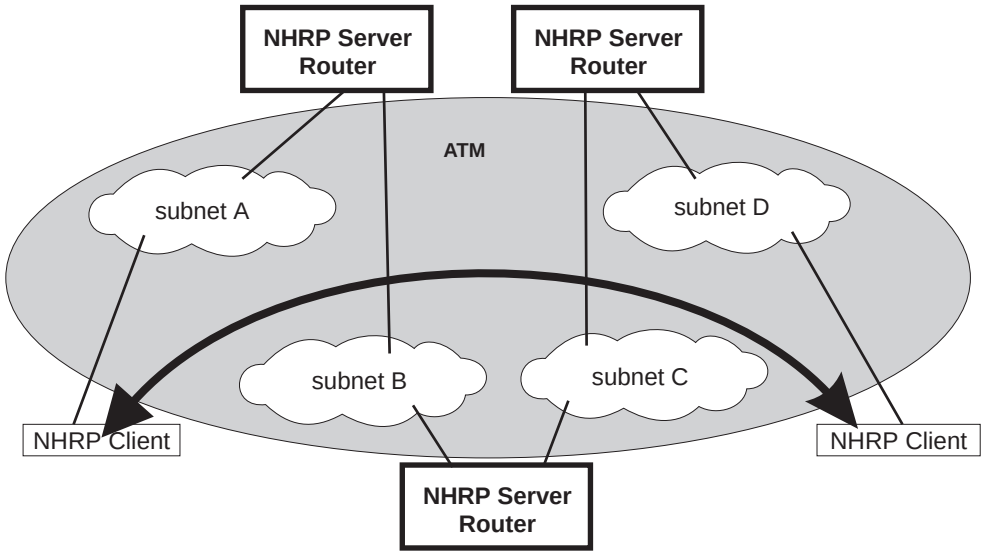

Figure 32-1. Next Hop Resolution Protocol (NHRP) Overview

The MSS Server can use NHRP to establish shortcuts for IP traffic over the ATM NBMA network for both RFC 1483 and Emulated LAN (ELAN) interfaces. The Internet draft does not address the use of NHRP in an ELAN environment, but the MSS Server includes enhancements to allow using LANs. These enhancements are currently implemented using the vendor-private extensions included in the NHRP protocol definition.

The NHRP draft describes the basic protocol flow as follows: NHRP clients register their protocol addresses and their NBMA addresses with one or more NHRP servers. The servers are typically routers on the routed path through the NBMA network to the clients. When a client wants to establish a shortcut to a destination,

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it sends a Next Hop Resolution Request packet along the routed path. The request includes the destination protocol address. The routers (that are also NHRP servers) along the routed path first check to see if the destination protocol address is an address that it can serve.

If the router can satisfy the request, the router returns a Next Hop Resolution Reply with the NBMA address of the destination station. The originator can then establish a direct virtual circuit with the destination. If it cannot satisfy the request, the router forwards the request to the next-hop router. This forwarding continues until the request can be satisfied, or it is determined that the destination cannot be reached.

To use client/server terminology, a device may be both a client and a server. The client is the device that originates Next Hop Resolution Requests, and the server is the one that provides Next Hop Resolution Replies with NBMA address information. The MSS Server is such a device; the client conceptually “registers” with the server function in the same machine, although no Registration Requests actually flow. The server also supports NHRP Registrations from remote NHRP clients.

The information provided by clients to their server, and by servers to requestors, must be refreshed periodically and may be purged if conditions dictate. Clients and Servers maintain caches of resolution information that they have sent and received; holding times are used to age out the entries or force refreshes.

Benefits of NHRP and the IBM implementation

In general, use of NHRP shortcuts can:

- Improve end-to-end performance, by eliminating hops between routers when the source and destination are on the same NBMA network and can communicate directly
- Reduce the load on network routers, since they are bypassed for traffic that, without NHRP, would be handled by the router. This can reduce overall costs as fewer routers or less bandwidth may be needed.

The IBM implementation of NHRP provides these additional benefits:

- The NHRP draft does not address using the protocol in an Emulated LAN environment. However, the IBM implementation of NHRP includes considerations for such environments; NHRP packets can flow between routers over ELAN connections, and shortcut VCs can be established.
- One-hop Routing: ATM devices that do not support NHRP can be the destination of shortcut paths, eliminating another router hop for traffic, by expanding the definition of the devices that are “served” to include devices that share a protocol subnetwork with the server. For example, all IP addresses on a classical IP subnet that a server is part of, are “served” by that server. The NHRP function interfaces with classical IP 1577 and LAN Emulation components to use their existing ATM address resolution capabilities and apply them to NHRP requests. This enhancement can even be used for traffic to legacy LAN-attached devices that connect to ATM through LAN switches; the NHRP server in the router replies to the client with ATM addressing information for the LAN switch, allowing the client to shortcut directly to that switch. For examples of these “one-hop routing” cases, see Figure 32-1 on page 32-1 and Figure 32-2 on page 32-4

Note: A hop is an operation performed by a traditional router when forwarding packets from one subnet to another. In particular those operations are (1) doing a lookup on a Layer 3 subnet identifier (2) determining the outbound "next hop" for the packet (3) stripping and replacing the Layer 2 packet header, removing ingress link information and adding egress link information. So, for "one-hop" routing this operation happens once during transfer of a packet from its source to its destination.

- The IBM implementation can operate in networks where some routers do not support NHRP. If the next-hop router is not capable of providing NHRP support, shortcut VCs can be established to the "last" server in the path. See "Disallowed Router-to-Router Shortcuts" on page 32-12 and "Exclude Lists" on page 32-10.
- The customer may configure the MSS Server to establish shortcuts only when traffic to a destination exceeds a given data rate. This can eliminate the creation of VCs for low volume or one-time traffic (for example, SNMP traps). See "data-rate parameter" on page 33-9 and "attempt shortcuts? parameter" on page 33-8.
- The router provides solutions for the "domino" effect that is described in the NHRP draft. See "attempt shortcuts? parameter" on page 33-8.
- All ATM-attached routers on the routed path should support NHRP for the optimal benefit, although the MSS Server can still operate and provide shortcuts in a mixed network.

Performance Characteristics

NHRP is used during initial contact from a source device to a destination. Once a shortcut VC has been established, NHRP is not involved in actual data transfer. Safeguards ensure that NHRP traffic is not retried for every packet. Also, the IBM implementation provides an option for NHRP shortcuts to be requested only when traffic to a certain destination exceeds a configurable data rate threshold. This can prevent, for example, the establishment of virtual circuits that would only be used for one SNMP trap frame that is generated by an IP host.

NHRP operation does not affect the performance of the router fastpath and will not significantly affect the slowpath. When shortcuts are available, the performance is improved by the elimination of extraneous hops over the ATM network. Also, the performance of intermediate routers that are bypassed by NHRP shortcuts should be improved, as they handle less traffic.

Note: If a configuration does not include a 1577 interface (that is, the router is configured only for ELANs), shortcut VCs can be established to the router only from clients that support the IBM extensions. This limitation can be avoided simply by defining a 1577 interface on the router.

Examples of NHRP Configurations

The following paragraphs give examples of NHRP configurations.

NHRP in an RFC 1577 Classic IP Environment with All Devices NHRP-capable

In this picture, the NHRP clients use RFC 1577 connections to communicate with the router. They use NHRP protocol to learn from the NHRP server about each other's ATM addresses. Then they establish a direct virtual circuit between them for IP traffic.

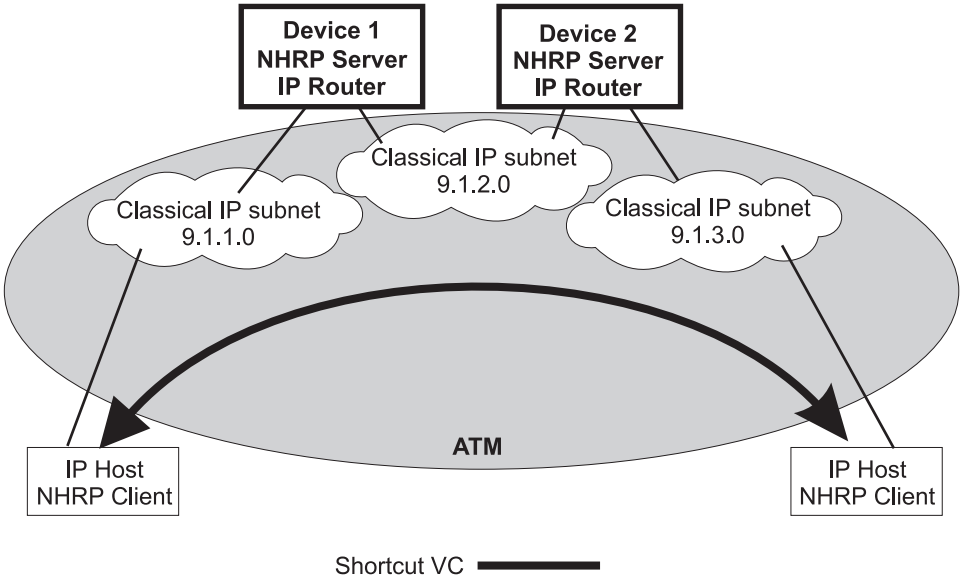

Figure 32-2. NHRP in a Classic IP Environment

NHRP in a Classic IP Environment with non-NHRP Device

This example shows how NHRP can be used between two 1577 devices. when one of them does not support NHRP. Here, Device2 provides the NHRP client with the ATM address of the non-NHRP device and the client can establish a shortcut for traffic to the non-NHRP host. However, when traffic flows from the non-NHRP device, it flows on the routed path to Device2; then Device2 acts as an NHRP client and establishes a shortcut to the destination.

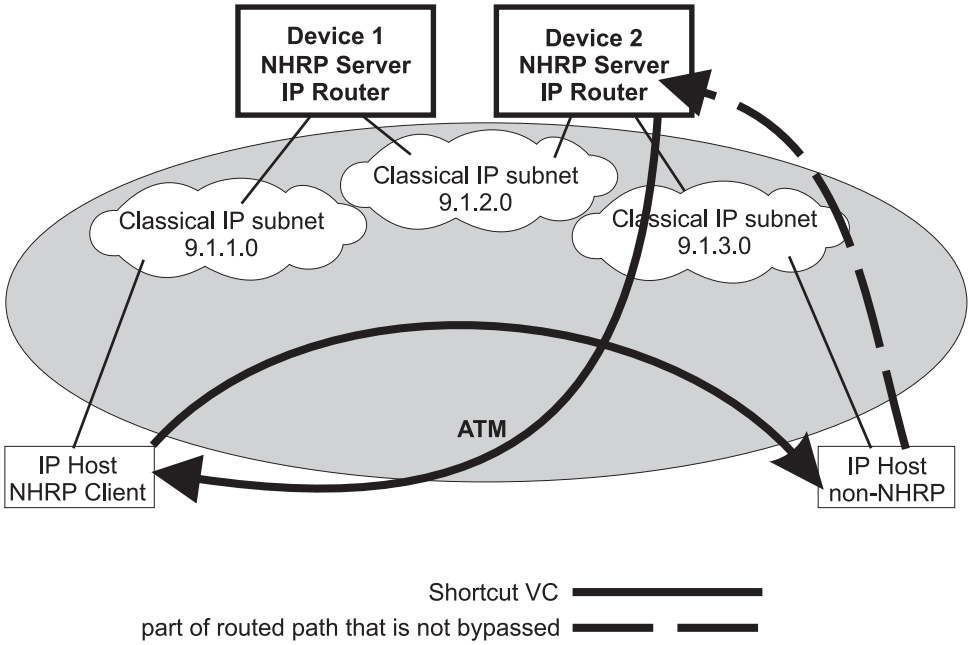

Figure 32-3. NHRP in a Classic IP Environment with non-NHRP Device

NHRP in a Pure LAN Emulation Environment

In the LAN emulation case, routers use the IBM extensions to provide NBMA information for devices on their ELANs. When Device1 receives traffic from host A destined to host B, it originates a Next Hop Resolution Request and sends it on the routed path. Device2 replies to the request with NBMA information about host B, one of the stations that it serves because they are on the same ELAN. Device1 then can establish a data direct VCC to host B even though host B does not participate in or support the NHRP exchanges. Note that this VCC would be used only for traffic in the direction from A to B. Similarly when host B sends traffic to host A, Device2 generates a Next Hop Resolution Request, Device1 replies with addressing information about host A, and Device2 establishes a data direct VCC to A for traffic from B to A.

The LECs in this example are standard-compliant devices with no NHRP support. They must satisfy the LEC requirements described in “NHRP Implementation” on page 32-8).

Nothing special has to be configured in these devices or in the NHRP servers. The NHRP traffic flows over the ELAN subnet with no additional VCs.

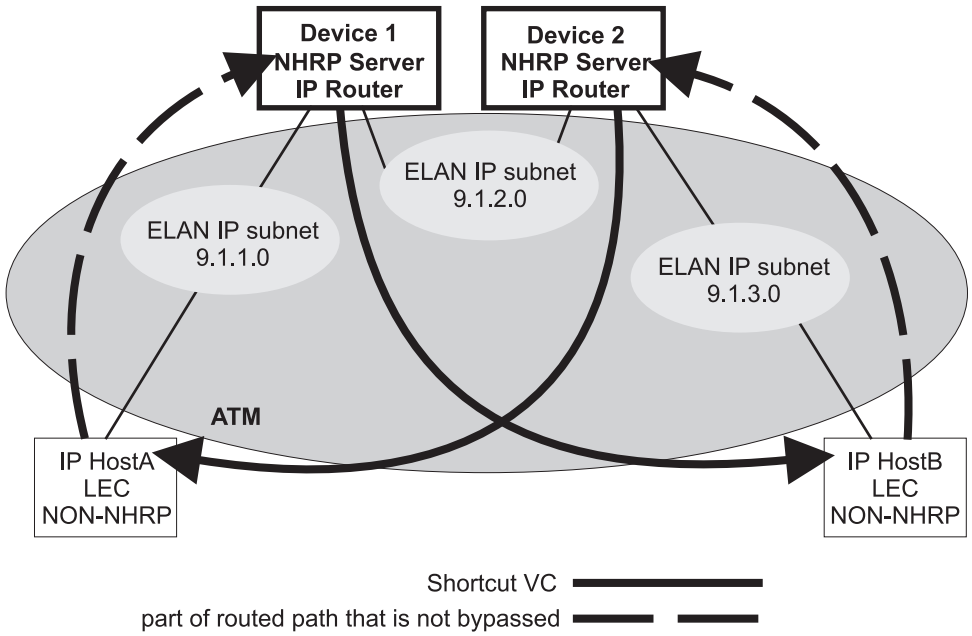

Figure 32-4. NHRP in an ELAN Environment

NHRP in a LAN Emulation Environment with LAN Switches

In this example, the source and destination stations are attached to legacy LANs and do not connect to the ATM net work. LAN switches operating as LAN Emulation Clients give ATM connectivity to the legacy LAN devices. The enhancements to NHRP and the IBM extensions allow the same kind of “one-hop routing” in this environment as described in the previous example. With the enhancements, the servers exchange the actual MAC addresses and routing information for the legacy-LAN devices. The MSS Servers can then establish data direct VCCs with the switches and pass the traffic directly. There is only one router “hop” in the path, although the traffic passes through two LAN switches.

This example also illustrates that the ELAN environment can be token-ring or Ethernet or any mixture of LAN types.

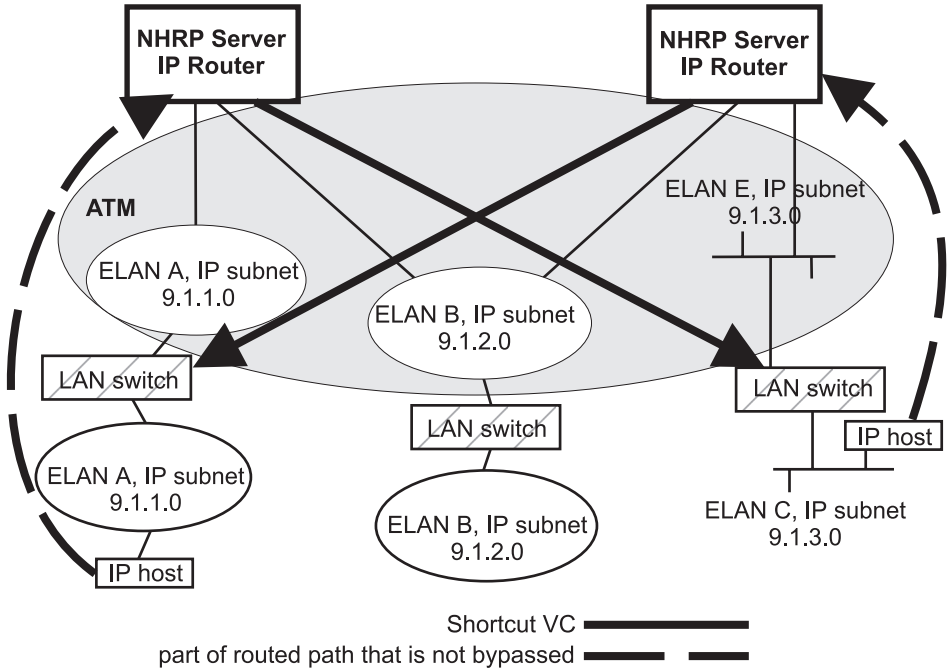

Figure 32-5. NHRP in an ELAN Environment with LAN Switches

NHRP in a Mixed Classical IP and ELAN Environment

The NHRP function in the router can operate with both Classic IP and ELAN interfaces in the same network. In this example, the NHRP client supports the IBM extensions and can shortcut directly to the LEC destination for traffic in that direction.

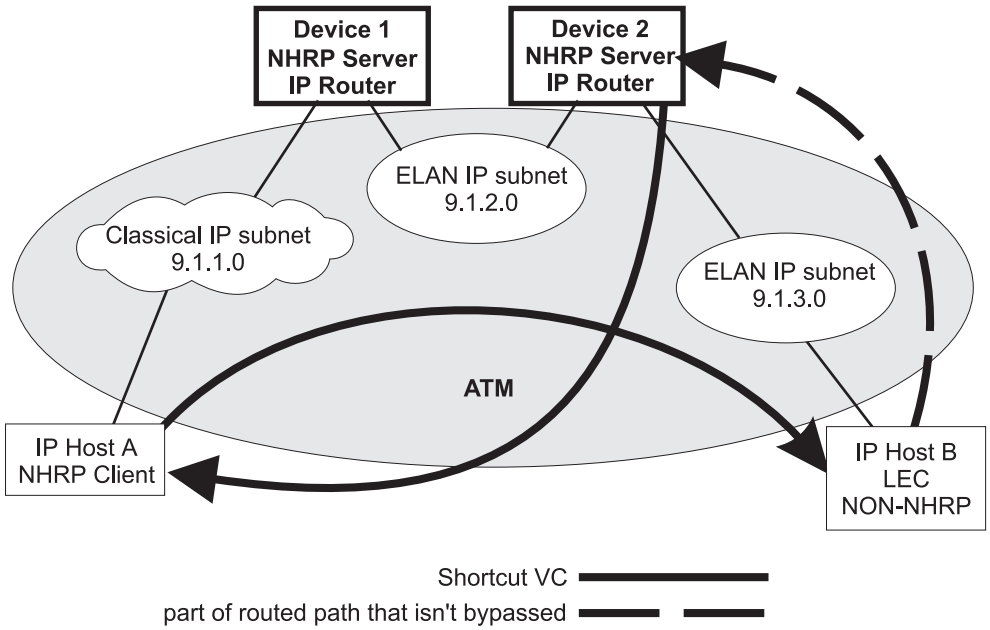

Figure 32-6. NHRP in a Mixed Classical IP and ELAN Environment

NHRP to an Egress Router

The source and/or destination stations of protocol traffic do not have to belong to subnets served by NHRP participants. They may access the ATM network via routers that communicate with the NHRP devices. In this case, the MSS Server provides shortcuts through the ATM network to eliminate as many hops as possible.

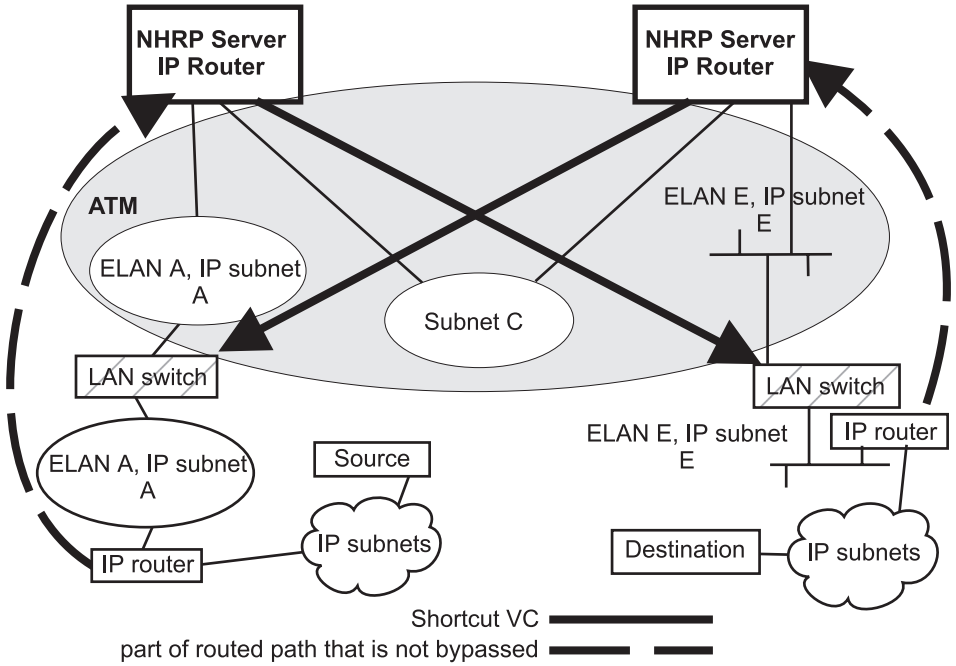

Figure 32-7. NHRP to an Egress Router

NHRP Implementation

NHRP interacts with the router function in the router. When the router function in the router is forwarding packets along the routed path and NHRP successfully obtains a shortcut VC, NHRP will update the router function to send the packet directly over the shortcut VC.

NHRP updates the routing function's forwarding table after the VC is up. This allows the switch from routed path to the shortcut path to occur without any packet loss.

When an NHRP shortcut is used, the router transmits frames to a next hop address on a subnetwork that the router itself is not a part of. So the NET, or interface, that provides the outbound path for the traffic is called a "virtual" network interface.

Virtual Network Interface (VNI)

Normally, outbound packet flow from a router is constrained by the following:

- Inability to send packets directly to network addresses that are not defined on a network interface.
- Inability to send packets to network types (for example, token-ring ELAN) unless that network type is defined on a network interface.

The Virtual Network Interface (VNI) net-handler removes all of these constraints, which allows the router to forward packets directly to next hops obtained via NHRP (shortcut routes). It enables one-hop routing, where NHRP shortcut routes can be made directly to devices that do not support NHRP.

The VNI supports token-ring, Ethernet V2 and Ethernet DIX ELAN network interfaces and classic IP network interfaces. When the outbound path is to use a classic IP (1577) interface, the implementation actually uses the existing 1577 net-handler interface for the VNI. However, when the outbound path is to use a LANE shortcut, a unique interface is accessed. This is called the LANE Shortcut Interface (LSI). The LSI is different from a traditional LEC interface because it can provide more than one LAN encapsulation type; that is, one VC may be established using token-ring encapsulation while another uses Ethernet V2. Also the LSI provides connections to more than one Emulated LAN; a traditional LEC interface connects to only one ELAN.

When you enable NHRP, an LSI is created for each ATM adapter. The LSI is assigned the next available interface number, and will be listed when you invoke console functions that display information about the router interfaces.

LANE Shortcut Interface (LSI)

The LANE shortcuts provided by the IBM extensions to NHRP are not compatible with some LAN Emulation Client (LEC) and end-station protocol stack implementations. This section describes how these incompatibilities can arise and, in some cases, how they can be overcome using configuration options.

Paranoid LECs are devices that use the LAN Emulation Flush Protocol to verify that clients setting up Data Direct VCCs to it are actually members of its ELAN. These devices will not work with NHRP shortcuts generated by LSIs since the LSI is not part of the target ELAN.

Note: The “Exclude List” configuration option can be used to prevent shortcuts to Paranoid LECs as described in “Exclude Lists” on page 32-10.

By default, the LSI will use the MAC address burned into the associated ATM adapter as the source MAC address of frames transmitted over the LANE shortcut VCCs. It is possible, though unlikely, that this could confuse some end-station protocol stack implementations, since the MAC address will not match that of the router that the end-station uses as a gateway to transmit packets to the associated IP address.

For this to happen, the end-station would have to learn router MAC addresses from unicast IP frames which is not normal (IP-to-MAC address mappings are normally learned from ARP packets). If this were to happen, the end-station might use the learned MAC address as the destination MAC address of frames that it transmits to the associated IP destination instead of using the MAC address of the router. Such frames would either be dropped or forwarded over the LANE shortcut VCC. Forwarding would only occur if the LEC learns MAC-to-ATM address binding from received frames (which is an optional implementation choice).

In either case, these frames will not reach the destination since the LSI discards frames received over a LANE shortcut VCC. Furthermore, the LSI releases the LANE shortcut VCC and no further shortcuts will be established to the associated ATM address. Traffic for destinations associated with that ATM address will follow

the routed path thereafter. Note that ELS messages and console display for LANE shortcuts aid in identifying these destinations.

The LSI can be configured not to use the universally administered MAC address as the source MAC address. With this option, you have two choices for the source MAC address:

1. You can use the MAC address of the last-hop router, provided in the NHRP resolution reply packet, as the source MAC address.

   Using the last-hop router's MAC address as the source MAC address solves the problem of end-station protocol stack confusion but introduces another potential problem. It may confuse LECs that learn MAC-to-ATM address binding from received frames, and therefore should not be used with LECs that perform this type of learning. For example, the LEC in IBM's 8281 ATM-LAN bridge performs this type of learning.

2. You can configure the source MAC address.

   The source MAC address can be configured to avoid the problem of duplicate MAC addresses seen on an ELAN because of inter-ELAN shortcuts. The MAC address should be configured for this LSI network when there are any disallowed LANE shortcut entries. See "LANE Shortcuts" on page 33-15 for details on displaying disallowed LANE shortcut entries.

These configuration options are provided to maximize flexibility in achieving compatibility with the largest possible set of destinations in a given installation. See "Configuring the LANE Shortcuts Interface (LSI)" on page 32-14 for further information and "Change" on page 33-6 for a description of the **change** command.

Configuration Parameters

This section describes some of the NHRP related configuration parameters and their recommended usage. See "NHRP Configuration Commands" on page 33-1 for command syntax, command parameters, valid values and default values.

NHRP Auto-Configuration

NHRP is enabled by default if IP is present in the box. It can be disabled by entering the **disable NHRP** command from the `NHRP config>` prompt. See "Accessing the NHRP Configuration Process" on page 33-1 for additional information.

When using an existing configuration file, NHRP is enabled by default if it was not previously configured. The configuration file will be automatically updated at runtime to create NHRP shortcut interfaces. You need to save this updated configuration file and reboot in order for the NHRP client to use LANE shortcuts.

Exclude Lists

Configuration allows you to create a list of protocol addresses (and associated masks) that represent two types of devices:

- Next-hop routers that do not contain an NHRP server function
- Destination devices to which shortcut VCs should not be allowed

Next-hop Routers: The exclude list can be used to identify routers that are on the routed path but do not support NHRP server function.

The server responds to a Next Hop Resolution Request by providing the ATM address of the next-hop router when all of the following are true:

- The next-hop address is different from the destination address.
- The router interface to the next-hop router is either an ATM classical IP or an ELAN subnet.
- The next-hop address is in the exclude list.

In processing the request, the router does not forward the Resolution Request on to the next-hop address, but responds to the client with addressing information that allows the client to establish a shortcut VC to the next-hop router.

Note: If the next-hop router is one of the Disallowed R2R Shortcuts, the router sends a NAK to the Resolution Request instead of a positive reply.

In general, if the next-hop router is on the exclude list, the router does not send it any NHRP packets that would only be handled by an NHRP server.

Destination Devices: The exclude list can also be used to prevent shortcut VCs to a given protocol address (for example, a device on a CIP or ELAN subnet that can support only a small number of VCs).

When processing a Next Hop Resolution Request for a destination device, the server responds to the client with addressing information that allows the client to establish a shortcut VC to the router itself when all of the following are true:

- The next-hop address equals the destination address.
- The router interface to the destination is either an ATM classical IP or an ELAN subnet.
- The destination address is in the exclude list.

Extensions

The NHRP protocol includes **Extensions**. Extensions are appended to NHRP packets. Extensions are used to request additional functions from the NHRP participants. The use of the **extensions** parameter lets you determine if the router sends certain extensions:

- path information extensions
- IBM vendor-private extensions

Path Information Extensions: Three extensions are defined in NHRP to provide path information. These extensions can be used to help monitor the request itself, to determine the path taken by the request, to determine who generated the reply, and the path taken by the reply. The path information extensions are:

- Forward Transmit - Each Next-Hop Server (NHS) that forwards the request along the way should append information about itself.
- Responder Address - The Next-Hop Server (NHS) that generates the reply should append information about itself.
- Reverse Transmit - Each Next-Hop Server (NHS) that forwards the reply along the way should append information about itself.

The router can be configured to send any or all of these extensions in Next Hop Resolution Request packets that it generates. The information received in the reply packets is displayed in the router's NHRP ELS messages.

IBM Vendor-Private Extensions: To support NHRP in an Emulated LAN environment, the server adds vendor-unique extensions to NHRP packets. Three of these extensions act as "queries"; the NHRP client places them in the Next Hop Resolution Request. If the server supports this function, it responds with three corresponding extensions containing ELAN address information (MAC address, ATM address and Routing information); these extensions are included in the Next Hop Resolution Reply.

The router can be configured so that it does not support the IBM-specific extensions. If the IBM specific extensions are not used, shortcuts directly to ELAN devices are not possible. Use the "Exclude List" option to disallow shortcuts selectively to certain ELAN devices.

Disallowed Router-to-Router Shortcuts

Operation of NHRP may result in establishing transit paths across NBMA network between routers. However, establishing an NHRP shortcut across a boundary where information used in route selection is lost may result in a routing loop. Such situations include the loss of BGP path vector information, and the interworking of multiple routing protocols with dissimilar metrics. Under such circumstances, NHRP shortcuts between routers should be disallowed. This situation can be avoided if there are no "back door" paths between the entry and egress router outside the NBMA network.

The server allows router-to-router (R2R) shortcuts by default. However, by configuring disallowed R2R shortcuts, you can create a list of destination or router addresses for which the router does not allow shortcuts.

To create a disallowed R2R shortcut, you must specify both a protocol address and a mask. The protocol address is either the destination or a router, and the mask allows for a range of addresses.

To illustrate how to specify disallowed R2R shortcuts using protocol addresses and masks, consider the following network diagram:

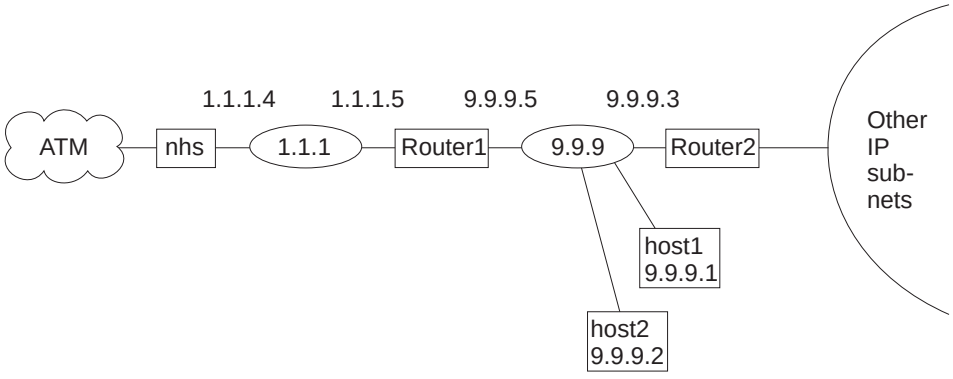

Figure 32-8. Using Disallowed Router-to-Router Shortcuts

Example 1: An entry with *address=9.9.9.1 mask=255.255.255.255* would cause the NHS to send a NAK to the sender of a Next Hop Resolution Request

with destination protocol address 9.9.9.1 (HOST1). Since 9.9.9.1 is not directly attached to one of the device subnets, but is reached by another router, the router checks the Disallowed R2R Shortcuts List.

Example 2: An entry with *address=9.9.9.0 mask=255.255.255.0* would cause the router to send a NAK for any destination address 9.9.9.1 through 9.9.9.255. HOST1, HOST2, and ROUTER2 could not be reached using shortcuts to the router but devices on the other subnets serviced by ROUTER2 could be reached.

Example 3: An entry with *address=1.1.1.5 mask=255.255.255.255* would cause the router to respond negatively for any destination whose next-hop router is 1.1.1.5, ROUTER1. The router would respond negatively for any address on subnet 9.9.9 and for any address on the other IP subnets reached via router 9.9.9.3 because next hop is 1.1.1.5.

Example 4: An entry with *address=anything mask=0.0.0.0* would disable R2R shortcuts for all addresses.

Protocol Access Control Usage

This parameter determines if the protocol layer access controls will be checked and, if so, how these controls will be applied to NHRP packets.

If this configuration parameter is set to its default value of *none*, the protocol layer access controls are not checked.

With the value of *source and destination*, when the NHRP requester is not a router, the NHRP client's IP address is assumed to be the source of all IP packets that will be transmitted by that client using the NHRP shortcut route. The router denies NHRP shortcut requests from a non-router NHRP client if any IP packets are being filtered for that IP destination/source address pair, where the source is the NHRP client's address.

Selecting the *destination only* option causes the router to deny shortcut requests from any NHRP client if any IP packets are being filtered to the destination address. If NHRP clients should not be trusted, *destination only* should be selected. *destination only* might be the best option when NHRP clients are non-routers with multiple IP addresses or non-router clients that transmit packet that originate from other sources.

NHRP clients that reside in the routers use the NHRP shortcut routes to forward packets from other sources: therefore, if *source and destination* is configured and the router receives a shortcut request from a router, the router applies the IP filters the same way as when *destination only* is selected.

NHRP Access Controls

NHRP access controls for denying shortcuts to certain IP addresses may be defined by adding those addresses to both the exclude list and disallowed-router-to-router shortcuts.

ATM Network ID

Since an server may have more than one ATM adapter, it may be connected to two different or unassociated networks. This must be considered when deciding when shortcut VCs should be allowed.

You can determine which interfaces should be treated as if they are connected to the same physical ATM network by assigning each ATM interface a Network-ID by using the **set** command at the `ATM Interface Config>` prompt as described in the "Using and Configuring ATM" chapter in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide*

ATM interfaces with the same Network-ID are considered to belong to the same network. By default, all ATM interfaces are assigned to Network-ID 0.

Configuring the LANE Shortcuts Interface (LSI)

The NHRP LANE Shortcut Interface (LSI) is automatically created for each ATM adapter when NHRP is enabled for the router. The LSI uses default values for the following parameters.

- ESI
- Selector
- Use Best Effort Service for Data VCCs
- Peak Cell Rate of outbound Data VCCs
- Sustained Cell Rate of outbound VCCs
- Use ATM adapter's universally administered MAC address for source

The default values may be modified using the **change** command from the `NHRP Advanced config>`prompt. See "Change" on page 33-6.

Configuring Devices in an ATM Network

If you have a NHRP client/server and its configuration requires you to give the ATM address of the router NHRP server, you must select the proper ATM address. You must use an address associated with an "ATM interface" in the device, and an IP address must be assigned to this interface. The last two digits of the router ATM address, the selector, are assigned dynamically after the router is activated (and may change if the configuration of the router changes), unless you have configured a specific selector.

You can specify the ATM address, including selector, by entering **prot arp** at the talk 6 Config> prompt, followed by **add atm**, giving the desired IP address and then specifying a selector. This is the same procedure used to define an ATMARP client.

Using NHRP with LAN Emulation

If you want to use NHRP on the device, you must configure all LECs with a unique locally administered MAC address (LAA). If you do not configure the LECs with unique LAAs, the NHRP shortcut capability to the corresponding switch or device will not work because:

- Traffic sent over an NHRP LANE shortcut VCC will contain the router Universally Administered (universally administered) MAC address as the source MAC address.
- Some network devices learn the association between the MAC address and the VCC from traffic the device has received. These devices then use the NHRP VCC to transmit data.

- If the router detects incoming traffic on an NHRP VCC, it will assume that an error condition has occurred and will shut down that VCC, preventing any further shortcuts to that network device.

Note: By default, the router enables IBM LAN Emulation Extensions on NHRP, so you must either disable the extensions or configure the unique locally administered MAC address for each LEC.

Route Switching Overview

Route Switching refers to mechanisms that allow legacy LAN-attached stations to participate in NHRP and achieve a layer-3 router-free (zerohop) path across the NBMA network. Legacy LAN-attached stations require MSS Route Switching client function to resolve a layer-3 network address to a layer-2 MAC address for zerohop routing.

Before enabling Route Switching, see “Route Switching Configuration Requirements” on page 32-20 and “Interoperability Issues” on page 32-17. If these requirements are not met, network connectivity and interoperability problems can result.

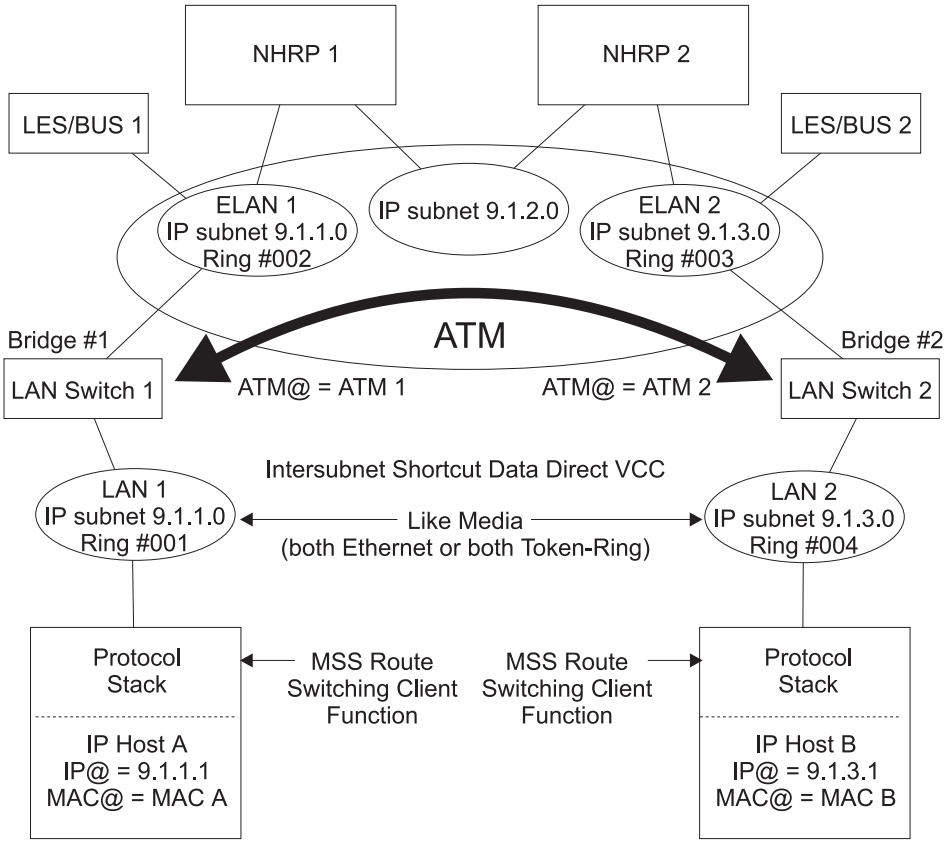

Figure 32-9. Route Switching Overview

Figure 32-9 is an example of the following protocol description:

- During initialization, the MSS Route Switching client in a legacy LAN-attached station discovers the MAC address of the NHRP server that is also its default router.

- When inter-subnet traffic is being forwarded to the router's MAC address, the MSS Route Switching client issues an NHRP Resolution Request to determine the Layer 2 information associated with the destination protocol address. The Layer 2 information consists of the destination MAC address, and for token-ring networks, the RIF. The example assumes that IP Host A issues an NHRP Resolution Request to determine the Layer 2 information associated with IP Host B.
- The NHRP server on the source ELAN (ingress server) communicates by using other NHRP servers along the routed path to the destination and obtains the necessary information from the server on the destination ELAN (egress server). NHRP Server 1 obtains the Layer 2 information (MAC B and the RIF from NHRP Server 2 to IP Host B) and the ATM address from NHRP Server 2.
- The ingress NHRP Server replies to the MSS Route Switching client with the Layer 2 information associated with the destination protocol address specified in the NHRP Resolution Request. The NHRP Resolution Reply to IP Host A contains MAC B and the RIF from IP Host A to IP Host B. This RIF is a concatenation of the RIF from IP Host A to NHRP Server 1, a virtual route descriptor and the RIF from NHRP Server 2 to IP Host B. The ingress server registers the virtual route descriptor to ATM address binding with the LES/BUS, if necessary.
- The MSS Route Switching client caches the supplied Layer 2 information to build the data link header for frames transmitted to the associated destination protocol address. In the example, this means that IP Host A uses MAC address B and the RIF from IP Host A to IP Host B in the data link header for frames transmitted to IP address 9.1.3.1.
- Frames destined for IP Host B are then delivered using the normal Layer 2 procedures, which result in a shortcut VCC between the edge devices. In the figure, the LEC in LAN Switch 1 issues an LE_ARP request for the next-route-descriptor (which is the virtual route descriptor in the RIF) and receives the ATM address of LAN Switch 2 in the LE_ARP response. LAN Switch 1 then establishes a data direct VCC with LAN Switch 2.
- The MSS Route Switching client refreshes active cache entries by sending out NHRP resolution requests before the hold time provided by the server expires. This prevents the ingress NHRP server from aging out and unregistering active destinations with the LES/BUS.

Route Switching Client software for different platforms and media types can be downloaded from **http://www.networking.ibm.com/nes/neshome.html**

Benefits of Route Switching

Route Switching:

- Can improve end-to-end network performance by eliminating all router hops in the data path.
- Imposes no special requirements (unlike MPOA) on the edge devices.
- Allows the legacy LAN-attached MSS Route Switching client to automatically discover its server.

Limitations of Route Switching

Route Switching is restricted to:

- Same media types at the packet source and destination.
- Same bridging types on the source and destination ELANs (transparent bridging only or source-routed bridging only)
- IP protocol only

When multiple devices are attached to the same ingress ELAN, the Route Switching client may use the routed path (instead of a shortcut) to destinations that are already registered with the LES/BUS by another device or to destinations that belong to the same ELAN as the Route Switching client.

Performance Characteristics of Route Switching

Route Switching is used during initial contact from a source station to a destination. Once a layer-2 path has been established, the Route Switching protocol is no longer involved in the actual data transfer, so network performance is unaffected by Route Switching.

Interoperability Issues

Route Switching requires a Release 2.0 LES/BUS implementation on the ingress ELAN.

When shortcut Data Direct VCCs are established between inter-ELAN edge devices as a result of Route Switching, the LECIDs may conflict. Certain edge devices may drop packets if the LECID in the received packet is the same as its own. This can be avoided by configuring a unique LECID range at each LES/BUS. Refer to the chapter entitled “Configuring LAN Emulation Services” in the *Software User's Guide* for additional information about LES/BUS.

Some edge devices filter traffic based on MAC addresses or other policies. Route Switching must not be enabled in these situations since the inter-ELAN packets over the shortcut VCC between the edge devices may be dropped.

Examples of Route Switching Configurations

The following figures are examples of Route Switching configurations.

Route Switching in Both Directions

In Figure 32-10 on page 32-18, the MSS Route Switching clients in the end stations communicate with their default routers over an ELAN. They use NHRP to learn about each other’s Layer 2 information. When traffic is sent using the end station’s Layer 2 information in the data link header, the LAN switches establish a shortcut VCC.

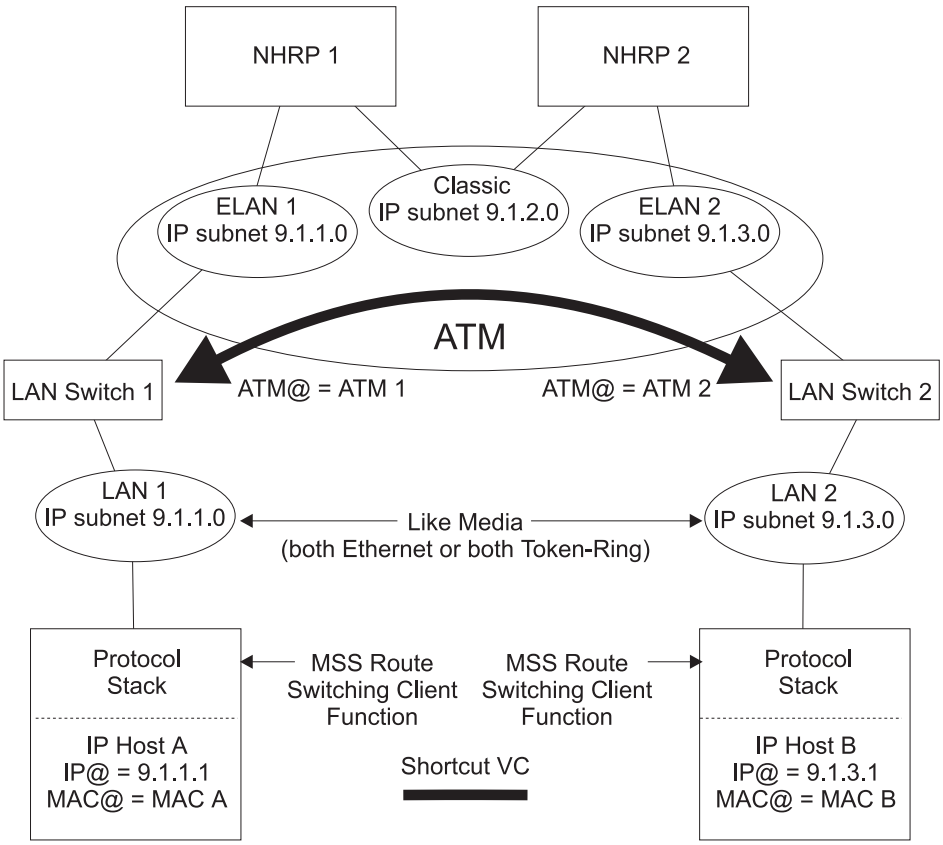

Figure 32-10. Route Switching in Both Directions

Route Switching in One Direction

Figure 32-11 on page 32-19 illustrates how route switching can be used between two end stations when one of them does not support the MSS Route Switching client function. In this configuration, NHRP Server 2 provides the Layer 2 information and the ATM address associated with the non-NHRP end station. The MSS Route Switching client can then establish a zerohop path for traffic to the non-NHRP host. However, traffic from the non-NHRP host flows on a routed path to the NHRP Server 2.

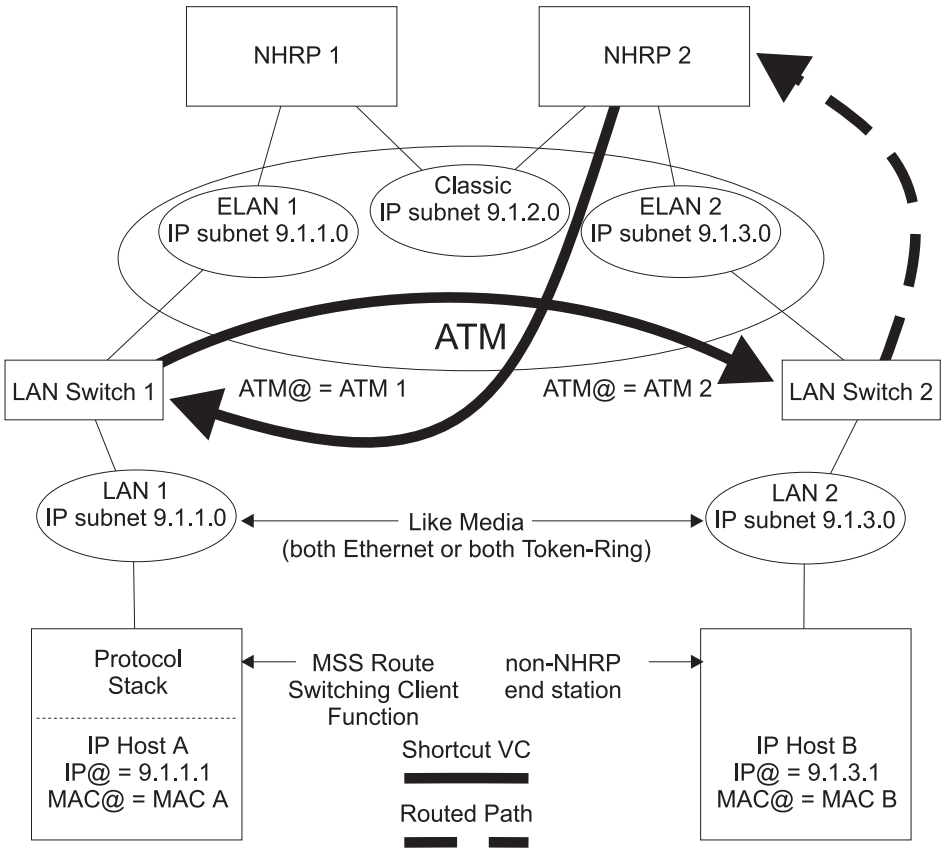

Figure 32-11. Route Switching in One Direction

Route Switching in a SuperELAN Bridged Environment

In Figure 32-12 on page 32-20, ELAN 1 and ELAN 2 are part of a SuperELAN bridged network. A shortcut VCC is used for traffic in both directions.

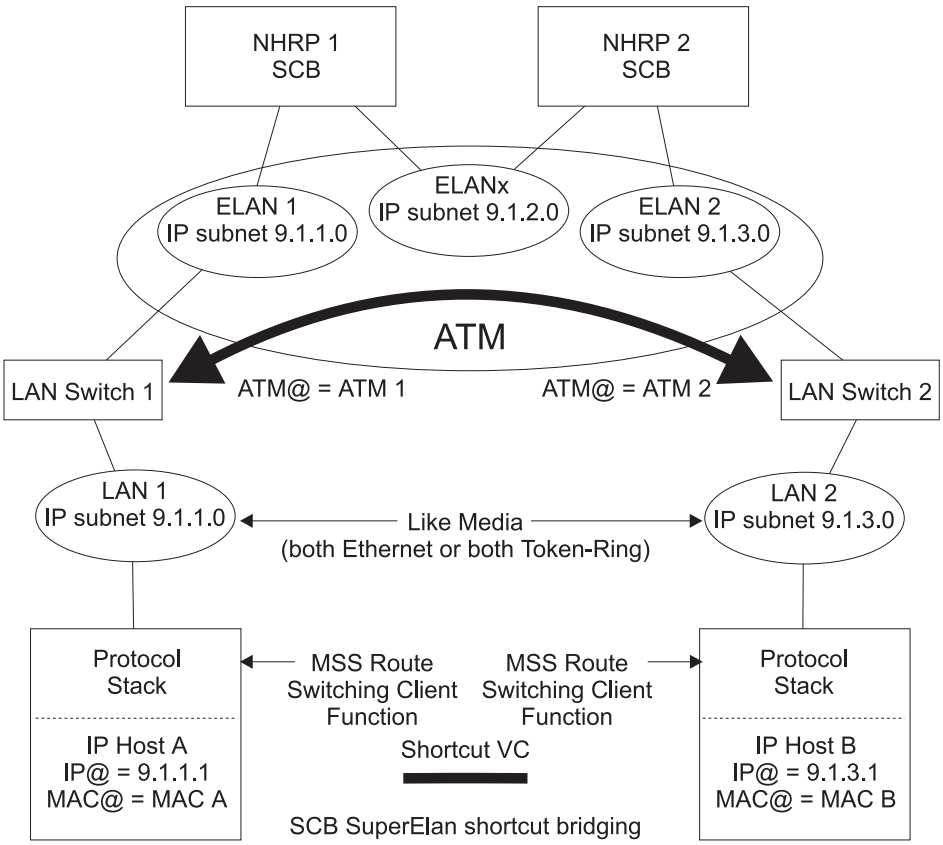

Figure 32-12. Route Switching in a SuperELAN Environment

Route Switching Configuration Requirements

Each of the following network configurations apply to all data paths between the Route Switching destinations and the LAN/ELANs where the Route Switching clients reside.

Note: Route-Switching is not supported in routed mode when the MSS Server's LES/BUS **bus-mode** is set to *VCC-Splice*.

SuperELAN Bridged Network

Route Switching may be enabled when the NBMA network is SuperELAN bridged. In this configuration, certain protocols like NetBIOS and SNA may be bridged, while IP may be routed. By enabling route switching, inter-subnet IP traffic will be shortcut switched. The *Mode_for_Route-Switching* configuration parameter must be set to *bridging*.

Routed Network

Route Switching may be enabled when the NBMA network is being used solely for layer-3 routing of inter-ELAN traffic (there is no bridged inter-ELAN traffic). By enabling route switching, inter-subnet IP traffic will be shortcut switched. The *Mode_for_Route-Switching* configuration parameter must be set to *routing*.

Route Switching must be disabled if inter-ELAN traffic also consists of any bridged protocols, unless the bridged protocols are source-route bridged. For token-ring networks, the ring numbers on the ingress and egress sides must be unique.

Transparent Bridged Network

Route Switching must be disabled in a traditional transparent bridged NBMA network.

Source-Route Bridged Network

Route Switching may be enabled in a token-ring source-route bridged NBMA network. In this configuration, certain protocols like NetBIOS and SNA may be bridged, while IP may be routed. By enabling route switching, inter-subnet IP traffic will be shortcut switched. If the network is a superELAN, the *Mode_for_Route-Switching* configuration parameter must be set to *bridging*. Otherwise, it must be set to *routing.*

Chapter 33. Configuring and Monitoring NHRP

This chapter describes how to configure and monitor the Next Hop Resolution Protocol (NHRP). For a description of this protocol, refer to “Next Hop Resolution Protocol (NHRP) Overview” on page 32-1.

This chapter contains the following sections:

- “Accessing the NHRP Configuration Process”
- “NHRP Configuration Commands”
- “Accessing the NHRP Monitoring Process” on page 33-12
- “NHRP Monitoring Commands” on page 33-12
- “NHRP Packet Tracing” on page 33-18

Accessing the NHRP Configuration Process

To access the NHRP configuration:

1. At the operator monitoring prompt (*), type **talk 6** and press enter.
2. At the `config>`prompt, type **protocol mpoa** and press enter.
3. At the `MPOA config>` prompt, type **nhrp** and press enter.
4. The `NHRP config>` prompt is displayed.

Route Switching configuration commands can be accessed from the `NHRP Advanced config>` prompt. See “Advanced Config” on page 33-2.

NHRP Configuration Commands

This section explains all of the NHRP configuration commands as shown in Table 33-1. Enter the commands at the `NHRP config>` prompt.

Table 33-1. NHRP Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Enable NHRP	Turns on NHRP for all interfaces that are not explicitly defined.
Disable NHRP	Turns off NHRP for all interfaces that are not explicitly defined.
List	Displays the NHRP configuration.
Advanced config	Gets you to the `NHRP Advanced config>` prompt, from which you can enter other commands as described in “NHRP Advanced Configuration Commands” on page 33-3.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

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Enable NHRP

Use the `enable` command to enable NHRP on all interfaces not explicitly defined using an NHRP advanced config command. It is a simple way to get NHRP up and running with default parameters.

Syntax:

enable NHRP

Disable NHRP

Use the `disable` command to disable NHRP on all interfaces not explicitly defined using an NHRP advanced config command.

Syntax:

disable NHRP

Example:

```
NHRP config> disable
  Disable NHRP for the router [No]:
```

Advanced Config

Use the **advanced** command to get to the NHRP advanced configuration prompt, `NHRP Advanced config>`. From this prompt, you can enter the commands described in “NHRP Advanced Configuration Commands” on page 33-3.

Syntax:

advanced NHRP

Example:

```
NHRP config> advanced
  NHRP Advanced config>
```

Note: Most installations will not need to use this “advanced” command. The **enable NHRP** command is sufficient to enable NHRP with recommended default options.

List

Use the **list** command to list the NHRP configuration.

Syntax:

list

Example:

```
NHRP config> list
  Box level NHRP enabled
    Explicit interface definitions override box level setting

  Interfaces explicitly defined for NHRP
  --------------------------------------
   Interface 0: ATM
     NHRP enabled

  NHRP LANE Shortcut Interface:
  -------------------------------------------------
   Interface: 1  ESI: burned-in          Sel: auto
   Use Best Effort: no   (Data)
   Cell Rate(kbps):  Peak: 155000    Sustained: 155000
   ATM adapter's burned-in MAC address is used as source address

  General Parameters
  ------------------
   Holding time:                          20 minutes
   Protocol Access Controls:              Use source and destination   address
   When should NHC attempt shortcuts?:    Based on datarate
      Data-rate threshold:                10 packets/second
   NHS allows shortcuts to ATMARP clients?: Yes

  Cache Sizes
  -----------
   Resolution cache:           512 entries
   Server purge cache:         512 entries
   Server registrations cache: 512 entries

  Extension Usage
  ---------------
   Use NHRP Forward transit NHS record client extension: No
   Use NHRP Reverse transit NHS record client extension: No
   Use Responder Address client extension:               No
   Use LANE shortcuts extension:                         Yes

  Route-Switching Parameters
  ----------------------------------
  Route-Switching:                              Disabled
  Route-Switching domain operating in mode:     Bridging
  Starting virtual segment for Route-Switching: 3840
  Number of segments reserved for Route-Switching  255

  List of NHRP IP exclude records
  -------------------------------
    # Address         Mask
    1 6.6.6.6         255.255.255.255
    2 5.5.5.0         255.255.255.0

  Disallowed router-to-router shortcuts for IP
  --------------------------------------------
     None
```

NHRP Advanced Configuration Commands

This section explains all of the NHRP advanced configuration commands as shown in Table 33-2 on page 33-4. Enter the commands from the `NHRP Advanced config>` prompt.

Table 33-2. NHRP Advanced Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Add	Adds an NHRP interface, exclude list, or disallowed R2R shortcuts.
Change	Changes an NHRP interface, or changes a LANE shortcut interface definition.
Delete	Deletes an NHRP interface, exclude list, or disallowed R2R shortcuts.
List	Displays the NHRP configuration.
Set	Sets NHRP parameters.
Enable-route-switching	Enables route switching.
Disable-route-switching	Disables route switching.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Add

Use the **add** command to add an explicit interface definition, an exclude list entry, or disallowed router-to-router shortcuts.

Syntax:

add interface definition
exclude list
disallowed router-to-router shortcuts

interface definition

Adds an explicit interface definition to either enable or disable an NHRP interface. If NHRP is disabled on a particular network interface, NHRP packets are not forwarded to any routers that are reached via that interface. Also, incoming NHRP frames are discarded.

Note: Any explicit interface definitions override the “NHRP enabled/disabled” box-level setting.

Example: **`add int`**

```
Interface Number [0]?
Enable NHRP [Yes]:
```

exclude list

Adds an exclude list entry. Specify a protocol address which must be excluded from the NHRP network. This option adds an exclude list entry and prompts you to add the exclude list entry to the disallowed router-to-router shortcuts. See “NHRP Access Controls” on page 32-13 for more information.

Valid values: IP address and mask.

Default: Empty.

Example: **add exc**

```
IP Address [0.0.0.0]? 6.6.6.5
Address Mask [255.255.255.255]?
Deny Shortcuts[Yes]?
Record added to Disallowed Router-to-Router Shortcuts
Record added to Exclude List
```

disallowed router-to-router shortcuts

Adds a router protocol address to which shortcuts are not allowed.

See "Disallowed Router-to-Router Shortcuts" on page 32-12 for more information.

Example: **add dis**

```
IP ADDRESS [0.0.0.0]?  8.8.8.1
Address Mask [255.255.255.255]?
```

Valid values: IP address and mask.

Default: Empty.

Delete

Use the **delete** command to delete an interface definition for NHRP, an exclude list entry, or disallowed router-to-router shortcuts.

Syntax:

delete interface definition for NHRP
exclude list
disallowed router-to-router shortcuts

interface definition for NHRP

Deletes an explicit NHRP interface definition.

Example: **del int**

```
Interface Number [0]?
```

exclude list

Deletes an exclude list entry. This option deletes an exclude list entry and prompts you to delete the entry from the disallowed router-to-router shortcuts. See "NHRP Access Controls" on page 32-13 for more information.

You must specify an index which must be deleted. Use the **list exclude** command to determine the right index.

Example: **del exc**

```
Enter index of access control to be deleted [1]?
# Address          Mask
1 6.6.6.6          255.255.255.255
Are you sure this the record you want to delete  [Yes]?
Record deleted from Exclude List
Delete from Disallowed Router-to-Router Shortcuts [Yes]?
Record deleted from Disallowed Router-to-Router Shortcuts
```

disallowed router-to-router shortcuts

Deletes a disallowed router-to-router shortcuts entry. You must specify an index to be deleted. Use the **list disallowed** command to determine the right index.

Example: **del dis**

```
Disallowed shortcuts index [1]?
```

Change

Use the **change** command to modify NHRP interface definitions.

Syntax:

ch**ange** interface definition
nhrp lane shortcut interface

interface definition for NHRP

Change an explicit interface definition to either enable or disable an NHRP interface.

Example: **ch int**

```
Interface Number [0]?
Enable NHRP [Yes]:
```

NHRP LANE shortcut Interface

Change a LANE shortcut interface definition.

Example: **ch nhrp**

```
Interface Number of NHRP LANE Shortcut Interface [0]?
(  1) Use burned in ESI
Select ESI [1]?
Use internally assigned selector? [Yes]:
Use Best Effort Service for Data VCCs? [Yes]:
Peak Cell Rate of outbound Data VCCs (Kbps) [0]?
Sustained Cell Rate of outbound Data VCCs (Kbps) [0]?
Use ATM adapter's burned-in MAC address for source?
```

Interface Number of NHRP LANE Shortcut Interface

Use the interface number assigned to the LSI. The interface number can be determined by using the **list interface** command.

(1) Use burned in ESI

Use universally administered ESI as part of the ATM address. You may be given other choices depending upon your configuration.

Select ESI

Specify the ESI.

Use internally assigned selector

Use internally assigned selector or assign a selector in the range 00 to FF.

Use Best Effort Service for Data VCCs

Specifies the type of traffic characteristics to be associated with Data VCCs. Bandwidth is not reserved for best effort traffic.

Peak Cell Rate of outbound Data VCCs (kbps)

Specifies the Peak Cell Rate (PCR) traffic parameter for the Data VCCs.

Sustained Cell Rate of outbound Data VCCs (Kbps)

Specifies the Sustained Cell Rate (SCR) traffic parameter for the Data VCCs.

Use ATM adapter's burned-in MAC address for source?

You can use as the source MAC address for LANE shortcuts:

1. The adapter's universally administered MAC address

2. The MAC address supplied in the NHRP resolution reply
3. The MAC address you configured by specifying a MAC address using the **change nhrp** command.

See “ATM and LAN Emulation” in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide* for further information.

Note: It is recommended that you use the default values until you have determined the specific processing options required by your environment.

List

Use the **list** command to display the NHRP configuration information.

Syntax:

list all
exclude list
disallowed router-to-router shortcuts
interface definitions
cache size
route-switching

all Displays the entire NHRP configuration.

Example: `li all`

Output is the same as for the **list** command. See “List” on page 33-2.

exclude list

Displays the exclude list entries.

Example: `li exc`

```
List of NHRP IP exclude records
-------------------------------
  # Address         Mask
  1 7.7.7.7         255.255.255.255
```

disallowed router-to-router shortcuts

Displays disallowed router-to-router shortcuts.

Example: `li dis`

```
Disallowed router-to-router shortcuts for IP
--------------------------------------------
  1 8.8.8.1         255.255.255.255
  2 6.6.6.1         255.255.255.255
```

interface definitions

Displays the NHRP interface definitions.

Example: `li int`

```
Interfaces explicitly defined for NHRP
--------------------------------------
   None

NHRP LANE Shortcut Interface:
-----------------------------------------------------
Interface: 3  ESI: burned-in          Sel: auto
Use Best Effort: yes  (Data)
Cell Rate(kbps):  Peak:      0/     0    Sustained:   1000/538764944
MAC address supplied by NHS is used as source address
```

cache size

Displays cache sizes.

Example: **`li ca`**

```
Resolution cache size is 1024 entries.
Server purge cache size not configured, default is 512 entries.
Server registrations cache size is 256 entries.
```

route-switching

Displays route-switching parameters.

Example: **`li ro`**

```
Route-Switching Parameters
--------------------------------
Route-Switching:                              Disabled
Route-Switching domain operating in mode:     Bridging
Starting virtual segment for Route-Switching: 3840
Number of segments reserved for Route-Switching  255
```

Set

Use the **set** command for the following:

Syntax:

set protocol access control usage
attempt shortcuts
holding time
data-rate threshold
extensions ...
cache size ...
shortcuts to atmarp clients
mode-for-route-switching
segment-range-for-route-switching

protocol access control usage

Determines if the IP access controls will be checked and, if so, how these controls will be applied to NHRP packets. See “Protocol Access Control Usage” on page 32-13 for more information.

Example: **`set prot`**

```
Use (Destination, Source & Destination, None) [None]?
```

Valid Values: None, Source and Destination, Destination

Default Value: None

attempt shortcuts

Determines how the NHRP client decides when to originate resolution requests.

Valid values: Y, N, Data-rate.

Y Yes. Always try to establish a shortcut VC by building a Next Hop Resolution Request and sending it to the next hop station.

N No. Never try to establish a shortcut. Using this option essentially disables the client function in the router. This setting might be used in an intermediate router (one that is not an entry point into the NBMA network for routed traffic) to eliminate the “domino effect,”

where traffic following the routed path triggers NHRP Resolution Requests at each NHRP router along the path.

Data-rate
Try to establish a shortcut only after the datarate threshold is reached.

Note: This setting can prevent the creation of VCCs for "one-time" traffic, such as SNMP traps that are sent to an SNMP manager.

Default: Data-rate.

Example: **`set attempt`**

```
Try shortcut VCs? (Yes, No, Data-rate) [Data-rate]?
```

holding time
Sets the holding time in minutes.

The holding time parameter is used for these functions:

- When the router responds to a Next Hop Resolution Request with information about itself (that is, the router is to become the next hop shortcut), the holding time is sent to the requestor as the length of time that the information can be considered valid.
- When the router responds to a Next Hop Resolution Request with information about another NBMA station that was not learned using NHRP (for example, the destination station is an ATM device with an IP address on one of the device subnets), the holding time is sent to the requestor as the length of time that the information can be considered valid.

Valid values: 1 - 60 minutes.

Default: 20 minutes.

Example: **`set hold`**

```
Holding time (in minutes)  [20]?
```

data-rate threshold
Sets the data rate threshold in packets/second.

The datarate threshold is used when the **attempt shortcuts** parameter is set to **Data-rate**.

When traffic is destined for a particular station, but the rate is less than this threshold, then the router does not attempt to establish shortcuts. (In other words, it does not generate Next Hop Resolution Requests and send them to the next hop along the routed path.) Once the traffic rate exceeds the threshold, the router tries to establish a shortcut. If it can successfully create a shortcut path, the path is used even if the traffic drops below the threshold. The path continues to be used until the traffic stops for a period of time. This is done to avoid going back and forth from the routed path to the shortcut path if traffic is sporadic.

Valid values: Minimum 1 packet/second. Maximum is 5120 packets/second.

Default: 10 packets/second.

Example: **`set data`**

```
Data-rate threshold in packets/second [10]?
```

extensions

Sets the selected NHRP extension usage to *YES* or *NO*.

Forward transmit NHS (default NO)
Reverse transmit NHS (default NO)
Responder Address (default NO)
Lane Shortcuts (default YES)

Valid Values: YES or **NO**

Example: **`set ext lane`**

```
Use LANE shortcuts extension [Yes]?
```

cache size *resolution* **OR** *registration* **OR** *server purge*

Sets the selected cache's maximum entries.

Cache sizes can be selected for any of the following:

resolution cache

This parameter lets you determine the number of entries in the cache for client functions. Each cache entry contains the protocol address-to-NBMA address mapping that can be used to create shortcut VCs. Entries are in the cache when the router has:

- Successfully resolved a protocol address to an NBMA address by sending Next Hop Resolution Requests.
- Attempted to resolve a protocol request to an NBMA address but has either not received a reply, or has received a negative reply, and the associated timer has not expired. These entries are kept in the cache to prevent the device from generating additional Next Hop Resolution Requests for some period of time.
- Received a registration request from a client and the holding time indicated in that request has not yet expired.

When the cache size is exceeded, no new attempts are made to resolve protocol addresses to NBMA addresses (in other words, no new Next Hop Resolution Requests are sent) until existing entries are purged, either because the holding time has expired or a specific purge request has been received from the originator of the information. Also, when cache size is exceeded, Registration Requests from new clients are rejected.

Valid values: 256 - 65535 entries.

Default: 512 entries.

Example: **`set cache res`**

```
Number of cache entries [512]?
```

registration cache

Sets a limit on the number of registration entries in the resolution cache. When the server receives a registration request, it checks to see if the number of NHRP client registrations is below this limit before adding a registration entry in the resolution cache.

Valid values: 256 - 16384 entries.

Default: 512 entries.

Example: **`set cache reg`**

```
Number of cache entries [512]?
```

server purge cache

This parameter lets you determine the number of entries in the server purge cache. An entry in this cache represents a destination protocol address and a client to which the server has provided Authoritative NBMA information for that destination.

The destination address may represent the server itself, devices on subnetworks to which the server is attached, NHRP clients that have registered with the server, or routers for which a R2R shortcut has been advertised. The router uses the information in these cache entries to notify clients to purge address information that becomes invalid before the holding time expires.

When the server purge cache size is exceeded, the server rejects Authoritative Next Hop Resolution Requests.

Valid values: 256 - 65535 entries.

Default: 512 entries.

Example: **`set cache serv`**

```
Number of cache entries [512]?
```

shortcuts to ATMARP clients

Allows or disallows shortcuts to ATMARP clients.

This parameter can be used to allow or disallow the server from giving out shortcuts to native ATMARP clients that do not support NHRP. This may be required if these clients are not capable of supporting large number of VCs. Use the “Exclude List” option if shortcuts need to be disallowed selectively to certain clients or subnets.

Example: **`set shortcut`**

```
Allow shortcuts to Classical IP clients?  [Yes]:
```

mode-for-route-switching

Sets the mode for route switching.

It is extremely important to set this parameter correctly so that Route-Switching mechanisms do not:

1. Interfere with other protocols running over the same ELANs
2. cause service disruption when traffic is shortcut switched

See “Route Switching Configuration Requirements” on page 32-20 to determine the right value for this parameter.

Valid values: bridging or routing

Default: bridging

Example: **`set mode-for-route-switching r`**

segment-range-for-route-switching

Reserves a range of segment numbers exclusively for route switching in source-route bridged token-ring networks. The virtual route descriptors

(RD) are selected from this range. The virtual RD is used in the merged RIF returned to the client and for registering the RD-to-ATM address mapping with the LES/BUS.

Valid values: 1 - 4095

Default: 3840 - 4095

Example: **`set segment`**

```
Starting virtual segment for Route-Switching [3840]?
Number of virtual segments reserved for Route-Switching [255]?
```

Enable_Route-Switching

Use the **enable_Route-switching** command to enable Route Switching. Route Switching will be enabled on those interfaces which have NHRP enabled.

You should enable Route Switching only if the network operating mode allows it. See “Route Switching Configuration Requirements” on page 32-20 to see if Route Switching is allowed.

Syntax:

enable_route-switching

Disable_Route-Switching

Use the **disable_Route-switching** command to disable Route Switching.

Syntax:

disable_route-switching

Accessing the NHRP Monitoring Process

To access the NHRP monitoring prompt:

1. At the operator monitoring prompt (*), type **talk 5** and press enter.
2. At the +>prompt, type **protocol mpoa** and press enter.
3. At the MPOA> prompt, type **nhrp** and press enter.
4. The NHRP> prompt is displayed.

NHRP Monitoring Commands

This section explains all of the NHRP monitoring commands as shown in Table 33-3 on page 33-13. Enter the commands from the NHRP> prompt.

Table 33-3. NHRP Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Box Status	Displays NHRP enable/disable status.
Interface Status	Displays NHRP interface status.
Statistics	Displays NHRP interface statistics.
Cache	Displays NHRP resolution cache entries.
Server_purge_cache	Displays NHRP server_purge_cache entries.
MIB	Displays MIB information.
LANE Shortcuts	Displays LANE shortcut entries.
CONFIG Parameters	Displays, changes or resets NHRP configuration information.
Reset	Dynamically reconfigure NHRP interfaces or protocol.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Box Status

Use the **box status** command to display NHRP status as configured for the box (for example, all interfaces not explicitly defined).

Syntax:

b**ox-status**

Example:

```
box status

Box level NHRP is ON by config
```

Interface Status

Use the **interface status** command to display NHRP status on interfaces.

Syntax:

in**terface-status**

Example:

```
interface status

Interface 0: UP  (NHRP enabled)
Interface 1: UP  (NHRP disabled)
Interface 2: DOWN
Interface 3: UP  (NHRP LANE Shortcut Interface)
```

Statistics

Use the **statistics** command to display NHRP statistics for all interfaces or for a specific interface.

Syntax:

s**tatistics** all
interface

all Lists NHRP statistics on all interfaces.

Example: statistics all

Output is the same as that for the **statistics interface** command as shown in the following example.

interface Lists NHRP statistics on a specified interface.

Example: `statistics interface`

```
Interface number [0]? 0

Statistics for Interface 0
--------------------------
Field Description                          Value
-----------------                          -----
Inbound Requests                            5
Outbound Requests                           3
Inbound Replies                             3
Outbound Replies                            5
Inbound Registers                           0
Outbound Registers                          0
Inbound Error Packets                       0
Inbound Error Indication Packets            0
Outbound Error Indication Packets           0
Reply Forwards                              0
Unrecognized Options                        0
Registration Overflows                      0
ProtocolErrors                              0
Negative Outbound Replies                   0
Inbound Packets on NHRP disabled interface  0
'Send_to_me' Outbound Replies               0
Inbound Purges                              0
Outbound Purges                             2
```

Cache

Use the **cache** command to display all NHRP resolution cache entries or a specific cache entry identified by a destination address.

Syntax:

cache list
entry

list Lists NHRP cache entries.

Example: `cache list`

```
Total Client Cache Entries = 3

NHRP Client Cache Entries
=========================

Dest Address    NextHop Address State Htime MTU  Net
------------    --------------- ----- ----- ---  ---
5.5.5.1         5.5.5.1         Act   1121  4490  1
5.5.5.2         5.5.5.2         Inact 1185  4490  1
6.6.6.1         6.6.6.1         Act   602   9180  0
```

entry Lists a specific NHRP cache entry.

Example: `cache entry`

```
Enter destination address  [0.0.0.0]? 6.6.6.1
Destination: 6.6.6.1
NextHop:     6.6.6.1
ATM Address: 39840F000000000000000000000410005A00DEADCA
State:       Act
Net:         0
HoldingTime: 433 seconds
MTU size:    9180
Flags:       0x00420000
```

Server_purge_cache

Use the **server_purge_cache** command to list all NHRP server purge cache entries.

Syntax:

server_purge_cache

MIB

Use the **MIB** command to display NHRP MIB related information.

Syntax:

mib list ...
entry ...

list Lists NHRP mib entries for:

- Server table
- Client table
- Next-Hop Server (NHS) statistics table
- Next-Hop Client (NHC) statistics table
- Resolution cache table

Example: `mib list server table`

```
MIB Server Table List
=====================

Index Server Address  State ATM Addr
----- --------------  ----- --------
0     6.6.6.2         UP    39840F000000000000000000000210005A00DEADC8
```

entry Lists a specific NHRP mib entry in either:

- Server table
- Client table
- Next-Hop Server (NHS) statistics table
- Next-Hop Client (NHC) statistics table
- Resolution cache table

Example: `mib entry serv`

```
Index [0]? 0
Index           : 0
Protocol        : 1x0800
Protocol Address: 6.6.6.2
ATM Address type: 0x0 (NSAP)
ATM Address     : 39840F000....
SubnetworkId    : 0
Authentication  : 1
Current Clients : 0
Max Clients     : 512
State           : 1
Net             : 1
```

LANE Shortcuts

Use the **lane shortcuts** command to display all or specific entries using LANE shortcuts. You can also display any ATM addresses for which LANE shortcuts are disallowed due to operational problems.

Syntax:

lane-shortcuts all

entry

disallowed

all Displays all LANE shortcuts.

Example: `lane all`

```
LANE Shortcut Interface #: 1, ATM Network Interface #: 0
=========================================================
   Next Hop Prot @   Dest Mac @         VPI/VCI
   ---------------   -----------------  --------
   5.5.5.1           04-AA-AA-AA-AA-01    0/34

   Current MTU being used: 4490
```

entry Displays a LANE shortcut entry.

Example: `lane entry`

```
LANE Shortcut Interface number [0]? 1
Enter IP address of next hop [0.0.0.0]? 5.5.5.1
Next Hop Addr:  5.5.5.1
Dest Mac Addr:  04-AA-AA-AA-AA-01
ATM Address:    39840F0000000000000000000310005A00DEAD02
Media type:     Token Ring
VPI/VCI:          0/34
Holding Time:   20 minutes
MTU size:       4490
RI Field:064001020203
```

disallowed

Displays all disallowed LANE shortcut entries.

Any ATM address listed in this display means that the NHRP LANE Shortcut Interface received data from that ATM address. This is not allowed since all NHRP LANE Shortcut Interface VCCs will be used only to transmit data to a LEC at the other end. If the LEC attempts to send data over a VCC set up by an NHRP LANE Shortcut Interface, then the VCC will be brought down and no further LANE shortcuts will be set up to that LEC.

Once the condition which caused the NHRP LANE Shortcut Interface to receive data has been corrected, then the device must be restarted in order to allow that ATM address to be again used for NHRP LANE shortcuts.

Example: `lan dis`

```
LAN Shortcut Interface #: 2, ATM Network Interface #: 0
=======================================================
Atm Address
-------------------------------------------
39840F0000000000000000000310005A00DEAD02
```

CONFIG Parameters

Use the **config parameters** command to access the command menus for **display**, **change**, or **reset** NHRP configuration parameters.

Table 33-4. NHRP Config Parameter Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Display	Displays the current NHRP and Route-switching configuration parameters.
Change	Allows NHRP configuration parameters to be dynamically changed without affecting the static configuration.
Reset	Reads the configuration parameter from the static configuration and uses it during the router's runtime.

Display

Use the **display** command to display the current NHRP and Route-Switching configuration parameters.

Syntax:

display nhrp

route-switching

nhrp Displays NHRP configuration parameters, including general parameters, cache sizes, extensions usage, exclude list, and disallowed router-to-router shortcuts.

route-switching
Displays route-switching configuration parameters.

Change

Use the **change** command to change the current NHRP configuration parameters. See “Set” on page 33-8 for a description of these configuration parameters.

Syntax:

change protocol_access_control_usage

attempt_shortcuts

holding_time

data-rate_threshold

cache_size

extensions

shortcuts_to_atmarp_clients

Reset

Use the **reset** command to reset the dynamic configuration parameter value to the value in the static configuration. See “Set” on page 33-8 for a description of these configuration parameters.

Syntax:

reset protocol_access_control_usage

attempt_shortcuts
holding_time
data-rate_threshold
cache_size
extensions
shortcuts_to_atmarp_clients
exclude_list
disallowed_router-to-router

Reset

Use the **reset** command to dynamically reconfigure NHRP protocol or an interface. A reset causes the applicable static configuration values to be used.

Syntax:

reset interface
nhrp

nhrp Resets NHRP statistics, interfaces, and configuration parameters to the static configuration values. This is equivalent to a cold-start of NHRP

interface De-activates the NHRP interface and then activates the interface with new interface static configuration values..

NHRP Packet Tracing

NHRP packet traces can be activated from the Event Logging System (ELS) which is an integral part of the router operating system. See “Using and Configuring the Event Logging System” and “Monitoring the Event Logging System” in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide*

The NHRP packet tracing mechanism supports the “set trace decode on” option. This option enables the NHRP packet trace output to be interpreted for viewing. The control frames over the LSI can also be traced apart from the NHRP protocol packets. For details on using the trace facility see the description of the **trace** command in “Monitoring the Event Logging System” in *Multiprotocol Switched Services (MSS) Interface Configuration and Software User’s Guide*

The NHRP protocol packets are identified by event 19 and the LSI control packets are identified by event 113.

Sample trace output #1:

```
Dir:OUTGOING  Time:0.0.48.88  Trap:6035
Comp:NHRP  Type:UNKNOWN  Port:1  Circuit:0x000000  Size:160
----------------------------------------------------------------
** NHRP/MPOA Frame **
AddressFamily:ATM_NSAP  ProtocolType:IPv4  HopCount:64  PacketSize:160
Checksum:0x03F4  ExtensionOffset:0x0038  Version:1  PktType:ResolutionRequest
SrcAddrTL:20  SrcSubAddrTL:0  SrcProtoLen:4  DstProtoLen:4
Flags:requester is a router  Flags:want authoritative only  Flags:want unique
only  ReqID:1
Src NBMA:39840F000000000000000000000610005A019600C9
Src Protocol Addr: 6.6.6.1  Dest Protocol Addr: 3.3.3.2
0038: 00 08 00 1C 08 00 5A 00  00 01 00 0A 00 00 00 00      ......Z.........
0048: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00      ................
0058: 00 08 00 34 08 00 5A 00  00 01 00 0C 00 00 00 00      ...4..Z.........
0068: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00      ................
0078: 00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00      ................
0088: 00 00 00 00 00 00 00 00  00 08 00 08 08 00 5A 00      ..............Z.
0098: 00 01 00 06 80 00 00 00                               ................
```

Sample trace output #2:

```
Dir:INCOMING  Time:0.0.50.69  Trap:6035
Comp:NHRP  Type:UNKNOWN  Port:1  Circuit:0x000000  Size:202
----------------------------------------------------------------
** NHRP/MPOA Frame **
AddressFamily:ATM_NSAP  ProtocolType:IPv4  HopCount:63  PacketSize:202
Checksum:0xEC88  ExtensionOffset:0x005C  Version:1  PktType:ResolutionReply
SrcAddrTL:20  SrcSubAddrTL:0  SrcProtoLen:4  DstProtoLen:4
Flags:requester is a router  Flags:authoritative info  Flags:requested info
unique  ReqID:1
Src NBMA:39840F000000000000000000000610005A019600C9
Src Protocol Addr: 6.6.6.1  Dest Protocol Addr: 3.3.3.2
1483 VCC Shortcut Information (CIE) follows:
  CIE Code:0  Prefix:32  MTU:4376  Htime:180  Preference:254
  CIE NBMA:39840F000000000000000000000310005A01950103
  CIE Protocol Addr: 3.3.3.1
005C: 00 08 00 1C 08 00 5A 00  00 01 00 0B 00 00 00 01      ......Z.........
006C: 97 00 01 04 03 03 03 02  11 18 90 00 5A 01 94 00      ............Z...
007C: 00 08 00 34 08 00 5A 00  00 01 00 0D 00 B4 14 00      ...4..Z.........
008C: 39 84 0F 00 00 00 00 00  00 00 00 00 03 10 00 5A      9..............Z
009C: 01 95 01 03 00 00 00 00  00 00 00 00 00 00 00 00      ................
00AC: 00 00 00 00 00 00 00 00  00 08 00 0E 08 00 5A 00      ..............Z.
00BC: 00 01 00 07 06 A0 00 80  00 20 80 00 00 00            ................
```

Chapter 34. Using AppleTalk Phase 2

This chapter describes the AppleTalk Phase 2 (AP2) configuration commands and includes the following sections:

- "Basic Configuration Procedures"
- "AppleTalk 2 Zone Filters" on page 34-2
- "Sample Configuration Procedures" on page 34-3

Basic Configuration Procedures

This section outlines the initial steps required to get the AppleTalk Phase 2 protocol up and running. Information on how to make further configuration changes will be covered in the command sections of this chapter. For the new configuration changes to take effect, the router must be restarted.

Enabling Router Parameters

When you configure a router to forward AppleTalk Phase 2 packets, you must enable certain parameters regardless of the number or type of interfaces in the router. If you have multiple routers transferring AppleTalk Phase 2 packets, specify these parameters for each router.

- Globally Enable AppleTalk Phase 2 - To begin, you must globally enable the AppleTalk Phase 2 software using the AppleTalk Phase 2 configuration **enable ap2** command. If the router displays an error in this step, there is no AppleTalk Phase 2 software present in your load. If this is the case, contact your customer service representative.
- Enable Specific Interfaces - You must then enable the specific interfaces over which AppleTalk Phase 2 is to send the packets. Use the **enable interface** *interface number* command to do this.

  Note: When enabling AppleTalk over ATM, you must enable the specific emulated LAN interfaces over which AppleTalk is to send packets. You must not enable AppleTalk over the physical ATM interface. All further uses of the word "interface" in this chapter refer to the emulated LAN interface, not the ATM physical interface.
- Enable Checksumming - You can then determine whether the router will compute DDP checksums of packets it originates. Checksum software does not work correctly in some AppleTalk Phase 2 implementations, so you may not want to originate packets with checksums for compatibility with these implementations. Normally, however, you will want to enable the generation of checksums. Any packet forwarded with a checksum will have its checksum verified.

Setting Network Parameters

You must also specify certain parameters for each network and interface that sends and receives AppleTalk Phase 2 packets. After you have specified the parameters, use the AppleTalk Phase 2 list configuration command to view the results of the configuration.

- Set the Network Range for Seed Routers - Coordinating network ranges and zone lists for all routers on a network is simplified by having specific routers

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designated as seed routers. Seed routers are configured with the network range and zone list while all other routers are given null values. Null values indicate that the router should query the network for values from the seed routers. For every network (segment) of your interconnected AppleTalk internet, at least one router interface must be configured as the seed router for that network. There are usually several seed routers on a network in case one of them fails. Also, a router can be a seed router for some or all of its network interfaces. Use the **set net-range** command to assign the network range in seed routers.

- Set the Starting Node Number - Use the **set node** command to assign the starting node number for the router. The router will AARP for this node, but if it is already in use, a new node will be chosen.
- Add a Zone Name - You can add one or more zone names for each network in the internetwork. You can add a zone name for a given network in any router connected to that network; however, only the seed router needs to contain the zone name information for a connected network. Attached routers dynamically acquire the zone name from adjacent routers using the ZIP protocol. Apple recommends that, for a given network, you choose the same seed router for the network number and the zone name. The zone name cannot be configured for a network unless the network number is also configured. To add a zone name for each network number, use the AppleTalk Phase 2 configuration **add zone** *name* command.

AppleTalk 2 Zone Filters

ZoneName filtering, although not required for AppleTalk, is a very desirable feature for the security and administration of large AppleTalk Internetworks. There are also provisions for restricting access to networks by net numbers.

General Information

AppleTalk is structured so that every network is identified in two ways. The first is a network number or range of consecutive network numbers that must be unique throughout the internet. The network number combined with the node number uniquely identifies any end station in the internet.

The second identifier for the network is one or more ZoneNames. These ZoneName strings are not unique throughout the internet. The end station is uniquely identified by a combined **object:type:ZoneName-string**.

A router first learns about a network when the new net range appears in the RTMP routing update from a neighboring router. The router then queries the neighbor for the ZoneNames of the new network. Note that the net range is repeated in every new RTMP update but that the ZoneNames are requested only once.

The end stations obtain the network numbers from the broadcasted RTMP (routing information) packets and then choose a node number. This net/node pair is then AARP'd for (AARP Probe) to see if any other end station has already claimed its use. If another station responds, another net/node pair is chosen by the end station and the process repeated until no responses are received.

Why ZoneName Filters?

When the typical AppleTalk end station wants to use a service (printer, file server) on the Apple Internet, it first looks at all available Zones and selects one. It then chooses a service type and requests a list of all names advertising the type in the chosen Zone. Several problems arise from this mechanism.

- A large internet may have many Zones. Presenting the user with a long list to choose from obscures the needed ones (thereby inhibiting usability of the list).
- The server may not want to make itself available throughout the internet (for security reasons). If the Zone that the service is in is not visible to the client, security is enhanced.
- Restricting the Zones that are visible from a department to the rest of the internet will allow the internet administration to let the department control (or not) its own domain while not increasing the overhead for the rest of the internet (reducing administration).

The filtering of network numbers further enhances the security and administration of the internet. Network access is only indirectly controlled by Zone filtering. An unregulated department could add networks with the same Zone names but new net numbers that conflict with other departments. Network number filtering can be used to prevent these random additions of zone names and net numbers from impacting the rest of the network.

How Do You Add Filters?

The router is configured with an exclusive (meaning block the specified zones) or inclusive (meaning allow only these zones) list of Zones for each direction on each interface. The specified interface will not readvertise filtered Zone information in the defined direction. If all Zones in a network's Zonelist are filtered, network information will also be filtered across the interface.

- Use configuration commands **add** and **delete**, to create the filter list for an interface.
- Use configuration commands **enable** and **disable** to specify how the filter list is applied.

  Use similar commands to create network number filters.

Other Commands:

You can use the `AP2 CONFIG>` **list** command to display all filter information for the interfaces. In addition, the **list** command accepts an *interface#* as an argument so that you can list information for only an interface.

Sample Configuration Procedures

This section covers the steps required to get AP2 up and running. For information on how to make further configuration changes, see “AppleTalk Phase 2 Configuration Commands” on page 35-1. For the configuration changes to take effect, you must restart the router.

To access the AP2 configuration environment, enter **protocol ap2** at the `Config>` prompt.

Enabling AP2

When you configure a router to forward AP2 packets, you must enable certain parameters. If you have multiple routers transferring AP2 packets, specify these parameters for each router. To enable AP2:

1. Use the **enable ap2** command to globally enable AP2 on the router. For example:

```
AP2 config>enable ap2
```

2. Enable the specific interfaces over which AP2 is to send packets. For example:

```
AP2 config>enable interface 1
```

Setting Network Parameters

To set up your router as a seed router, you must set the network range, a starting node number, and at least one zone name. You can configure some interfaces on a router as seed routers and leave other interfaces as non-seed routers. You must have at least one seed router for each AppleTalk network, and you should configure several seed routers on a network in case one of them fails.

After you have specified the parameters, you can use the **list** command at the `AP2 config>` prompt to view your configuration.

Setting Up Zone Filters

Zone filtering lets you filter zones in each direction on each interface. To filter incoming packets, set up an input filter. To filter outgoing packets, set up an output filter. The interface will not readvertise filtered zone information in the direction that you define. Follow these steps to set up a zone filter:

1. Add zone filters to an interface. Use the **add zfilter in** command to add an input zone filter to an interface. Use the **add zfilter out** command to add an output zone filter to an interface. For example:

```
AP2 config>add zfilter in
Interface # [0]? 1
Zone name []? Admin
```

2. Enable the zone filters that you added. This turns on the filter and controls whether the filter is inclusive or exclusive. Inclusive filters forward only the zone information in that filter. Exclusive filters block only the zone information in that filter. For example:

```
AP2 config>enable zfilter in exc
Interface # [0]? 1
```

The following are some examples that explain how to set up zone filters in the internet shown in Figure 34-1 on page 34-5.

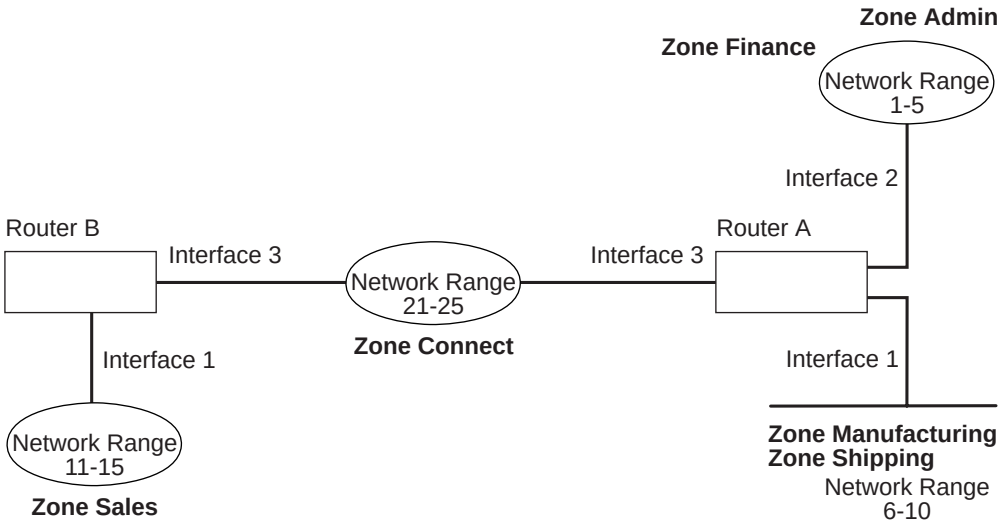

Figure 34-1. Example of Zone Filtering

Example 1

The following is an example of how to filter the Manufacturing zone from all other networks. To do this, you would set up an input filter on Interface 1 of Router A to exclude the Manufacturing zone.

1. On Router A, add an input zone filter to Interface 1.

```
AP2 config>add zfilter in
Interface # [0]? 1
Zone name []? Manufacturing
```

2. Enable the input zone filter and make the filter exclusive.

```
AP2 config>enable zfilter in exc
Interface # [0]? 1
```

   This excludes Manufacturing zone information from entering Router A, thereby filtering the zone from the rest of the internet.

Example 2

The following example shows how to filter the Manufacturing zone from Network 11-15, but still allow the Manufacturing zone to be visible on Network 1-5. To do this, you would set up an output filter on Interface 3 of Router A to exclude Manufacturing zone information from being forwarded out of Interface 3. The interface will continue to advertise Manufacturing zone information over interfaces 1 and 2 on Router A, making it visible on Network 1-5.

1. Add an output zone filter to Interface 3.

```
AP2 config>add zfilter out
Interface # [0]? 3
Zone name []? Manufacturing
```

2. Enable the output zone filter and make the filter exclusive.

```
AP2 config>enable zfilter out exc
Interface # [0]? 3
```

   This filter excludes Manufacturing zone information from the output of Interface 3.

Example 3

The next example shows how to set up a filter so that the Admin zone is visible on all networks, but the Finance zone is not visible to the rest of the internet.

1. Add an input zone filter to Interface 2 on Router A.

```
AP2 config>add zfilter in
Interface # [0]? 2
Zone name []? Admin
```

2. Enable the input zone filter and make it inclusive.

```
AP2 config>enable zfilter in inc
Interface # [0]? 2
```

   By setting up this input filter as inclusive, only Admin zone information is forwarded through Interface 2 to the rest of the internet.

Setting Up Network Filters

Network filters are similar to zone filters, except they let you filter an entire network. To set up a network filter:

1. Add a network filter. Use the **add nfilter in** command to add an input network filter to an interface. Use the **add nfilter out** command to add an output network filter to an interface. For example:

```
AP2 config>add nfilter out
Interface # [0]? 2
First Network range number (decimal) [0]? 11
Last Network range number (decimal) [0]? 15
```

   The network range you enter here must match the range that you assigned to that network.

2. Enable the network filter that you added and make it either inclusive or exclusive. Inclusive filters forward only network information in that filter. Exclusive filters block only network information in a filter, and they allow all other network information to be forwarded.

```
AP2 config>enable nfilter in exc
Interface # [0]? 2
```

Following are some examples that explain how to set up network filters in the internet, as shown in Figure 34-2.

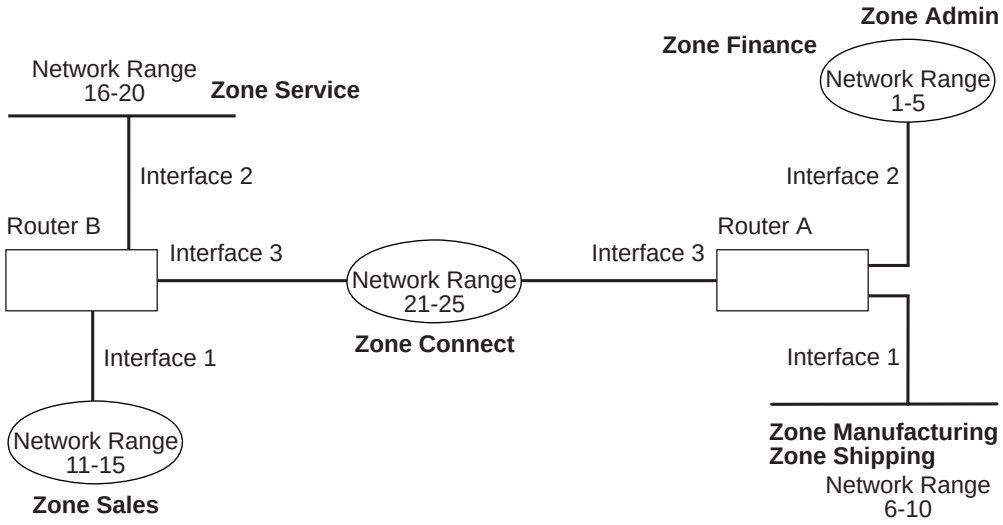

Figure 34-2. Example of Network Filtering.

Note: Interfaces refer to emulated LAN interfaces, not ATM physical interfaces.

The following steps show how to filter Network 6-10 so that it is not visible to Network 16-20 as shown in Figure 34-2.

1. Add an output network filter for Network 6-10 to Interface 2 on Router B.

```
AP2 config>add nfilter out
Interface # [0]? 2
First Network range number (decimal) [0]? 6
Last Network range number (decimal) [0]? 10
```

2. Enable the output network filter as exclusive.

```
AP2 config>enable nfilter out exc
Interface # [0]? 2
```

   This filter excludes all information on Network 6-10 from being forwarded through Interface 2 to Network 16-20.

Chapter 35. Configuring and Monitoring AppleTalk Phase 2

This chapter describes the AppleTalk Phase 2 (AP2) configuring and monitoring commands. It includes the following sections:

- "Accessing the AppleTalk Phase 2 Configuration Environment"
- "AppleTalk Phase 2 Configuration Commands"
- "Accessing the AppleTalk Phase 2 Monitoring Environment" on page 35-8
- "AppleTalk Phase 2 Monitoring Commands" on page 35-9

Accessing the AppleTalk Phase 2 Configuration Environment

To access the AppleTalk Phase 2 configuration environment, enter the following command at the `Config>` prompt:

```
Config> ap2
AP2 Protocol user configuration
AP2 Config>
```

AppleTalk Phase 2 Configuration Commands

This section describes the AppleTalk Phase 2 configuration commands.

The AppleTalk Phase 2 configuration commands allow you to specify network parameters for router interfaces that transmit AppleTalk Phase 2 packets. The information you specify with the configuration commands becomes activated when you restart the router.

Enter the AppleTalk Phase 2 configuration commands at the `AP2 config>` prompt. Table 35-1 shows the commands.

Table 35-1. AppleTalk Phase 2 Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Add	Adds zone names, network filters, and zone filters to an interface.
Delete	Deletes the zone names, interfaces, network filters, and zone filters.
Disable	Disables interfaces, checksumming, split-horizon routing, network filters, or zone filters, or globally disables AppleTalk Phase 2.
Enable	Enables interfaces, checksumming, split-horizon routing, network filters, zone filters, or globally enables AppleTalk Phase 2.
List	Displays the current AppleTalk Phase 2 configuration.
Set	Sets the cache size, network range, and node number.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

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Add

Use the **add** command to add the zone name to the interface zone list or to add the zone name to the interface zone list as the default for the interface or to add network and zone filters.

Syntax:

add zone . . .
defaultzone . . .
nfilter in . . .
nfilter out . . .
zfilter in . . .
zfilter out . . .

zone *interface# zonename*

Adds the zone name to the interface zone list. If you define a network number for an interface, you should also define the zone names for the interface. If you did not define a network number, do not define zone names.

Example:

```
ap2config>add zone
Interface # [0]? 0
Zone name []? Finance
```

defaultzone *interface# zonename*

Adds a default zone name for the interface. If a node on the network requests a zone name that is invalid, the router assigns the default zone name to the node until another zone name is chosen. If you add more than one default to an interface, the last one added overrides the previous default. If you do not add a default, the first zone name added using the **zone** command is the default.

Example:

```
ap2config>add defaultzone
Interface # [0]? 0
Zone name []? Headquarters
```

nfilter in *interface# first network# last network#*

Adds a network filter to the input of the interface. The network range that you enter must match the network range you set for that interface. You cannot filter only a portion of a network range. For example, if you set a network range of 1–10, and you set up a filter for 5–8, the router filters the full network range of 1–10.

Example:

```
ap2config>add nfilter in
Interface # [0]? 0
First Network range number (decimal) [0]? 1
Last Network range number (decimal) [0]? 10
```

nfilter out *interface# first network# last network#*

Adds a network filter to the output of the interface. The network range that you enter must match the network range you set for that interface. You cannot filter only a portion of a network range. For example, if you set a network range of 1–0, and you set up a filter for 5–8, the router filters the full network range of 1–10.

Example:

```
ap2config>add nfilter out
Interface # [0]? 0
First Network range number (decimal) [0]? 11
Last Network range number (decimal) [0]? 20
```

zfilter in *interface# zone name*

Adds a zone name filter to the input or output of the interface.

Example:

```
ap2config>add zfilter in
Interface # [0]? 1
Zone name []? Marketing
```

zfilter out *interface# zone name*

Adds a zone name filter to the output of the interface.

Example:

```
ap2config>add zfilter out
Interface # [0]? 0
Zone name []? Corporate
```

Delete

Use the **delete** command to delete a zone name from the interface zone list, network or zone name filters, or all AppleTalk Phase 2 information from an interface.

Syntax:

del**ete** zone . . .
nfilter in . . .
nfilter out . . .
zfilter in . . .
zfilter out . . .
interface

zone *interface# zonename*

Deletes a zone name from the interface zone list.

Example:

```
ap2config>delete zone 2 newyork
```

nfilter in *interface# first network# last network#*

Deletes a network filter from the input of the interface. You must enter the same network range numbers you set using the **add nfilter in** command.

Example:

```
ap2config>delete nfilter in
Interface # [0]? 0
First Network range number (decimal) [0]? 1
Last Network range number (decimal) [0]? 12
```

nfilter out *interface#*

Deletes a network filter from the output of the interface. You must enter the same network range numbers you set using the **add nfilter out** command.

Example:

```
ap2config>delete nfilter out
Interface # [0]? 0
First Network range number (decimal) [0]? 11
Last Network range number (decimal) [0]? 20
```

zfilter in *interface# zone name*

Deletes a zone name filter from the input of the interface.

Example:

```
ap2config>delete nfilter in
Interface # [0]? 1
Zone name []? Marketing
```

zfilter out *interface# zone name*

Deletes a zone name filter from the output of the interface.

Example:

```
delete zfilter out

Interface # [0]? 1
Zone name []? Marketing
```

interface Use this command to delete an interface. This is the only way to delete zone names that have non-printing characters.

Example:

```
ap2config>delete interface 1
```

Disable

Use the **disable** command to disable AP2 on all interfaces or on a specified interface, checksumming, filtering, APL/AP2 translation, or split horizon routing.

Syntax:

disable
ap2
checksum
interface . . .
nfilter in . . .
nfilter out . . .
zfilter in . . .
zfilter out . . .
split-horizon-routing . . .

ap2 Disables the AppleTalk Phase 2 packet forwarder for all interfaces.

Example:

```
ap2config>disable ap2
```

checksum

Specifies that the router will not compute the checksum in packets it generates. The router usually checksums all packets it forwards. This is the default.

Example:

```
ap2config>disable checksum
```

interface *interface#*

Disables all AP2 functions on the specified network interface. The network continues to remain available for all other protocols.

Example:

```
ap2config>disable interface 2
```

nfilter in *interface#*

Disables, but does not delete, the input network filters on this interface.

Example:

```
ap2config>disable nfilter in
Interface # [0]? 2
```

nfilter out *interface#*

Disables, but does not delete, the output network filters on this interface.

Example:

```
ap2config>disable nfilter out
Interface # [0]? 2
```

zfilter in *interface#*

Disables, but does not delete, the input zone filters on this interface.

Example:

```
ap2config>disable zfilter in
Interface # [0]? 1
```

zfilter out *interface#*

Disables, but does not delete, the output zone filters on this interface.

Example:

```
ap2config>disable zfilter out 0
Interface # [0]? 1
```

split-horizon-routing *interface#*

Disables split-horizon-routing on this interface. You need to disable split-horizon routing only on Frame Relay interfaces that are on a hub in a partially-meshed Frame Relay network. Disabling split-horizon routing causes all of the routing tables to be propagated on this interface.

Example:

```
ap2config>disable split-horizon-routing 0
```

Enable

Use the **enable** command to enable the checksum function, to enable a specified interface, to enable AppleTalk 2 gateway function, or to globally enable the AppleTalk Phase 2 protocol.

Syntax:

enable
- ap2
- checksum
- interface . . .
- nfilter in . . .
- nfilter oout . . .
- split-horizon-routing . . .
- zfilter . . .

ap2 Enables the AppleTalk Phase 2 packet forwarder over all of the interfaces.

Example:

```
ap2config>enable ap2
```

checksum

Specifies that the router will compute the checksum in packets it generates. The router checksums all AP2 packets it forwards.

Example:

```
ap2config>enable checksum
```

interface *interface#*

Enables the router to send AppleTalk Phase 2 packets over specific interfaces.

Example:

```
ap2config>enable interface 3
```

nfilter in *exclusive* **or** *exclusive interface#*

Enables network input filters and controls how the filter is applied to the interface. Inclusive forwards matches. Exclusive drops matches.

Example:

```
ap2config>enable filter in inc
Interface # [0]? 1
```

nfilter out *exclusive* **or** *exclusive interface#*

Enables network output filters and controls how the filter is applied to the interface. Inclusive forwards matches. Exclusive drops matches.

Example:

```
ap2config>enable filter out exec
Interface # [0]? 1
```

split-horizon-routing *interface #*

Enables split-horizon routing on the interface. The default is *enabled*.

Example:

```
ap2config>enable split-horizon-routing 1
```

zfilter Enables zone filters assigned to an interface. Must specify if filter is “in” or “out” and if the filter is inclusive or exclusive. Inclusive means that only packets matching the filter will be routed. Exclusive means that all packets matching the filter will be discarded.

Example:

```
ap2config>enable zfilter in inc
Interface # [0]?
```

Example:

```
ap2config>enable zfilter out exec
Interface # [0]? 0
```

List

Use the **list** command to display the current AP2 configuration. In the example, the router is a seed router on

Note: The **list** command accepts an *interface#* as an argument.

Syntax:

list

Example:

```
ap2config>list
APL2 globally  enabled
Checksumming  disabled
Cache size 500

List of configured interfaces:

Interface       netrange         /  node        Zone
```

APL2 globally
Indicates whether AppleTalk Phase 2 is globally enabled or disabled.

Checksumming
Indicates whether checksum is enabled or disabled.

Cache size
Number of fastpath cache entries.

List of configured interfaces
Lists each interface number and its network range, node number, and zone name(s) as well as the default zone.

For each interface also lists whether or not input and output zone filters and network filters and enabled or disabled. If they are enabled, indicates whether or not they are inclusive or exclusive.

Input/output Zfilters
Indicates zone filters assigned to an interface. Inclusive means that only packets matching the filter will be routed. Exclusive means that all packets matching the filter will be discarded. The name of the zone filtered is displayed. Input means that the filter is applied to traffic coming into the interface. Output means that filter is applied to traffic going out to the interface.

Input/output Nfilters
Indicates net filters assigned to an interface. Inclusive means that only packets matching the filter will be routed. Exclusive means that all packets matching the filter will be discarded. The range of networks filtered is displayed. Input means that the filter is applied to traffic coming into the interface. Output means that filter is applied to traffic going out to the interface.

Split-horizon-routing
Shows whether or not split-horizon routing is enabled or disabled on each interface.

Set

Use the **set** command to define the cache-size of fastpath or specific AppleTalk Phase 2 parameters, including the network range in seed routers and the node number.

Syntax:

set	cache-size . . .
	net-range . . .
	node . . .

cache-size *value*

Cache-size corresponds to the total number of AppleTalk networks and nodes that can simultaneously communicate through this router using the fastpath feature. (Fastpath is a method of precalculating MAC headers to forward packets more quickly.) The default is 500, which allows up to 500 networks and nodes to simultaneously communicate through the router and still use fastpath. If the number of networks and nodes becomes greater than the cache size, the router still forwards the packets, but it does not use fastpath. Valid values for cache size are: 0 (disable), 100 to 10 000. Although not recommended, setting the cache-size to zero disables the fastpath feature and no memory is used for the cache. You need to change this default only for very large networks. Each cache-size entry uses 36 bytes of memory.

Example:

```
ap2config>set cache-size 700
```

net-range *interface# first# last#*

Assigns the network range in seed routers using the following:

- interface# - Designates the router interface to operate on.
- first# - Assigns the lowest number of the network range. Legal values are 1 to 65279 (10xFEFF hexadecimal).
- last# - Sets the highest number of the network range. Legal values are *first#* to 65279.

A single numbered network has the same first and last values. A first value of zero deletes the netrange for the interface and turn the "seeded" interface into an "unseeded" interface. First# and last# are inclusive in the network range.

Example:

```
ap2config>set Net-Range 2 43 45
```

node *interface# node#*

Assigns the starting node number for the router. The router will AARP for this node but if it is already in use, a new node will be chosen. The following explains each argument that is entered after this command:

- interface# - Designates the router interface to operate on.
- node# - Designates the first attempted node number. Legal values are 1 to 253. A node# value of zero deletes the node number for the interface and forces the router to choose one at random.

Example:

```
ap2config>set node 2 2
```

Accessing the AppleTalk Phase 2 Monitoring Environment

To access the AppleTalk Phase 2 monitoring environment, enter the following command at the + (GWCON) prompt:

```
+ protocol ap2
AP2>
```

AppleTalk Phase 2 Monitoring Commands

This section describes the AppleTalk Phase 2 monitoring commands which allow you to view the parameters and statistics of the interfaces and networks that transmit AppleTalk Phase 2 packets. Monitoring commands display configuration values for the physical, frame, and packet levels. You also have the option of viewing the values for all three protocol levels at once.

Enter the AppleTalk Phase 2 monitoring commands at the AP2> prompt. Table 35-2 shows the commands.

Table 35-2. AppleTalk Phase 2 Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Atecho	Sends echo requests and watches for responses.
Cache	Displays the cache table entries.
Clear Counters	Clears all cache usage counters and packet overflow counters.
Counters	Displays the overflow count of AP2 packets for each interface.
Dump	Displays the current state of the routing table for all networks in the internet and their associated zone names.
Interface	Displays the current addresses of the interfaces.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Atecho

The **atecho** command sends AppleTalk Echo Requests to a specified destination and watches for a response. This command can be used to verify basic AppleTalk connectivity and to isolate trouble in the AppleTalk internetwork.

Syntax:

a**techo** *dest_net dest_node*

dest_net Specifies the destination AppleTalk network number, in decimal. This is a required parameter.

dest_node
Specifies the destination AppleTalk node number, in decimal. This is a required parameter.

Note: For many AppleTalk nodes, the network address (network number and node number) is dynamically assigned and might not be readily available. However, there are still a number of ways to use the **atecho** command effectively:

1. The AppleTalk address for router nodes is statically configured in many cases. Connectivity between router nodes is critical to overall network connectivity.
2. By setting the atecho destination node number to 255, you can query all nodes on the specified network number on a directly attached

AppleTalk network. The received responses will indicate the node's node number. These node numbers can then be used to echo these nodes from distant routers to verify connectivity.

src_net Source AppleTalk network number. This is an optional parameter. If not specified, the router uses its interface network number on the outgoing interface leading to the destination network.

src_node Source AppleTalk node number. This is an optional parameter. If not specified, the router uses its interface node number on the outgoing interface leading to the destination network.

size Number of bytes to use in the AppleTalk echo requests. This is an optional parameter. Default is 56 bytes.

rate Rate of sending AppleTalk echo requests. This is an optional parameter. Default is one second.

Note: If you enter **atecho** with no parameters, you are prompted for all the parameters. Enter values for the required parameters and either enter values for the optional parameters or accept defaults.

Cache

The **cache** command displays information about the cache-size entries.

Syntax:

ca**che**

Example: `cache`

```
Destination  Interface   Usage  Next Hop
122/22        1          1       27/5
138/51        0          1       27/5
23/7          1          1       Direct
```

Destination
AppleTalk node address (network number/node number).

Net Number of the interface used to forward to the destination node.

Usage Number of times this cache entry has been used in this aging period, which is five seconds. An unused entry is deleted after 10 seconds.

Next Hop The AppleTalk address of the next hop router used to forward a packet to the destination node, or Direct if the destination node is directly connected to the interface.

Clear Counters

The clear-counters command clears all cache usage counters and packet overflow counters.

Syntax:

clear-counters

Counters

Use the **counters** command to display the number of packet overflows on each network that sends and receives AppleTalk Phase 2 packets. This command displays the number of times the AppleTalk Phase 2 forwarder input queue was full when packets were received from the specified network.

Syntax:

counters

Example: counters

```
AP2 Input Packet Overflows

Net            Count

Eth/0            4
```

Dump

Use the **dump** command to obtain routing table information about the interfaces on the router that forwards AppleTalk Phase 2 packets.

Note: dump *interface#* displays the part of the overall network and zone information that is visible on that interface.

Syntax:

dump

Example: dump

```
Dest Net    Cost     State   Next hop        Zone
  10-19       0       Dir    0/0       "Ethertalk", "Sales"
  40-49       1      Good    10/13     "Marketing", "CustomerSer",
                                       "TokenTalk"
  20-29       2      Sspct   10/13     "Fuchsia", "Backbone",
                                       "Engineering", "MKTING"

3 entries
```

You can also use the **dump** command with a specific interface to display the routes that are visible on that interface. You can use this feature to make sure filters are configured correctly because it shows whether or not filtered zones or networks are visible to an interface.

Example: dump 0

```
View for interface 0

Dest net   Cost  State   Next hop   Zone
 214-214   1     Good     152/152   "eth-214"
 153-153   0      Dir               "eth153"
 152-152   0      Dir               "ser152"

3 entries
```

Dest Net Specifies the destination network number, in decimal.

Cost Specifies the number of router hops to this destination network.

State Specifies the state of the entry in the routing table. It includes the following:

Next hop Specifies the next hop for packets going to networks that are not directly connected. For directly-connected networks, this is node number 0.

Zone(s) Specifies the human-understandable name for that network. The zone name(s) is enclosed in double quotes in case there are embedded spaces or non-printing characters. If the zone name contains characters beyond the 7-bit ASCII character set (they are 8-bit), the zone name that displays will depend on the characteristics of your monitoring terminal.

Interface

Use the **interface** command to display the addresses of all the interfaces in the router on which AppleTalk Phase 2 is enabled. If the interface is present in the router but is disabled, this command shows that status.

Note: `interface` *interface#* displays the active filtering for that interface. It displays net, node, default zone, and active filters for one interface.

Syntax:

interface

Example: `interface`

```
Interface     Addresses

  Eth/0       10/52 on net 10-19    default zone  "Sales"
```

You can also enter the interface command followed by a specific interface number to view the AP2 configuration of that interface.

Example: `interface 1`

```
Eth/0   1/30 on net 1-5   default zone "marketing"

Input Net filters inclusive   1-5
Output Zone filters inclusive "finance"
Output Net filters exclusive  1-5
```

Chapter 36. Using VINES

This chapter describes the commands to configure the Banyan VINES protocol and includes the following sections:

- "VINES Overview"
- "VINES Network Layer Protocols" on page 36-2
- "Basic Configuration Procedures" on page 36-7
- "Accessing the VINES Configuration Environment" on page 37-1
- "Running Banyan VINES on the Bridging Router" on page 36-8
- "VINES Configuration Commands" on page 37-1.

Note: If you need more detailed information on VINES Protocols, consult the Banyan publication: *VINES Protocol Definition,* order number: 003673

VINES Overview

VINES Over Router Protocols and Interfaces

The VINES protocol routes VINES packets over the following interfaces and protocols:

- PPP Banyan Vines Control Protocol (PPP BVCP)
- Frame Relay
- Ethernet/802.3
- 802.5 Token Ring
- X.25
- Ethernet ATM LAN Emulation Client
- Token-Ring ATM LAN Emulation Client
- FDDI

It also supports packets across an 802.5 Source Routing Bridge (SRB).

The VINES protocol is implemented at the network layer (layer 3) of the OSI model. VINES routes packets from the transport layer in one node to the transport layer in another node. As VINES routes the packets to their destination nodes, the packets pass through the network layers of the intermediate nodes where they are checked for bit errors. A VINES IP packet can contain up to 1500 bytes including the network layer header and all higher layer protocol headers and data.

Service and Client Nodes

The VINES network consists of service nodes and client nodes. A service node provides address resolution and routing services to the client nodes. A client node is a physical neighbor on the VINES network. All routers are service nodes. A Banyan node can be a service node or client node.

Each service node has a 32-bit network address and a 16-bit subnetwork address. The IBM 8210 has a configurable network address. This address identifies the router as a service network node for Vines. Banyan has assigned the range30800000 to 309FFFFF to IBM for use in its routers. This router uses the range 30900000 to 3097FFFF.

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Note: It is extremely important that no two routers be assigned the same network address. The network address for a Banyan service node is the 32-bit hexadecimal serial number of the service node. The subnetwork address for all service nodes is 1.

The network address for each client node is generally the network address of the service node on the same network. However, if a client node is on a LAN that has more than one service node, it is assigned the network address of the service node that responds first to the client node's address assignment request. The subnetwork address for each client node is a hexadecimal value of 8000 to FFFE.

VINES Network Layer Protocols

This implementation of VINES consists of the following four network layer protocols. The next sections describe these protocols and their implementations.

- "VINES Internet Protocol (VINES IP)." Routes packets through the network.
- "Routing Update Protocol (RTP)" on page 36-4. Distributes topological information to support the routing services provided by VINES IP.
- "Internet Control Protocol (ICP)" on page 36-6. Provides diagnostics and support functions to certain transport layer protocol entities, such as providing notification on some network errors and topological conditions.
- "VINES Address Resolution Protocol (VINES ARP)" on page 36-6. Assigns VINES internet addresses to client nodes that do not already have addresses.

VINES Internet Protocol (VINES IP)

The VINES IP protocol routes packets through the network using the destination network number in the VINES IP header. VINES IP consists of an 18-byte network layer header which prefixes each packet. Table 36-1 on page 36-3 summarizes the fields within this header.

VINES IP Implementation

When VINES IP receives a packet, it checks the packet for size and exception errors. A size error is a packet that is less than 18 bytes or greater than 1500 bytes. If it contains a size error, VINES IP discards the packet. An exception error is, for example, a bad checksum or a hop count that has expired.

If the packet does not contain size or exception errors, VINES IP checks the destination address and forwards the packet as follows:

- If the destination address equals the local VINES IP address and the checksum is valid, the local node accepts the packet.
- If the destination address equals the broadcast address and the checksum is valid, VINES IP accepts the packet, processes it locally, and checks the hop count field of the IP header. If the hop count is greater than 0, VINES IP decrements the hop count by one and rebroadcasts the packet on all local media except the one on which the packet was received.
- If the destination address does not equal the local VINES IP address or the broadcast address, VINES IP checks its routing tables for the next hop. If the hop count equals 0, VINES IP discards the packet. Otherwise, it decrements the hop count by one and forwards the packet to the next hop.

If the destination VINES IP address is not in the routing table and the error bit in the transport control field is set, VINES IP drops the packet and returns an ICP Destination Unreachable message to the source. If the error bit in the transport control field is not set, VINES IP discards the packet and does not return a message to the source.

Table 36-1. Vines IP Header Fields Summary

VINES IP Header Field	# of Bytes	Description
Checksum	2	Detects bit-error corruption of a packet.
Packet Length	2	Indicates the number of bytes in the packet including the VINES IP header and data.
Transport Control	1	Consists of the following five subfields: **Class** Determines the type of nodes to which VINES IP broadcast packets are sent. **Error** If the error bit is set, an exception notification packet is sent to the transport layer protocol entity when a packet cannot be routed to a service or client node. **Metric** Requests that the service node of the destination client node return to the source a routing cost from the service node to the destination client node. **Redirect** Indicates whether the packet contains an RTP message specifying a better route to use. **Hop Count** Specifies the range a packet can travel. The hop count can range from 0x0 to 0xf.
Protocol Type	1	Specifies the VINES network layer protocol of the packet as VINES IP, RTP, ICP, or VINES ARP.
Destination Network Number	4	A 4-byte network number in the VINES IP address of the destination.
Destination Subnetwork Number	2	A 2-byte subnetwork number in the VINES IP address of the destination.
Source Network Number	4	A 4-byte network number in the VINES IP address of the source.
Source Subnetwork Number	2	A 2-byte subnetwork number in the VINES IP address of the source.

Routing Update Protocol (RTP)

RTP gathers and distributes routing information that VINES IP uses to compute routes throughout the network. RTP enables each router to periodically broadcast routing tables to all of its neighbors. The router then determines the destination neighbor it will use to route the packet.

Service nodes maintain two tables: a routing table and a neighbor table. Both of these tables have timers that age their contents to eliminate out-of-date entries. Routing updates for X.25 interfaces occur when there is a change in the routing database, for example, when a node goes up/down or the metric changes.

Routing Table

The routing table contains information about the service nodes. Figure 36-1 shows a sample routing table. Descriptions of the fields in this table follow the figure.

```
Net Address  Next Hop Nbr Addr Nbr Intf   Metric   Age (secs)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  S  30622222       30622222:0001    Eth/0       20       30

  H  0027AA21       0027AA21:0001    Eth/1       2        120

  P  0034CC11       0034CC11:0001    X.25/0      45       0

  3 Total Routes


S ⇒ Entry is suspended,  H ⇒ Entry is in Hold-down,
P ⇒ Entry is permanent
```

Figure 36-1. Sample Routing Table

Routing Table Field Description

Net Address

The Net Address is a unique 32-bit number. An S, H, or P preceding the Net Address field indicates the following:

- **S** Indicates the service node is in suspended state and is advertised, for 90 seconds, as being down. After 90 seconds, the router removes the entry for this service node from the routing table.
- **H** Indicates the service node is in hold-down state and is advertised, for 2 minutes, as being down. After 2 minutes, the router advertises the service node as operational. If a service node is in suspended state and it receives an RTP packet, the service node enters the hold-down state.
- **P** Indicates that the X.25 interface enters permanent state for 4-1/2 minutes after initialization. After 4-1/2 minutes, the neighbor enters the permanent state and its age stays at 0 while in this state. If the X.25 interface goes down, the entry is removed from the routing table.

Next Hop Nbr Addr

The address of the neighbor service node that is the next hop on the least-cost path to the network.

Nbr Intf
The medium to which the next hop neighbor service node is attached.

Metric
An estimated cost, in 200-millisecond increments, to route the VINES packet to the destination service node.

Age (secs)
The current age, in seconds, for the entry. If a router does not receive an update about a service node that is in the routing table at least every 360 seconds (6 minutes), the router removes the entry for that service node from the routing table.

Neighbor Tables

The neighbor table contains information about the neighbor service nodes and client nodes connected to the router. Figure 36-2 shows a sample neighbor table and descriptions of the fields in this table follow the figure.

```
Nbr Address    Intf   Metric   Age(secs)   H/W Addr RIF
- - - - - - - - - - - - - - - - - - - - - - - - - - - -

30633333:0001  TKR/0     4        30     0000C0095012

0035CC10:8000  Eth/1     2        120    0000C0078221

2 Total Neighbors
```

Figure 36-2. Sample Neighbor Table

Neighbor Table Field Description

Nbr Address
The address of the neighbor node. In Figure 36-2, the address 30633333:0001 is a service node and address 0035CC10:8000 is a client node.

Intf
The medium to which the neighbor node is attached.

Metric
An estimated cost, in 200-millisecond increments, to route the VINES packet to the neighbor node.

Age (secs)
The current age, in seconds, for the entry. If a router does not receive a routing update from a neighbor at least every 360 seconds (6 minutes), the router removes the entry for that neighbor from the neighbor table and, if the neighbor is a service node, from the routing table.

H/W Addr
The node's LAN address if the neighbor is connected to a LAN. If the frame relay protocol is running, the H/W Addr is the Data Link Connection Identifier (DLCI). For X.25 interfaces, the H/W Addr is the X.25 address of the neighbor.

RIF
Routing Information Field. A sequence of segment and bridge numbers, in hexadecimal, which indicate a path through the network between two stations. RIF is required for source routing.

RTP Implementation

RTP entities issue the following packets:

- *RTP request packets.* Requests to the service nodes to obtain the current network topology. On initialization, an X.25 interface generates routing request packets every 90 seconds to each X.25 destination on the X.25 interface. When the X.25 interface receives a routing response packet, three full routing database updates, spaced 90 seconds apart, are sent to the services nodes that sent the routing response packets. Once the X.25 interface receives routing response packets from all of the X.25 destination nodes, routing requests are no longer sent to those X.25 addresses.
- *RTP update packets.* Packets sent by client nodes to the service nodes to notify the service nodes of their existence. RTP update packets are also sent by the service nodes to notify other nodes of their existence and to advertise their routing databases.
- *RTP response packets.* Packets service nodes send in response to RTP request packets.
- *RTP redirect packets.* Informs the nodes of the best paths between them for routing packets.

Unless connected by a permanent circuit, every client and service node broadcasts an RTP update every 90 seconds. This notifies the neighbors of the node's existence and its type (service or client node) and, in the case of service nodes, advertises their routing databases. When a router receives an update packet from a service node, RTP extracts the VINES IP address and looks in the routing table for an existing entry on that service node. If it exists, RTP updates the entry and resets the entry's timer. If an entry does not exist, RTP creates one and initializes the timer for that entry.

Internet Control Protocol (ICP)

ICP generates network information messages on two types of packets destined for the local router:

- *Destination unreachable packet.* Indicates a packet could not reach its destination and was returned to its source. The router then issues an ELS message and flushes the packet.
- *Delay metric packet.* A request packet from a source node for the routing metric from the destination service node to the destination client node.

VINES Address Resolution Protocol (VINES ARP)

The VINES ARP protocol assigns unique VINES IP addresses to the client nodes. VINES ARP includes the following packet types:

- *Query request packet.* Packets the client nodes broadcast on initialization.
- *Query response packet.* The service node's response to a query request packet.
- *Assignment request packet.* The client node's response to a query response packet.
- *Assignment response packet.* Includes the network and subnet addresses the service node assigned to a client node.

To assign a VINES IP address to a client node, VINES ARP implements the following algorithm:

1. The client node broadcasts a query request packet.
2. Service nodes respond with a query response packet containing the destination MAC address of the client node and a broadcast VINES IP address.
3. The client node issues an assignment request packet to a service node that responded with a query response packet.
4. The service node responds with an assignment response packet that contains the VINES network and subnetwork addresses.

Each client node maintains a timer that has a default setting of two seconds. The timer starts when a client node transmits a query request or assignment request packet. The client node stops and resets the timer when it receives a query response packet. When a timeout period exceeds two seconds, the client node initializes, broadcasts a query request packet, and resets the timer. Table 36-2 summarizes the states the service and client nodes enter during VINES ARP implementation.

Table 36-2. Client and Service Node VINES ARP States

Client Node States	
Initialization	The client node is initializing.
Query	The client node is transmitting a query request packet.
Request	The client node received a query response packet from a service node and is transmitting an assignment request packet to the service node it heard from.
Assigned	The client node received an assignment response packet containing the VINES network and subnetwork addresses.
Service Node States	
Initialization	The VINES ARP protocol is initializing.
Listen	The service node is waiting for query request packets from the client nodes.
Service	The service node received a query request packet and sent a query response packet.
Assignment	The service node issues an assignment response packet containing the VINES network and subnetwork addresses.

Basic Configuration Procedures

The steps to initially configure each router that sends and receives VINES packets are as follow:

1. Assign a unique 32-bit hexadecimal address to each router in the VINES network. Using the **set network-address** *hex #* command, enter a network address from 30900000 to 3097FFFF. The network address for Banyan servers is the 32-bit hexadecimal serial number of the service node. This number is automatically read from the node server key.
2. Globally enable the VINES protocol using the **enable VINES** command.

3. Enable the interface cards that are to transmit and receive the VINES packets using the **enable interface** *interface#* command.

For configuration changes to take effect you must restart the router. Enter **reload** after the OPCON prompt (*) and answer **yes** to the following prompt:

```
Are you sure you want to reload the router? (Yes or No): yes
```

To view the configuration, enter the **list** command after the `VINES config>` prompt.

Running Banyan VINES on the Bridging Router

Banyan VINES servers must have this Banyan option to communicate with other servers or routers:

Server-to-server LAN.

To communicate across X.25 WANs, VINES servers directly connected to the WAN need these two options:

Server-to-server WAN
X.25 support on the server (hardware and software).

Running Banyan VINES over WAN Links

When you set up a PPP, Frame Relay, or X.25 link for use with VINES, you must set the HDLC speed of the link, even if you set the clocking to external.

If you set the HDLC speed to zero, VINES assumes that the speed is 56 Kbps. Do not set the speed to a value that is faster than the line.

Chapter 37. Configuring and Monitoring VINES

This chapter describes the VINES configuring and monitoring commands and includes the following sections:

- "Accessing the VINES Monitoring Environment" on page 37-5
- "VINES Monitoring Commands" on page 37-5

Accessing the VINES Configuration Environment

To access the VINES configuration environment, enter the following command at the `Config>` prompt:

```
Config> protocol vin
VINES Protocol user configuration
VINES Config>
```

VINES Configuration Commands

This section summarizes and then explains the VINES configuration commands. Enter these commands at the `VINES config>` prompt.

Table 37-1. VINES Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.
Add	Adds an X.25 address translation.
Delete	Deletes an X.25 address translation.
Disable	Disables the VINES protocol on all interfaces or a single interface and disables checksumming.
Enable	Enables the VINES protocol on all interfaces or a single interface and enables checksumming.
List	Displays the current VINES configuration.
Set	Assigns the network addresses to routers in the VINES network and sets the maximum number of physical neighbor client and service nodes.
Exit	Returns you to the previous command level. See "Exiting a Lower-Level Environment" on page xxviii.

Add

Adds an X.25 address translation.

Syntax:

add interface ...

Specifies the interface number.

remote-X.25-addr
Can include up to 15 digits. If the virtual circuit connection has been configured as PVC, the VINES *remote-X.25-addr* must match the PVC

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address configured at the X.25 prompt. If the addresses do not match, the system defaults to a switched virtual circuit (SVC).

handle user-configurable name that uniquely identifies each remote server.

Example: `add interface 0 4508907898 test`

Delete

Deletes an X.25 address translation.

Syntax:

delete interface ...

Specifies the interface number.

remote-X.25-addr
Can include up to 15 digits. If the specified interface has not been configured using the VINES **add interface** command, the terminal displays the message `That X.25 address has not been configured.`

Example: `delete interface 1 4799999999 compress`

Disable

Use the **disable** command to disable the VINES protocol on all interfaces or a single interface, or to disable checksumming.

Syntax:

disable checksumming ...
interface ...
vines

checksumming *interface#*
Disables checksumming on packets that the specified interface generates, broadcast packets excluded. For all interfaces, the default is checksumming disabled.

Example: `disable checksumming 0`

interface *interface#*
Disables the VINES protocol on the specified interface.

Example: `disable interface 1`

vines Disables the VINES protocol on all interfaces.

Example: `disable vines`

Enable

Use the **enable** command to enable the VINES protocol on all interfaces or a single interface, or to enable checksumming.

Syntax:

enable checksumming ...
interface ...
vines

checksumming *interface#*

Enables checksumming on packets that the specified interface generates.

Example: `enable checksumming 0`

interface *interface#*

Enables the VINES protocol on the specified interface.

Example: `enable interface 1`

vines Globally enables the VINES protocol. If you receive an error message after entering this command, contact your customer service representative. The VINES software may not be in your software load.

Example: `enable vines`

List

Use the **list** command to display the current VINES configuration.

Syntax:

list

Example: `list`

```
VINES:  enabled/disabled
VINES network number (hex):
Maximum Number of Routing Table Entries:
Maximum Number of Neighbor Service Nodes:
Maximum Number of Neighbor Client Nodes:

List of interfaces configured for VINES:

intf 0        (checksumming enabled/disabled)
intf 1        (checksumming enabled/disabled)
intf 2        (checksumming enabled/disabled)

VINES X.25 Configuration

Interface     Remote X.25 Address        Remote Handle
    0            4508907898              test

VINES config>
```

VINES Indicates whether VINES is globally enabled or disabled.

VINES network number (hex)

A configurable 32-bit hexadecimal address for routers in the VINES network.

Maximum Number of Routing Table entries

A configured value specifying the maximum number of entries allowed in the VINES routing table.

Maximum Number of Neighbor Service Nodes

A configured value specifying the maximum number of neighbor service nodes connected to the router.

Maximum Number of Neighbor Client Nodes

A configured value specifying the maximum number of client nodes connected to the router.

List of interfaces configured for VINES

Displays the interfaces that have VINES enabled and whether checksumming is enabled or disabled.

VINES X.25 Configuration

This information represents the following:

Interface The interface that is configured for X.25.

Remote X.25 Address

The DTE address of the remote server.

Remote Handle

A user-configurable name that uniquely identifies the remote server.

Set

Use the **set** command to assign network addresses to routers in the VINES network and to specify the maximum number of client and service nodes.

Syntax:

set client-node-neighbors ...
network-address ...
routing-table-size ...
service-node-neighbors ...

client-node-neighbors #

Specifies the maximum number of client nodes on your network. **Client-node-neighbors** includes all of the nodes on each network directly connected through the router. The range is 1 to 65535, and the default is 25.

Note: It is recommended that you set this number significantly higher than the number of nodes in your network. This will enable your network to continue functioning without reconfiguring and restarting the routers when additional nodes are added. The increase in this number depends on the size of your network and the amount of anticipated growth. As a rule, set **client-node-neighbors** 25 % higher than the actual number of client stations on LANs that are local to the router.

Example: `set client-node-neighbors 20`

network-address *hex#*

Assigns a network address to each router in the VINES network. *Hex#* is a 32-bit hexadecimal value from 30900000 to 3097FFFF.

Example: `set network-address 30922222`

routing-table-size *#*

Specifies the maximum number of service nodes and routers in the VINES network. The range is 1 to 65535, and the default is 300.

Note: Make sure that the number you specify is large enough to accommodate additional VINES servers and 8210s as your network grows.

Example: `set routing-table-size 250`

service-node-neighbors #

Specifies the maximum number of physical neighbor service nodes. This number includes VINES servers and 8210s that are the first point-of-contact after crossing a WAN. The range is 1 to 65535, and the default is 50.

Example: **`set service-node-neighbors 100`**

Accessing the VINES Monitoring Environment

To access the VINES monitoring environment,

```
* t 5
```

Then, enter the following command at the **+** prompt:

```
+ protocol vin
VINES>
```

VINES Monitoring Commands

This section describes the VINES monitoring commands. Enter these commands at the `VINES>` prompt.

Table 37-2. VINES Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Counters	Displays routing errors and the number of times the VINES input queue was full when packets were received from the specified interface.
Dump	Displays the current contents of the VINES routing and neighbor tables.
Route	Displays an entry from the VINES routing table.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Counters

Use the **counters** command to display routing errors and the number of times the VINES input queue was full when packets were received from the specified interface.

Syntax:

counters

Example: **`counters`**

```
  Routing Errors
Count           Type
-----           ----
  2          Net Unreachable
  3          Hop Count Expired
  3          Routing Update from Orphan Client
  0          Routing Redirect Received
  0          Routing Response Received

  VINES Input Packet Overflows
   Net      Count
   ---      -----
  Eth/0      5
  Eth/1      1
```

Net Unreachable
: The number of times the router received a packet destined for a node that was not found in the routing table.

Hop Count Expired
: The number of times the router discarded a packet because its hop count expired.

Routing Update from Orphan Client
: The number of times the router received an update packet from a client node whose service node does not exist. A routing update from an orphan client can occur when the router boots and hears from the client node first rather than the service node, or when a client's service node is down and an entry has been removed from the routing table database.

Routing Redirect Received
: The number of times the router received redirect packets from the service nodes.

Routing Response Received
: The number of times response packets were generated as a result of request packets initiated by the router.

VINES input packet overflows
: The number of times the VINES forwarder input queue was full when packets were received from the specified interface. The packets are subsequently discarded.

Dump

Use the **dump** command to display the contents of the VINES routing and neighbor tables.

Syntax:

d**ump**	neighbor-tables
	routing-tables

neighbor-tables
: Displays information about each neighbor service and client node connected to the router.

  Example: `dump neighbor-tables`

```
  Nbr Address    Intf     Metric  Age(secs)   H/W Addr    RIF
 ------------------------------------------------------------
  30622222:0001  TKR/0     4           30     0000C00     95012
  0035CC10:8000  Eth/0     2          120     0000C00     78221

   2 Total Neighbors
```

Nbr Address

The address of the neighbor node. In the above example, address 30622222:0001 is a service node and address 0035CC10:8000 is a client node.

Intf The medium to which the neighbor node is attached.

Metric An estimated cost, in 200-milliseconds, to route the VINES packet to the neighbor node.

Age (secs)

The current age, in seconds, for the entry. If a router does not receive a routing update from a neighbor at least every 360 seconds (6 minutes), the router removes the entry for that neighbor from the neighbor table and, if the neighbor is a service node, from the routing table.

H/W Addr

The node's LAN address if the neighbor is connected to a LAN. If the frame relay protocol is running, the H/W Addr is the Data Link Connection Identifier (DLCI). For X.25 interfaces, the H/W Addr is the X.25 address of the neighbor.

RIF Routing Information Field. A sequence of segment and bridge numbers, in hexadecimal, which indicate a path through the network between two stations. RIF is required for source routing.

routing-tables

Displays information about each service node known by the router.

Example: `dump routing-table`

```
Net Address  Next Hop Nbr Addr   Nbr Intf  Metric   Age (secs)
-----------  -----------------   --------  ------   ----------
S  30622222   30622222:0001      Eth/0        20         30
H  0027AA21   0027AA21:0001      Eth/1        2          120
P  0034CC11   0034CC11:0001      X.25/0       45         0

3 Total Routes

S ==> Entry is suspended, H ==> Entry is Holdown, P ==> Entry
is permanent
```

Net Address

The Net Address is a unique, configurable 32-bit hexadecimal value from 30900000 to 3097FFFF. This range of numbers is assigned to IBM by Banyan. It is very important that no two routers on a network are assigned the same Net Address. The Net Address for a Banyan service node is the 32-bit hexadecimal serial number of the service node. An S, H, or P preceding the Net Address field indicates the following:

S: The service node is in suspended state and is advertised, for 90 seconds, as being down. After 90 seconds, the router removes the entry for this service node from the routing table.

H: The service node is in hold-down state and is advertised, for 2 minutes, as being down. After 2 minutes, the router advertises the service node as operational. If a service node is in suspended state and it receives an RTP packet, the service node enters the hold-down state.

P: After initialization, the X.25 interface enters permanent state for 4 and 1/2 minutes. After 4 and 1/2 minutes, the neighbor enters the permanent state and its age stays at 0 while in this state. If the X.25 interface goes down, the entry is removed from the routing table.

Next Hop Nbr Addr
The address of the neighbor service node that is the next hop on the least-cost path to the network.

Nbr Intf The medium to which the next hop neighbor service node is attached.

Metric An estimated cost, in 200-milliseconds, to route the VINES packet to the destination service node.

Age (secs)
The current age, in seconds, for the entry. If a router does not receive a routing update about a service node that is in the routing table at least every 360 seconds (6 minutes), the router removes the entry for that service node from the routing table.

Route

Use the **route** command to view an entry from the routing table.

Syntax:

r**oute** given address

given address
The network address of the service node.

Example: `route 30622222`

```
Net Address  Next Hop Nbr Addr   Nbr Intf  Metric   Age (secs)
-----------  -----------------   --------  ------   ----------
30622222      30622222:0001       Eth/0       2       30
```

Chapter 38. APPN

This chapter describes APPN and includes the following sections:

- "What is APPN?"
- "What APPN Functions Are Implemented on the Router?" on page 38-3
- "APPN Network Node Optional Features" on page 38-6
- "Router Configuration Process" on page 38-16
- "APPN Configuration Notes" on page 38-29

Note: All references to token-ring and Ethernet apply emulated LANs.

What is APPN?

Advanced Peer-to-Peer networking (APPN) extends the SNA architecture by enabling Type 2.1 (T2.1) nodes to communicate directly without requiring the services of a SNA host computer.

Peer-to-Peer Communications

T2.1 nodes can activate connections with other T2.1 nodes and establish LU-LU sessions with other nodes. The relationship between a pair of T2.1 nodes is referred to as a *peer relationship* because either side can initiate communication.

Prior to APPN, a T2.1 node could communicate directly with another T2.1 node, but required the services of a centralized SNA host to locate its partner and any associated resources. All routes between the two nodes were predefined. APPN enhanced the T2.1 node function by:

- Requiring network resources to be defined only at the node where they are located
- Distributing information about these resources throughout the network as needed
- Dynamically generating routes between nodes using current information about the network's topology and the desired class of service

APPN Node Types

The APPN architecture allows four types of nodes in a network:

- APPN network nodes
- APPN end nodes
- Low-entry networking (LEN) end nodes
- PU 2.0 nodes supported by DLUR

The router can be configured as an APPN network node that supports connections with all four node types. The router cannot function as an end node for APPN.

APPN Network Node

An APPN network node provides directory and routing services for all resources (LUs) in its domain. A network node's domain consists of:

- Local resources owned by the node
- A control point (CP), which manages the node's resources

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- Resources owned by APPN end nodes and LEN end nodes that use the services of the network node

APPN network nodes also:

- Exchange information about the topology of the network. This information is exchanged each time network nodes establish a connection or when there is a change in the topology of the network (such as when a network node is deactivated, brought on line, or when a link is congested or fails). When a network node receives a topology update, it broadcasts this information to other active and network nodes with which it has CP-CP sessions.
- Act as intermediate nodes, receiving session data from one adjacent node and passing that data on to the next adjacent node along the route.

As a network node, the router can act as a server to attached APPN end nodes and LEN end nodes and provide functions that include:

Directory services
: The network node, communicating with other network nodes, can locate a resource in the network on behalf of an APPN end node. The network node also maintains a local directory of APPN and LEN end node resources that it can search on behalf of an attached APPN end node, attached LEN end node, or other network nodes.

Topology and Routing services
: At the request of an APPN end node, the network node dynamically determines the route from an origin logical unit (LU) to a destination LU in the network. The network node also maintains information on other network nodes and the routes to those nodes. The route is based on the current topology of the network.

Management services
: The network node can pass *alert* conditions to a designated focal point to allow centralized problem management. The network node is responsible for processing alert conditions for all the resources in its domain. “Managing a Network Node” on page 38-13 describes this process.

APPN End Nodes

An APPN end node provides limited directory, routing, and management services for logical units (LUs) associated with the node. An APPN end node selects a network node to be its network node server. If the network node agrees to act as the APPN end node’s server, the end node can register its local resources with the network node. This enables the network node server to intercept and pass along search requests for resources located on the APPN end node.

The APPN end node and its network node server communicate by establishing CP-CP sessions. An APPN end node may be connected to a number of network nodes, but only one of these nodes acts as the APPN end node’s server at any one time.

The APPN end node forwards all requests for unknown resources to the network node server. The network node server, in turn, uses its search facilities to locate the requested resource and calculate a route from the APPN end node to the resource.

LEN Nodes

A LEN node is a T2.1 node without APPN extensions. A LEN node can establish peer connections with other LEN nodes, APPN end nodes, and APPN network nodes, as long as all of the required destination LUs are registered with the LEN node. A LEN node can also serve as a gateway between an APPN network and a SNA subarea network.

Because a LEN node cannot establish CP-CP sessions with an APPN network node server, it cannot register its resources with the server or request that the server search for a resource and dynamically calculate a route to that resource. A LEN node may indirectly use the directory and routing services of a network node by predefining remote LUs (owned by nonadjacent nodes) as being located on an APPN network node, although the actual location may be anywhere in the network. When the LEN node needs to initiate a session with the remote LU, it sends a session activation request (BIND) for the LU to the network node. In this case, the network node acts as the LEN node's network node server, locating the requested resource, calculating a route, and forwarding the BIND to its correct destination.

When configuring the router network node, you can specify the names of LUs that are associated with an attached LEN end node. These LU names reside in the router network node's local directory. If the router network node receives a request to search for one of these LEN end node resources, it will be able to find the LU in its local directory and return a positive response to the node originating the search. To reduce the number of LU names you need to specify for an attached LEN end node, the router supports the use of generic LU names, which allow a wildcard character to represent a portion of an LU name.

PU 2.0 Nodes

A PU 2.0 node is a type T2.0 node containing dependent LUs. PU 2.0 nodes are supported by the Dependent LU Requestor (DLUR) function which is implemented by an APPN end node or network node. PU 2.0 nodes require the services of a system services control point, which is made available through the DLUR-enabled APPN node. Note that APPN nodes can contain dependent LUs supported by the DLUR function. However, the router does not contain dependent LUs.

What APPN Functions Are Implemented on the Router?

The router implements the APPN Release 2 base architecture functions as defined in the Systems Network Architecture APPN Reference. The APPN network node functions implemented by the router are summarized in Table 38-1. Notes on specific functions follow the table. For a description of the APPN management services supported by the router, see "Managing a Network Node" on page 38-13.

APPN uses LU 6.2 protocols to provide peer connectivity between CP-CP session partners. The router network node implements the LU 6.2 protocols required for CP-CP sessions and those used in sessions between a network node CP and its network management focal point. The router implementation of APPN does not provide an application program interface to support user-written LU 6.2 programs.

Table 38-1 (Page 1 of 3). Implementation of APPN Network Node Functions

APPN Function	Yes	No	Notes
Session services and supporting functions			
Multiple CP-CP sessions	X		

Table 38-1 (Page 2 of 3). Implementation of APPN Network Node Functions

APPN Function	Yes	No	Notes
Mode name to class of service (COS) mapping	X		1
Limited resource link stations	X		2
BIND segmentation and reassembly	X		3
Session-level security	X		4
Intermediate session routing			
Intermediate session routing	X		
Routing of dependent LU sessions	X		
Fixed and adaptive session-level pacing	X		
RU segmentation and reassembly	X		5
Directory services			
Broadcast searches	X		
Directed searches	X		
Directory caching	X		
Safe storage of directory services cache		X	6
Central directory server		X	7
Central directory client	X		7
Registration of APPN EN LUs with network node server	X		
Definition of LEN node LUs on network node server	X		
Use of wild cards to define attached LEN node resources	X		
Accept multiple “resource found” conditions	X		
Network node server for DLUR EN - Option set 1116	X		
Topology and routing services			
Topology exchange	X		
Periodic topology broadcasts	X		8
Topology database maintenance	X		9
Topology awareness of CP-CP sessions	X		
Randomized route computation	X		10
Cached routing trees	X		11
Safe storage of topology database		X	
Garbage Collection Enhancements	X		
Connectivity			
Connection network definition	X		12
Multiple transmission groups	X		
Parallel transmission groups	X		
Management services			
Multiple domain support (MDS)	X		
Explicit focal point	X		

Table 38-1 (Page 3 of 3). Implementation of APPN Network Node Functions

APPN Function	Yes	No	Notes
Implicit focal point	X		
Held alerts	X		
SSCP-PU sessions with focal points		X	
SNA/MS problem diagnosis data in alerts	X		

Notes:

1. New mode names can be defined on the router using the Command Line interface. These new mode names can be mapped to existing Class of Service (COS) definition names or to new COS definitions, which may be defined using the Configuration tool.
2. Limited resource link stations are supported for:
   - connection network links
   - ATM SVC.
3. When the router activates a TG to an adjacent node, it negotiates with that node the maximum message size that can be sent across the TG. If a BIND message is larger than the negotiated message size, the router segments the BIND. Segmentation only occurs if the adjacent node is capable of reassembling the BIND. The router supports BIND reassembly.
4. A session level security feature can be enabled for connections between the router network node and an adjacent node. Both partners in the connection require a matching hexadecimal key that enables each node to verify its partner before the connection is established.
5. When routing session data to an adjacent node, the router segments a request/response unit (RU) if the message unit exceeds the maximum message size that can be sent across the transmission group. If the router receives a segmented RU, the node reassembles it.
6. After successfully locating a resource in the APPN network, the router stores or *caches* this information in its local directory database for future use. However, the router does not save these cached directory entries to a permanent storage medium, such as a disk, to provide for recovery if the node fails.
7. The router cannot be used as a central directory server for an APPN network. The router is capable of using a central directory server, however, to obtain directory information about the location of a resource in the network.
8. To prevent other network nodes from discarding information about the router from their topology databases, the router creates a topology database update (TDU) about itself and its locally-owned transmission groups every 5 days and broadcasts this TDU to network nodes.
9. An interval timer is associated with every resource entry in the router's network topology database. If the router does not receive any information about a resource within 15 days, it discards the entry for that resource from the database.
10. If there is more than one least-weight route from an origin LU to a destination LU for a given class of service, the router randomly selects one of these routes for the session. This practice helps distribute the flow of traffic in the network.

11. The router maintains a copy of the network topology database. The database identifies the available routes to other network nodes for a particular class of service. When the router needs to calculate a route to a network node or to an end node adjacent to that network node, it uses information in the topology database to generate a routing tree for that network node. The routing tree identifies the optimal routes to the network node for the class of service required.

    When the router generates a new routing tree, it stores that tree in a cache. When the router receives a service request, it checks this cache first to see if a route has been computed. Use of the cache reduces the number of route calculations required. When the router receives topology information that invalidates a routing tree, it discards the tree. The router recalculates the tree as needed and caches the new tree.

12. The router can be defined as a member of a connection network on Ethernet ports, Token-Ring ports, HPR over IP, and ATM ports.

APPN Network Node Optional Features

In addition to the base APPN Architecture functions, the router also implements the following option set towers and new functions:

087 Garbage Collection Enhancements

1002 Adjacent Link Station name

1007 Parallel TGs

1012 LU name = CP name

1067 Dependent LU Requester

1071 Generalized ODAI Usage

1101 Preloaded Directory Cache

1107 Central Resource Registration (of LUs)

1116 Network Node Server support for DLUS-Served LU registration

1119 Report Branch Topology to a Manager

1120 Branch Awareness

1200 Tree Caching and TG Caching

1201 Permanent Storage Medium

1400 High-Performance Routing (HPR)

1401 Rapid Transport Protocol (RTP)

1402 Control Flows over RTP

Node performance tuning

Node service traces

Accounting and node statistics collection

High-Performance Routing

HPR is an enhancement to APPN architecture that provides better performance over high speed, low error rate links using existing hardware. HPR replaces the normal APPN intermediate session routing (ISR) with a Network Control Layer (NCL) containing a new type of source routing function called automatic network routing (ANR). The complete HPR route is contained in the ANR packet allowing intermediate routing nodes to route the packets with less processing overhead and storage.

HPR also eliminates the error recovery and flow control (session-level pacing) procedures for each link between nodes and moves the error recovery and flow/congestion control procedures to the end-points of an HPR connection. A transport layer using a new error recovery procedure called Rapid Transport Protocol (RTP) is used by the endpoints of the HPR connection. HPR intermediate nodes have no session or RTP connection awareness. This new transport layer features:

- Selective retransmission error recovery procedure
- Segmentation and reassembly
- Adaptive Rate-Based (ARB) flow and congestion control mechanism that meters data onto a route that allows efficient utilization of network resources while minimizing congestion. ARB uses a preventative rather than reactive approach to flow and congestion control.
- Nondisruptive Path Switch (NDPS) function that automatically reroutes traffic around node or link failures without disrupting end user sessions.
- Detection of Forward Explicit Congestion Notification (FECN) bit set, allowing RTP's adaptive rate-based flow and congestion control algorithm to adjust the data send rate. This algorithm prevents traffic bursts and congestion, maintaining a high level of throughput.

The router implements both ANR routing and Rapid Transport Protocol. Therefore, the router can function both as an intermediate routing HPR node and as an HPR connection endpoint node.

Interoperability

HPR uses APPN network control functions including class of service (COS)-based least-weight route calculation and transmission priority. HPR interoperates seamlessly with APPN ISR:

- The network automatically adapts to the presence of HPR-capable nodes and HPR-enabled links.
- An APPN network can have any mix of ISR and HPR links, although the greatest benefit of HPR is realized when the network has three or more HPR-enabled nodes with two or more HPR-capable links back-to-back. This allows the middle HPR node to be an HPR intermediate node and use only ANR routing, allowing session data to be routed through the middle node using only NCL.
- A given session route can be made up of a combination of ISR and HPR links.
- HPR uses the same TG and node characteristics for least-weight route calculation as APPN ISR. No special consideration is given to HPR capable nodes or links other than their potentially improved characteristics (such as higher effective capacity if a higher speed link).

Traffic types

APPN ISR uses the IEEE 802.2 LLC Type 2 protocol for token-ring and Ethernet. APPN HPR, which is supported on token-ring and Ethernet, does not use LLC Type 2 protocol, but does use some functions of an APPN link station for XID and inactivity timeout. A single APPN link station is therefore used for ISR or HPR. Different mechanisms are used to distinguish between ISR and HPR traffic depending upon the DLC type.

Each protocol that uses a port must have a unique SAP address. A unique SAP address identifies the APPN link station for HPR traffic (Local HPR SAP address parameter). If ISR traffic is destined for a link station, then a different SAP address (Local APPN SAP address parameter) must be used. The ISR traffic uses LLC Type 2 LAN frames. The HPR traffic is handled in similar fashion to LLC Type 1 LAN frames and must have a different SAP address.

The default SAP address for HPR traffic is X'C8'. If X'C8' has already been used by another protocol on a port, the default must be overridden.

Note: There is only one APPN link station even though APPN ISR and HPR traffic use different SAP addresses.

Dependent LU Requester (DLUR)

The DLUR option extends the support of T2.0 or T2.1 devices containing dependent LUs to APPN nodes. The DLUR function on an APPN network node or an APPN end node works in conjunction with a dependent LU server (DLUS) in a mixed APPN/subarea network. The DLUS function may reside in some other part of the mixed network from the DLUR.

The dependent LU flows (SSCP-PU and SSCP-LU) are encapsulated over an LU 6.2 (CP-SVR) pipe established between the DLUR APPN node and the DLUS SSCP. The CP-SVR pipe is made up of a pair of LU 6.2 sessions using a new CPSVRMGR mode between the DLUR and the DLUS. This pipe brings the SSCP function (in the DLUS) to the DLUR APPN node where it can be made available to attached T2.0/T2.1 nodes containing dependent LUs.

The dependent LU will appear to be located within the domain of the serving SSCP. Session initiation flows will be emulated from the DLUS, but session bind and data paths will be calculated directly between the dependent LU and its session partner. This path may or may not traverse the serving DLUS node.

Set the adjacent node type parameter to **PU 2.0 Node** when defining a link station to a T2.0 adjacent node containing dependent LUs. Set the adjacent node type parameter to **APPN end node** or **LEN end node** when defining a link station to a T2.1 adjacent node containing dependent LUs.

Functions Supported

The APPN DLUR option includes the following functions:

- Support for downstream T2.0 nodes containing dependent LUs that respond with XID type 0 and XID type 1.
- Support for downstream T2.1 nodes containing dependent LUs that respond with XID type 3.
- Support for dependent LUs that is equivalent to the support provided by the Subarea environment for:

- Activating PUs and their LUs
- Locate and be located by other LUs in an APPN or subarea network
- Determine LU's characteristics
- Allow terminal operators to logon to applications both in APPN and subarea networks
- SSCP takeover
- Uninterrupted LU-LU sessions, if the supporting DLUS (SSCP) fails
- SLU init, PLU init, and Third-party init

Restrictions

The DLUR option, as implemented on the router network node, has the following functional restrictions:

- Only secondary LUs (SLUs) can be supported by the DLUR function. An LU supported by DLUR cannot function as a primary LU (PLU). Therefore, the downstream physical unit (DSPU) should be configured as secondary.
- Because only SLUs are supported, Network Routing Facility (NRF) and Network Terminal Option (NTO) are not supported.
- Extended recovery facility (XRF) and XRF/CRYPTO are not supported.
- DLUR and DLUS must be in the same APPN topology network, but they can be in different subnets. The CPSVRMGR session cannot pass through a subarea network. If the Border Node (either the same netid or different netid) is used, the DLUR can reside in a different (sub-)network than DLUS.

VTAM Considerations for DLUR

The following are example VTAM Switched Major Node definitions for DLUR. You should note that PATH statements are necessary only if VTAM is initiating the connection to the DSPU.

You should refer to *VTAM Resource Definition Reference* SC31-6427, for details of the DLC parameter statements for the Switched Major Node definitions.

```
DABDLURX VBUILD TYPE=SWNET,MAXGRP=400,MAXNO=400,MAXDLUR=20
************************************************************************
*IN THE DLCADDR, THE 'SUBFIELD_ID' = CV SUBFIELD OF THE CV91           *
* MINUS 0X90.                                                          *
*FOR EXAMPLE, THE CV94 SUBFIELD IS CODED ON DLCADDR=(4,X,...           *
************************************************************************
************************************************************************
* Following are PU Statements for 2.0 and for 2.1
************************************************************************
************************************************************************
* 2.0 PU STATEMENT
************************************************************************
*PU20RT   PU   ADDR=05,PUTYPE=2,MAXPATH=8,ANS=CONT,USSTAB=AUSSTAB,
*              ISTATUS=ACTIVE,MAXDATA=521,IRETRY=YES,MAXOUT=7,
*              PASSLIM=5,IDBLK=017,IDNUM=00035,MODETAB=AMODETAB
*              LOGAPPL=ECHO71,DLOGMOD=M23278I 1
************************************************************************
* Path statements are not required if the DSPU is initiating the
* connection to VTAM
************************************************************************
*PU20LU1  LU    LOCADDR=2          11
*PU20LU2  LU    LOCADDR=3
*PU20LU3  LU    LOCADDR=4
************************************************************************
* 2.1 PU STATEMENT
************************************************************************
*PU21RT   PU   ADDR=06,PUTYPE=2,CPNAME=PU21RT,ANS=CONT,MAXPATH=8,
*              ISTATUS=ACTIVE,USSTAB=AUSSTAB,MODETAB=AMODETAB
*              LOGAPPL=ECHO71,DLOGMOD=M23278I   1
************************************************************************
************************************************************************
* There is no difference in the path statement definitions
* between a PU 2.0 and a PU 2.1
*
* Path statements are required if VTAM is initiating the connection
* to the DSPU.
*
************************************************************************
```

```
************************************************************************
************************************************************************
* LU statements
************************************************************************
************************************************************************
*PU21LU1  LU    LOCADDR=2          11
*PU21LU2  LU    LOCADDR=3
*PU21LU3  LU    LOCADDR=4
************************************************************************
```

Notes:

1 The difference between PU statement coding is:

- For 2.0 definitions, the PU statement has IDBLK=...,IDNUM=....
- For 2.1 definitions, the PU statement has CPNAME=....

2 Port name in ASCII defined on the router and used by DSPU

3 SAP of DSPU (noncanonical, except for Ethernet)

6 MAC address of the DSPU (noncanonical, except for Ethernet MAC address, which is canonical)

7 DLSw appears to VTAM like a token ring DLC

11 LU coding

APPN Connection Network

When nodes are attached to a shared-access transport facility (SATF), any-to-any connectivity is possible. This any-to-any connectivity allows direct connections between any two nodes, eliminating routing through intermediate network nodes and the corresponding data traversing the SATF multiple times. To achieve this direct connectivity, however, TGs must be defined on each node for all the other possible partners.

Defining connections between all possible pairs of nodes attached to the SATF results in a large number of definitions (increasing on the order of the square of the number of nodes involved) and also a large number of topology database updates (TDUs) flowing in the APPN network. To alleviate these problems, APPN allows nodes to become members of a connection network to represent their attachment to an SATF. Session traffic between two nodes that have been defined as members of a connection network can be routed directly, without passing through a network node (achieves direct connectivity). To become a member of a connection network, an APPN node's port must be "attached" to a Connection Network by defining a connection network interface. When the port is defined, a Connection Network TG is created by the APPN component to identify the direct connection from the port to the SATF (i.e. the connection network). This TG is not a conventional TG as in the case of defined link stations, but rather represents the connection to the Connection Network in the topology database.

Note: TGs for end nodes are not contained in the network topology database, but are contained in the node's local topology database. TDUs do not flow through the network when a connection is established through a Connection Network or when an end node is made a member of a Connection Network.

Because the connectivity is represented by a TG from a given node to a Connection Network, normal topology and routing services (TRS) can be used for the network node server to calculate the direct path between any two nodes attached to the SATF (with TGs to the same Connection Network). DLC signaling information is returned from the destination node during the normal locate process to enable the origin node to establish a connection directly to the destination node.

Therefore, to achieve direct connectivity on an SATF, instead of each node on the SATF being defined (or connected) to each other, each node is connected to a Connection Network. The Connection Network is often visualized as a virtual node on the SATF to which all other nodes are attached. This model is frequently used and, in fact, the term Virtual Routing Node (VRN) is often interchanged with the term Connection Network.

When a connection network is defined, it is named. This name then becomes the CP name of the VRN and must follow all the requirements of any CP name. See Table 39-21 on page 39-41 for a list of these requirements.

Restrictions

- The same connection network (VRN) can be defined on only one LAN. The same VRN can be defined on multiple ports having the same characteristics to the same LAN however.
- There is only one connection network TG from a given port to a given connection network's VRN.

- Because the VRN is not a real node, CP-CP sessions cannot be established with or through a VRN.
- When a connection network is defined on the router network node, a fully qualified name is specified for the *connection network name* parameter. Only connection networks with the same network ID as the router network node may be defined. The network ID of the VRN is then the same as the network ID of the router network node.

Branch Extender

The Branch Extender (BrNN) function is designed to optimize the connection of a branch office to an APPN WAN backbone network. The BrNN isolates all the end nodes on one or more branch office LANs from the backbone WAN. The domain of a BrNN may contain only end nodes and cascaded BrNNs. The domain of a BrNN does not contain network nodes or nodes with DLUR.

When configuring a BrNN, configure link stations to the backbone to be uplinks. This causes the BrNN to appear as a conventional end node to the backbone. From the perspective of the backbone, all resources in the domain of the BrNN appear to be owned by the BrNN, hiding the topology of the BrNN's domain from the backbone and reducing the number of broadcast locates in the backbone.

A BrNN presents a conventional network node interface over downlinks. End nodes in the domain of the BrNN register their resources with the BrNN and use the BrNN as a conventional network node server.

A BrNN accomplishes:

- Reduction of the number of network nodes in a large APPN network.
- Hidden branch office topology from the WAN.
- Direct, peer-to-peer communication between defined branches connected to the same connection network.
- Reduces CP-CP session traffic on the WAN link.

The following are limitations of Branch Extender:

- Network nodes are allowed to connect only over links that a BrNN defines as uplinks.
- Only end nodes or cascaded BrNNs may be attached to a BrNN downlink. Border nodes acting as end nodes and DLUR nodes may not be attached to a BrNN downlink.
- A node cannot connect to a Branch Extender over an uplink and a downlink at the same time.
- A BrNN can have CP-CP sessions with only one network node at a time.

Branch Extender vs Border Node

Both Branch Extender and Border nodes serve to minimize network topology. The choice of which to use depends upon the network.

A **branch extender** is the appropriate choice when you have a single network with one or more groups of end nodes where each group of end nodes typically needs to communicate with other end nodes in that group, and only occasionally need to

interact with the backbone network. In this case, a branch extender allows you to connect a group of end nodes to the backbone. None of the devices downstream from the branch extender may be network nodes, DLUR, VTAM, or VTAM end nodes. With the branch extender in place the backbone network's view of the branch extender is as a giant end node with all the downstream LUs being owned by this giant end node. The backbone has no knowledge of the topology downstream from the branch extender, thus reducing the overhead of topology exchanges. Conversely, the branch extender's network node server, which is part of the backbone, will have knowledge of all the LUs owned by the branch extender if the branch extender is configured to register resources. This serves to reduce the number and size of broadcast searches.

A **border node** is the appropriate choice when you have multiple networks you want to tie together, or when you have a large network you want to subdivide without restriction on what node types are allowed in the subdivided pieces. There is no concept of upstream or downstream and you can have additional border nodes, network nodes, end nodes, DLUR, VTAM, or VTAM end nodes located anywhere in your network. Unlike the branch extender, a border node cannot register resources from another network.

Managing a Network Node

The router network node can act as an APPN entry point that forwards APPN-related alerts to an APPN focal point. APPN focal points may be defined explicitly or implicitly.

You can use SNMP to access these IETF standardized MIBs:

- APPC (RFC 2051)
- APPN (RFC 2155)
- HPR (RFC number not available in time for publication)
- DLUR (RFC number not available in time for publication)

You can also use SNMP to access these enterprise-specific MIBs:

- IBM APPN Memory
- IBM Accounting
- IBM HPR NCL
- IBM HPR Route Test
- IBM Branch Extender Node

Entry Point Capabilities for APPN-related Alerts

The router network node can serve as an APPN entry point for alerts related to the APPN protocol. As an entry point, the router is responsible for forwarding APPN and LU 6.2 generic alerts about itself and the resources in its domain to a *focal point* for centralized processing. A focal point is an entry point that provides centralized management and control for other entry points for one or more network management categories.

Note: If a focal point is not available to receive an alert from the device, the alert is held (stored) by the device.

Entry points that communicate with a focal point make up that focal point's *sphere of control*. If a focal point explicitly defines the entry points in its sphere of control

and initiates communication with those entry points, it is an *explicit focal point*. If a focal point is designated by its entry points, which initiate communication with the focal point, the focal point is an *implicit focal point*. The focal point for the router can be either an explicit or implicit focal point.

If the session between the router entry point and its primary focal point fails, the router can initiate a session with a designated backup focal point. Before initiating a session with a backup focal point, the router entry point makes an attempt to reestablish communication with its primary focal point. If that attempt fails, the router switches to the backup focal point. After switching to a backup focal point, the router will periodically attempt to re-establish its session with the primary focal point. The interval between attempts is doubled each time an attempt fails until a maximum interval of one day is reached. From that point on, the attempt is performed daily.

Notes:

1. If the focal point is explicit and the explicit focal point retains the re-establishment responsibility for itself, this retry mechanism is disabled.
2. If the focal point is explicit and assigns re-establishment responsibility to the router, the router will attempt to re-establish communication until the next restart of APPN in the router.

The router entry point communicates with the focal point through an LU 6.2 session. Multiple-domain support (MDS) is the mechanism that controls the transport of management services requests and data between these nodes. The router network node does *not* support SSCP-PU sessions with focal points.

Management processes within the router's control point are handled by its control point management services (CPMS) component. The CPMS component within the router network node collects unsolicited problem management data from resources within the router's domain and forwards this data to the appropriate focal point.

Supported Message Units

The router network node uses the following message units for sending and receiving management services data, including alert messages from domain ENs:

Message unit	Description
CP-MSU	Control point management services unit. This message unit is generated by CPMS and contains alert information forwarded by the router entry point. CPMS passes CP-MSU message units to MDS.
MDS-MU	Multiple-domain support message unit. This message unit is generated by MDS. It encapsulates the CP-MSU for transport between nodes.

SNMP Capabilities for APPN MIBs

An operator or application at an SNMP network management station can query objects in the APPN MIBs (using the SNMP **get** and **get_next** commands) to retrieve APPN status information and node statistics. A subset of APPN MIB objects can be modified using the SNMP **set** command.

Topology Database Garbage Collection

Information flows between APPN NNs to inform the NNs about network resources. Each NN keeps a topology database consisting of the names and characteristics of those resources. When a resource is eliminated from the network, it can also be deleted from each NN topology database. When a NN detects that a resource in its topology database is obsolete, the node will broadcast information stating that the resource should be garbage-collected. If NNs receiving this information support Enhanced Garbage Collection, they should delete that resource from their topology database. The record is not actually garbage-collected until the next garbage collection cycle. A NN examines each resource in its topology database once a day.

Configurable Held Alert Queue

The configurable held alert queue function allows you to configure the size of the held alert queue. If a focal point is not available, the held alert queue saves APPN alerts. When a focal point becomes available, the held alerts are sent. If more alerts arrive than can be held, the oldest alerts are discarded.

Note: If you configure a large value for the **Held Alert Queue Size**, the extra memory should be accounted for. You can do this by letting the tuning algorithm automatically calculate the **Maximum Shared Memory** value. See “APPN Node Tuning” on page 38-24 for additional information about the node tuning algorithm.

Implicit Focal Point

A focal point is a node with centralized management responsibility. The managing node can contact the managed node (router) and establish a management session. The managing node is then an explicit focal point. When the name of the managing node is configured at the router and the router can initiate a management session, the managing node is an implicit focal point. You can configure a single, primary implicit focal point with up to eight backup implicit focal points, where each focal point is a fully qualified network name. The router will attempt to contact each focal point in order until a successful management session is established.

If the management session is with a backup implicit focal point, the device will periodically attempt to re-establish its session with the primary implicit focal point. The interval between attempts is doubled each time an attempt fails until a maximum interval of one day is reached. From that point on, the attempt is performed daily.

Note: If an explicit focal point initiates a management session with a device, it will cause a session with an implicit focal point to terminate.

HPR over IP

HPR over IP allows HPR/APPN applications to run over an IP backbone network and still take advantage of APPN Class of Service. HPR over IP encapsulates HPR data into a UDP/IP packet for delivery over the IP network.

Supported DLCs

Table 38-2 shows the DLC ports supported by the device over APPN:

Table 38-2. Port Types Supported for APPN Routing

Port Type	Standard	HPR	ISR	DLUR*
DLSw (remote only) ***		No	Yes	Yes
LANE	Forum compliant	Yes	Yes	Yes
ATM		Yes	No	Yes
HPR over IP		Yes	No	Yes

Notes:

1. * This column refers to the port providing the connection to the downstream PU (DSPU).

Router Configuration Process

This section describes the router configuration process and includes details about parameters.

Configuration Changes That Require the APPN Function to Restart

- Network ID of the network node
- Control point name of the network node
- XID number (of network node) for subarea connection
- Adjacent node type (of link station)
- Any parameters under the following options:
  - High-Performance Routing (HPR) at the node level
  - Dependent LU Requester (DLUR) at the node level
  - Connection network
  - Class of service
  - Node tuning
  - Node management
  - Mode name mappings
  - Delete TN3270E

Configuration Requirements for APPN

APPN routing is configured on the individual adapters supporting the DLC desired. To use APPN routing, at least one of the following DLCs must be configured and enabled:

- Token-ring emulated LAN ports
- Ethernet emulated LAN ports

You can configure these APPN Network Node Features:

- High-Performance Routing parameters (optional)
- Connection networks for LAN ports (optional)
- Dependent LU Requester (optional)

Configuring the Router as an APPN Network Node

You can configure the router as an APPN network node in one of three ways, depending on the level of connectivity you desire with other nodes.

- Minimum configuration
- Initiate connections configuration
- Controlling connections configuration

Minimum Configuration

This group of APPN configuration steps:

- Allows the network node to accept any request it receives from another node to establish a connection.
- Restricts the network node from initiating connections with other nodes.

If you choose the minimum configuration steps, adjacent nodes must define connections to the router network node to ensure connectivity. Because APPN nodes can initiate CP-CP sessions with the router network node, these nodes do not need to be defined in the router's configuration. In general, when configuring APPN on the router, you can simplify the task considerably by allowing the router network node to accept connection requests from any node. Configuring the network node in this manner eliminates the need to define information about adjacent nodes, except in the following cases:

- The adjacent node is a LEN end node. LEN end nodes do not support CP-CP sessions, so information about such nodes and their LU resources must be configured on the router network node.
- You want the router network node to be able to initiate a CP-CP session with an adjacent APPN node.

In these cases, you must specify information about the adjacent node when enabling APPN routing on the specific port you are using to connect to the adjacent node, and should follow the configuration steps described in “Initiate Connections Configuration” on page 38-18.

Use the following procedure for minimum configuration steps:

1. If you are configuring APPN using a DLSw port:
   a. Enable bridging on the node
   b. Enable DLSw on the node
   c. Define the DLSw port with a locally administered MAC address for DLSw.
2. Enable APPN routing on the port.

   Note: Since *Service Any* is enabled by default, the node accepts any request for a connection that it receives from another node.
3. Enable the APPN Network Node.
4. Configure the following parameters:
   - Network ID
   - Control point name
5. Define the XID number for subarea connections parameter for the APPN network node (optional).
6. Accept all other defaults.

7. Optionally do the following:
   - Modify High-Performance Routing parameters
   - Configure Dependent LU Requester
   - Define connection networks
   - Define new COS names or mode name mappings
   - Tune the performance of this node
   - Perform node service trace diagnostics
   - Collect statistics for this network node

Notes:

1. APPN routing must be defined and enabled on the specific ports you configure the router network node to use.
2. Bridging and DLSw must still be enabled on the specific adapter ports you desire the device network node to use.

Initiate Connections Configuration

This group of APPN configuration steps:

- Allows the network node to accept any request it receives from another node to establish a connection.
- Enables the network node to initiate connections with other nodes that you specify, including LEN end nodes.

Because APPN nodes can initiate CP-CP sessions with the router network node, these nodes do not need to be defined in the router's configuration, except in the following cases:

- The adjacent node is a LEN end node. LEN end nodes do not support CP-CP sessions, so information about such nodes and their LU resources must be configured on the router network node.
- You want the router network node to be able to initiate a CP-CP session with an adjacent APPN node.

If neither of these cases apply to your configuration, you should follow the configuration steps described in “Minimum Configuration” on page 38-17.

Use the following procedure for initiate connections configuration :

1. If you are configuring APPN using a DLSw port:
   a. Enable bridging on the node
   b. Enable DLSw on the node
   c. Define the DLSw port with a locally administered MAC address for DLSw.
2. Select the ports over which to initiate connections to adjacent nodes. The following are the DLC port types supported by APPN:
   - DLSw
   - Emulated token-ring LAN port
   - Emulated Ethernet LAN port
3. Enable APPN routing on APPN ports with the *enable APPN routing on this port* parameter.

   Note: Since *Service Any* is enabled by default, the node accepts any request for a connection that it receives from another node.

4. Define APPN link stations on the selected DLC ports for the adjacent nodes to which this network node may initiate a connection.

   Note: Link stations do not have to be defined on every port, only those over which you want to initiate connections to adjacent nodes.

5. Enable the APPN network node.
6. Configure the following parameters for the APPN network node:
   - Network ID
   - Control point name
7. Define the XID number for subarea connections parameter for the APPN network node (optional).
8. Accept all other defaults
9. Optionally do the following:
   - Modify High-Performance Routing parameters
   - Configure Dependent LU Requester
   - Define connection networks
   - Define new COS names or mode name mappings
   - Tune the performance of this node
   - Perform node service trace diagnostics
   - Collect statistics for this network node

Controlling Connections Configuration

This group of APPN configuration steps:

- Allows the network node to accept requests only from nodes that you specify.
- Enables the network node to initiate connections with other nodes that you specify, including LEN end nodes.

This configuration provides a higher level of security because you explicitly define which APPN nodes may communicate with this router network node. A connection request from an adjacent node will be accepted only if its fully qualified CP name parameter has been configured on this network node. This group of configuration steps optionally enables you to have a secure link with each adjacent node by configuring the session level security feature for each link.

Use the following procedure for the controlling connections configuration:

1. Select ports over which you desire to establish connections to adjacent nodes from the following DLC port types supported by APPN:
   - Emulated token-ring LAN port
   - Emulated Ethernet LAN port
   - IP
2. Define ports selected as direct APPN ports with the following parameters:
   - Enable *APPN routing* on this port
   - Disable the *service any port* parameter
3. If you are configuring APPN using a DLSw port:
   - Enable bridging on the node
   - Enable DLSw on the node.
   - Define the DLSw ports with the following parameter:
     - Define a locally administered MAC address for DLSw

– Disable the *Service any* node parameter

4. Enable APPN routing on the port.
5. Define APPN link stations on the selected DLC ports for the adjacent nodes:
   - that may initiate a connection to this network node.
   - which you desire this router network node to initiate a connection.

   Specify the following link station parameters:
   - Fully Qualified CP name of adjacent node (required)
   - Any required addressing parameters for adjacent node
   - And optionally:
     CP-CP Session Level Security
     Security Encryption Key
6. Enable the APPN network node.
7. Configure the following parameters for the APPN network node:
   - Network ID
   - Control point name
8. Define the XID number for subarea connections parameter for the APPN network node (optional):
9. Accept all other defaults.
10. (Optional) Configure the following router network node options:
    - Modify High-Performance Routing parameters
    - Configure Dependent LU Requester
    - Define connection networks
    - Define new COS names or mode name mappings
    - Tune the performance of this node
    - Perform node service trace diagnostics
    - Collect statistics for this network node

Configuring Branch Extender

To configure Branch Extender, set the following configuration parameters as appropriate for your network.

1. Use the **set node** command to:
   a. Answer yes to the *Enable Branch Extender* question. If you answer no, none of the following Branch Extender questions will appear.
   b. Answer yes or no to the *Permit search for unregistered LUs* question depending on whether or not you want to allow searches from the backbone for LUs that were not registered with the network node server.
   c. Your answer to the *Branch uplink* question will determine the default for the analogous link level question.
2. Use the **add link** command to:
   a. Answer yes to the *Branch uplink* question if you want the router to appear as an end node on this link. An end node is for links to network nodes in the backbone. Note that this question doesn't appear and is forced to yes if you have defined the adjacent link station to be a network node on one of the earlier configuration prompts. Answer no if you want the router to

appear as a network node on this link. A network node is for links to end nodes

b. The *Is uplink to another Branch Extender node* question is asked only if this link has been defined as a limited resource and has also been defined as a Branch Extender uplink. Answer yes if the adjacent node is another Branch Extender.

c. The *Preferred network node server* question is asked only if the adjacent node is a network node and CP-CP sessions are supported on this link. Since you can only have a single preferred network node server you won't be prompted for this question once it has been set to yes on any link.

High-Performance Routing

See “Configuration Requirements for APPN” on page 38-16 for information about configuring the protocols that support APPN and HPR routing on the router. In the case of HPR parameters such as retry and path switch timers, the configuration is done at the node level and is not specified on individual adapters.

DLUR

See Table 38-2 on page 38-16 for a list of ports that support DLUR.

Configuring Focal Points

Focal points can be explicit or implicit. Explicit focal points are configured at the focal point itself. No configuration at the router is required.

Implicit focal points on the other hand are configured at the router. You configure them with the command **add focal_point**. Add the primary implicit focal point first. If you add another focal point, it is known as the first backup implicit focal point. If you add yet another, it is known as the second backup implicit focal point. Up to eight backup implicit focal points may be added for a total of 9.

To delete a focal point use the command **delete focal_point**. You will be prompted for the name of the focal point to delete. When the name is deleted, the remaining focal points retain their relative position with each other. Subsequent focal points will be added at the end of the list.

There is no way to insert a focal point in the middle of the list. You must delete them one at a time and then re-enter the entire list.

Configuring Held Alert Queue Size

To configure the size of the held alert queue enter the command **set management** and answer the ***Held Alert Queue Size*** question. The queue defaults to a size of 10 alerts, and valid values are from 0 thru 255 alerts.

As you increase the size of the held alert queue, additional memory is needed. If you set it to a high value, you may want to adjust the "Maximum Shared Memory" value. See“APPN Node Tuning” on page 38-24 for additional information.

Defining Transmission Group (TG) Characteristics

When you configure APPN on the router, you can specify the Transmission Group (TG) characteristics for the link station that defines a connection between the router network node and an adjacent node. These characteristics, such as the security of a link or its effective capacity, are used by APPN when calculating an optimum or least-weight route between nodes in the APPN network.

APPN on the router uses a set of default TG characteristics for each port (or DLSw port). These defaults, defined by the *default TG characteristics* parameter apply to all the TGs for link stations defined on a port unless they are overridden for a particular link station by the *modify TG characteristics* parameter.

These default TG characteristics are also used for dynamic link stations established when an adjacent node requests a connection with the router network node, but does not have a predefined link station definition on the router network node. The *Service any node* parameter must be enabled.

You can change the following parameters using the router **talk 6**> interface as well as the Configuration Program:

time cost
byte cost
user-defined TG characteristics 1 - 3
effective capacity
propagation delay
security

Calculating APPN Routes Using TG Characteristics

The APPN route calculation function uses a COS definition for TGs which is a table containing rows of TG characteristic ranges. Each row defines a given range for each of the eight TG characteristics and the corresponding TG weight for that row. APPN starts at the top of the table and continues down the table until all eight of the TG characteristic parameter values fit within the ranges given for that row. APPN then assigns the weight of that row as the TG weight for that link. There is also a COS definition for nodes that calculates a node's weight. The route calculation function continues until it has found the path with the least combined weight of TGs and nodes. This is the least weight route.

As an example of how TG characteristics are used to influence the selection of a route through an APPN network node, suppose that a route from network node router A to network node router D can pass through either network node router B or router C. In this example, router A defines connections to both router B and router C. However, the connection from router A to router B is a 64-Kbps link, while the connection from router A to router C is a slower-speed 19.2-Kbps link.

To ensure that the higher-speed connection from router A to router B is viewed as the more desirable path for routing APPN interactive traffic, the effective capacity TG characteristic for the link station associated with this path would be modified. In this case, the default value for effective capacity is X'38', which correctly represents a link speed of approximately 19.2-Kbps. However, the effective capacity would be changed to X'45' to properly represent the 64-Kbps link. Since the effective capacity for the TG from router A to router B is now X'45', this path is assigned a lower weight in the COS file for interactive traffic. Consequently, the

connection from router A to router B is represented as more desirable than the connection from router A to router C.

You can also change the TG characteristics if you purposefully want to favor certain TGs for route selection. In addition to the five architected TG characteristics, there are also three user-defined TG characteristics. You may define these user-defined TG characteristics in order to bias the route selection calculation in favor of certain paths.

Note: For DLSw ports the TG characteristics that you define effect only the selection of routes between APPN nodes over these DLSw ports. These characteristics have no direct effect on any intermediate routing performed by DLSw on APPN's behalf.

COS Options

You can use a template to create new user-defined COS names and associated definitions for TGs and nodes which can be used with new mode names or mapped to existing mode names.

In addition you can create new mode names that can be mapped to existing COS names.

Each COS definition file is identified by a COS name and contains an associated transmission priority and a table of ranges of acceptable TG and node characteristics that APPN compares against actual TG and node characteristics to determine weights for TGs and nodes from which APPN calculates the least weight route for the session. Using the Configuration Program you can:

- View a COS definition file:
  - View the transmission priority
  - View a list of node row references along with their corresponding weights
  - View a list of TG row references along with their corresponding weights
- Select standard or ATM COS tables as templates to define a new user-defined COS definition file with a new COS name:
  - Import an IBM-defined COS definition file to use as a template
  - Import a previously exported user-defined COS definition file to use as a template
- Define the minimum and maximum ranges for the user-defined TG characteristics within an IBM-defined COS definition.

  Note: In an IBM-defined COS definition you can edit only the user-defined TG characteristic ranges.

Using Configuration Program or **talk 6** you can:

- Use standard COS tables or the Enhanced COS tables (for ATM).
- Define a new mode name and its mapping to a COS name.
- Change a mode name to COS name mapping:
  - Remap an IBM-defined mode name to a different COS name.
  - Remap a previously specified user-defined mode name to a different COS name.

Refer to the discussion of Topology and Routing Services in the *SNA APPN Architecture Reference*, SC30–3422, for a description of standard and ATM COS tables.

APPN Node Tuning

The performance of the router APPN network node can be tuned in two ways:

- By manually setting the values of the *maximum shared memory*, *percent of APPN shared memory to be used for buffers*, and the *maximum cached directory entries* tuning parameters using the **talk 6** option of the command line interface.
- By selecting values for the *maximum number of ISR sessions*, *maximum number of adjacent nodes* and other parameters shown in Table 39-6 on page 39-11, and having the tuning algorithm automatically calculate the *maximum shared memory* and *maximum cached directory entries* tuning parameter values.

  Use the IBM 8210 Multiprotocol Switched Services Server Configuration Program to invoke the tuning algorithm.

The *maximum shared memory* parameter affects the amount of storage available to the APPN network node for network operations. For example, you can allow APPN to have a 4K RU size by setting *maximum shared memory* to at least 1 Megabyte and setting *percent of APPN shared memory used for buffers* to a sufficiently large value to allow at least 1 Megabyte of memory to be available to the buffer manager.

The *maximum cached directory entries* parameter affects the amount of directory information that will be stored or cached to reduce the time it takes to locate a resource in the network.

In general, tuning the APPN network node involves a trade-off between node performance and storage usage. The better the performance, the more storage required.

Tuning Notes

1. The tuning parameter settings should reflect anticipated growth in your network.
2. If you define connection networks within your APPN network and you anticipate that most end nodes will initiate LU-LU sessions with other end nodes on the same connection network, you should set the *maximum number ISR sessions* parameter to a smaller value (1). Using connection networks in this manner reduces the shared memory requirements for the router network node because most LU-LU sessions will not flow through the APPN component in the router.
3. Because the *maximum shared memory* parameter affects storage allocation within the router, you should use care when explicitly defining this parameter. Use the defaults as a guide when increasing or reducing maximum shared memory manually.

Node Service (Traces)

The APPN Node Service (Traces) option allows you to start any APPN trace through **talk 6** or the Configuration Program. The traces are activated when the configuration file is applied to the router. The traces will continue to be active until they are stopped when a new configuration that stops the traces is applied to the router.

Note: Running traces on the router can affect its performance. Traces should be started only when needed for node service and should be stopped as soon as the required amount of trace information is gathered.

The APPN traces are grouped into the following 5 categories:

- Node-level traces specify traces concerning the overall APPN network node.
- Interprocess signals traces specify component-level traces concerning signals between APPN components.
- Module entry and exit traces specify component-level traces concerning the entry and exit of APPN modules.
- General traces specify component-level traces concerning the APPN components.
- Miscellaneous traces specify trace information about DLC transmissions and receptions.

Accounting and Node Statistics

Intermediate sessions are LU-LU sessions that pass through the APPN network node, but whose endpoints (origin and destination) lie outside of the network node. Information about intermediate sessions is generated by the ISR component in the network node and falls into two categories:

- Intermediate session names and counters
- Route selection control vector (RSCV) data for intermediate sessions

Enabling the *collect intermediate session information* parameter instructs the router to collect session names and counters for all active intermediate sessions. Enabling the *save RSCV information for intermediate sessions* parameter instructs the router to collect RSCV data for active intermediate sessions. The RSCV data is useful for monitoring session routes. In both cases, you can retrieve the data on active sessions by issuing SNMP **get** and **get-next** commands for variables in the APPN Management Information Base (MIB).

You can enable or disable the *collect intermediate session information* using:

- Configuration Program
- Command line **talk 6**
- SNMP **SET** command

Note: This function can use a significant amount of APPN memory. You should configure APPN with the needed memory before you enable the collection of ISR information.

For accounting purposes, you can maintain records of intermediate sessions passing through the network node. The data records can be created and stored in router memory. SNMP must be used to retrieve data from accounting records stored in the router's local memory.

Notes:

1. You can enable collection of active intermediate session data (session counters and session characteristics) in SNMP MIB variables explicitly or implicitly.

   To enable collection explicitly, set the *collect intermediate session information* parameter to yes.

   To enable collection implicitly, set *create intermediate session records* to yes. This setting will override the setting of *collect intermediate session information*.

2. Configuration changes to the APPN accounting parameters made using the **talk 6** interface will not take effect until the router or the APPN function on the router is restarted. You can make changes interactively, however, by issuing SNMP **set** commands to modify the APPN MIB variables associated with the configuration parameters. Refer to the *Multiprotocol Switched Services (MSS) Interface Configuration and Software User's Guide* for a list of these MIB variables.

3. Data on intermediate session RSCVs is obtained by examining the BIND request used to activate a session between two LUs. RSCV data is not collected for sessions that have already been established because the BIND information for those sessions is not available.

4. Intermediate session data is not collected for HPR sessions since intermediate sessions are not part of HPR. If the router contains an ISR/HPR boundary, intermediate session data is collected when it flows across that boundary.

DLUR Retry Algorithm

If communication between DLUR and DLUS is broken, the following algorithm is used to reestablish communication:

If *Perform retries to restore disrupted pipe* is No:

- If DLUR receives a nondisruptive UNBIND (sense code of X'08A0 000A'), DLUR waits indefinitely for a DLUS to reestablish the broken pipe.
- If the pipe fails for any other reason than a disruptive UNBIND, DLUR attempts to reach the primary DLUS once. If this is unsuccessful, DLUR attempts to reach the backup DLUS. If DLUR is unable to reach the backup DLUS, it waits indefinitely for a DLUS to reestablish the broken pipe.

If *Perform retries to restore disrupted pipe* is Yes, DLUR will attempt to reestablish the pipe based on the following configuration parameters:

- Delay before initiating retries
- Perform short retries to restore disrupted pipe
- Short retry timer
- Short retry count
- Perform long retries to restore disrupted pipe
- Long retry timer

There are two cases that determine the retry algorithm:

- For the case of receiving a nondisruptive UNBIND:

  1. Wait for the amount of time specified by the *Delay before initiating retries* parameter. This delay allows time for an SSCP takeover, where the pipe would be reestablished by a new DLUS without action on the DLUR's part.

2. Attempt to reach the primary DLUS.
3. If unsuccessful, attempt to reach the backup DLUS.
4. If the attempt to reach the backup DLUS is unsuccessful, DLUR will retry as described in steps 5 - 7 as long as the DSPU is requesting ACTPU.
5. Wait for the amount of time specified by the *Long retry timer*.

   Note: If *Perform long retries to restore disrupted pipe* is No, no further retries will be attempted.

6. Attempt to reach the primary DLUS.
7. If the attempt to reach the primary DLUS is unsuccessful, attempt to reach the backup DLUS.

- For all other cases of pipe failure, DLUR will try the primary DLUS and then the backup DLUS immediately. If this fails, DLUR will:

  1. Wait for the amount of time specified by the minimum of the *short retry timer* and the *Delay before initiating retries* parameters.
  2. Attempt to reach the primary DLUS.
  3. If the attempt to reach the primary DLUS is unsuccessful, attempt to reach the backup DLUS
  4. If pipe activation continues to fail, DLUR will retry as described in steps 1 - 3 for the number of times specified in the *short retry count*.

     If the *short retry count* is exhausted, DLUR will retry as defined in steps 5 - 7 as long as the DSPU is requesting ACTPU.
  5. Wait for the amount of time specified by the *Long retry timer*

     Note: If *Perform long retries to restore disrupted pipe* is No, no further retries will be attempted.

  6. Attempt to reach the primary DLUS.
  7. If the attempt to reach the primary DLUS is unsuccessful, attempt to reach the backup DLUS.

APPN Implementation on the Router Using DLSw

The router also supports APPN over DLSw for connectivity to nodes through a remote DLSw partner. An example is shown in Figure 38-1. This support allows customers with DLSw configurations to migrate their networks to 8210.

Note: It is recommended to use APPN over direct DLCs when available instead of APPN over DLSw.

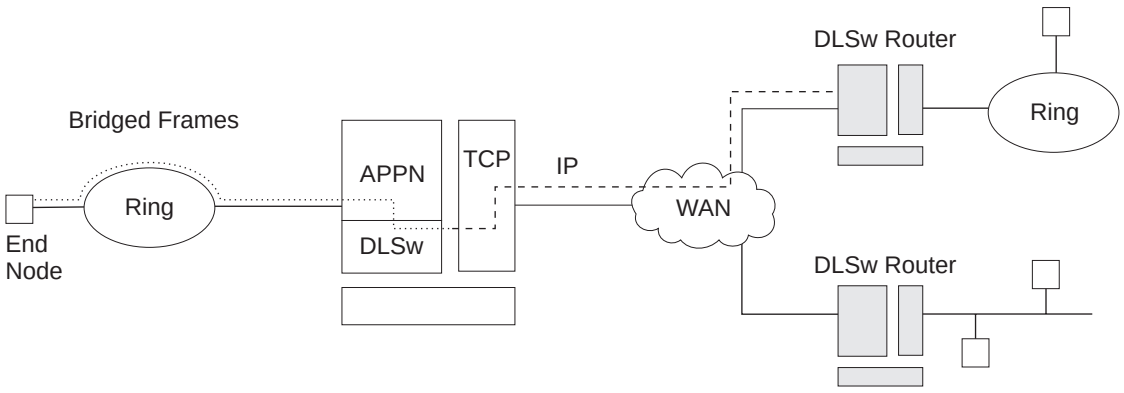

Figure 38-1. Data Flow in an APPN Configuration Using DLSw Port

APPN configuration restrictions using DLSw:

- Connectivity through remote DLSw partners only
- Only 1 DLSw port per router
- Use of a locally administered MAC address
- HPR is not supported on DLSw ports
- DLSw ports cannot be members of connection networks
- Parallel TGs are not supported on DLSw ports

See “Configuring the Router as an APPN Network Node” on page 38-17 to configure APPN using DLSw.

How APPN Uses DLSw ports to Transport Data

When APPN is configured on the router to use Data Link Switching (DLSw) port, DLSw is used to provide a connection-oriented interface (802.2 LLC type 2) between the APPN component in the router and APPN nodes and LEN end nodes attached to a remote DLSw partner.

When configuring a DLSw port for APPN on the router, you assign the network node a unique MAC and SAP address pair that enables it to communicate with DLSw. The MAC address for the network node is locally administered and must not correspond to any physical MAC address in the DLSw network.

Port Level Parameter Lists

Use the following tables to configure APPN ports:

- Port Configuration on page 39-26
- Port Definition on page 39-31
- Port Default TG Characteristics on page 39-33
- Port default LLC Characteristics on page 39-38

Link Level Parameter Lists

Use the following tables to configure APPN link stations:

- HPR Defaults on page 39-40
- Link Station - Detail on page 39-41
- Modify TG Characteristics on page 39-48
- Modify Dependent LU Server on page 39-50
- Modify LLC Characteristics on page 39-50
- Modify HPR Defaults on page 39-52

LU Parameter List

Use the following table to configure an LU:

- LEN End Node LU Name on page 39-53

Node Level Parameter Lists

Use the following tables to configure an APPN node:

- APPN Routing on page 39-3
- High Performance Routing (HPR) on page 39-6
- HPR Timer and Retry Options on page 39-6
- Dependent LU Requester on page 39-8
- Connection Network - Detail on page 39-54
- TG Characteristics (Connection Network) on page 39-57

- APPN COS - Additional port to CN on page 39-61
- Node Level Traces on page 39-14
- Interprocess Signals Traces on page 39-17
- Module Entry and Exit Traces on page 39-19
- General Component Level Traces on page 39-20
- APPN Node Management on page 39-23

APPN Configuration Notes

The following examples show special parameters to consider when configuring various features to transport APPN traffic.

Note: These examples show sample output. The output you see may not appear exactly like the output shown here.

Note: In some configuration examples, the results of a **talk 6 list** command may show more configuration than is actually presented in the sample. However, the sample will show all of the configuration that is unique.

Configuring APPN over ATM

The following sample configures APPN over ATM.

Notes:

1. When PVCs are configured, the link station must be defined on both APPN nodes wanting to use the PVC. The link station must be defined with **Activate link automatically**= yes.
2. When parallel TGs over ATM are configured, the adjacent node name and TG number must be defined in both nodes for each link station.

```
add po
APPN Port
Link Type:  (E)THERNET, (T)OKEN RING,
 (D)LSw,(A)TM, (IP) [ ]?atm 1
Interface number(Default 0): [0]?6
Port name (Max 8 characters) [ATM006]?

WARNING!! You are changing an existing record.
Enable APPN on this port (Y)es (N)o [Y]?
Port Definition
        Service any node: (Y)es (N)o [Y]?
        Maximum BTU size (768-2048) [2048]?
        Maximum number of link stations (1-976) [512]?
        Percent of link stations reserved for incoming calls (0-100) [0]?
        Percent of link stations reserved for outgoing calls (0-100) [0]?
        Local ATM Address (hex) [99998888777766]?
        Local SAP address (04-EC) [4]?
        Enable Incoming Calls (Y)es (N)o [N]?
        ATM Network Type: 0 = CAMPUS, 1 = WIDEAREA [0]?
        Shareable Connection Network Traffic (Y)es (N)o [N]?
        Shareable Other Protocol Traffic (Y)es (N)o [N]?
        Broadband Bearer Class: 0 = CLASS_A, 1 = CLASS_C, 2 = CLASS_X [2]?
        Best Effort Indicator (Y)es (N)o [N]?
        Forward Traffic Peak Cell Rate (1-16777215) [131750]?
        Forward Traffic Sustained Cell Rate (1-16777215) [131750]?
        Forward Traffic Tagging (Y)es (N)o [Y]?
        Forward Traffic QOS Class: 0 = CLASS_0, 1 = CLASS_1, 2 = CLASS_2,
         3 = CLASS_3, 4 = CLASS_4 [0]?
        Backward Traffic Peak Cell Rate (1-16777215) [460800]?
        Backward Traffic Sustained Cell Rate (1-16777215) [39168]?
        Backward Traffic Tagging (Y)es (N)o [Y]?
        Backward Traffic QOS Class: 0 = CLASS_0, 1 = CLASS_1, 2 = CLASS_2,
         3 = CLASS_3, 4 = CLASS_4 [0]?
        Call out anonymously (Y)es (N)o [N]?
        LDLC Retry Count(1-255) [3]?
        LDLC Timer Period(1-255 seconds) [1]?
        Limited resource timer for HPR(1-2160000 seconds) [180]?
Would you like TG characteristics updated to recommended
values based on config changes: (Y)es (N)o [N]?
Edit TG Characteristics: (Y)es (N)o [N]?
Write this record? [Y]?
The record has been written.
```

```
nada205 APPN config>add li atm006 2
APPN Station
Station name (Max 8 characters) [ ]? tograya
WARNING!! You are changing an existing record.
        Limited resource: (Y)es (N)o [N]?
        Activate link automatically (Y)es (N)o [Y]?
        Virtual Channel Type (0 = PVC , 1 = SVC) [0]? 3
        Destination ATM Address  [39999999999999000009999010103168902259411]?
        VPI (0-255) [0]?
        VCI (0-65535) [70]? 34
        ATM Network Type: 0 = CAMPUS, 1 = WIDEAREA [0]?
        Shareable Connection Network Traffic (Y)es (N)o [N]?
        Shareable Other Protocol Traffic (Y)es (N)o [N]?
        Remote SAP(04-EC) [4]?
        Adjacent node type: 0 = APPN network node,
        1 = APPN end node or Unknown node type,
        2 = LEN end node [0]?
        Allow CP-CP sessions on this link (Y)es (N)o [Y]?
        CP-CP session level security (Y)es (N)o [N]?
        Configure CP name of adjacent node: (Y)es (N)o [N]?
        LDLC Retry Count(1-255) [3]?
        LDLC Timer Period(1-255 seconds) [1]?
Would you like TG characteristics updated to recommended
values based on config changes: (Y)es (N)o [N]?
Edit TG Characteristics: (Y)es (N)o [N]?
Write this record? [Y]?
The record has been written.



nada205 APPN config>add link atm006
APPN Station
Station name (Max 8 characters) [ ]?tograya
WARNING!! You are changing an existing record.
        Limited resource: (Y)es (N)o [N]?
        Activate link automatically (Y)es (N)o [Y]?
        Virtual Channel Type (0 = PVC , 1 = SVC) [0]? 1 4
        Destination ATM Address  [39999999999999000009999010103168902259411]?
        Broadband Bearer Class: 0 = CLASS_A, 1 = CLASS_C, 2 = CLASS_X [2]?
        Best Effort Indicator (Y)es (N)o [N]?
        Forward Traffic Peak Cell Rate (1-16777215) [30000]?
        Forward Traffic Sustained Cell Rate (1-16777215) [20000]?
        Forward Traffic Tagging (Y)es (N)o [Y]?
        Forward Traffic QOS Class: 0 = CLASS_0, 1 = CLASS_1, 2 = CLASS_2,
         3 = CLASS_3, 4 = CLASS_4 [0]?
        Backward Traffic Peak Cell Rate (1-16777215) [30000]?
        Backward Traffic Sustained Cell Rate (1-16777215) [20000]?
        Backward Traffic Tagging (Y)es (N)o [Y]?
        Backward Traffic QOS Class: 0 = CLASS_0, 1 = CLASS_1, 2 = CLASS_2,
         3 = CLASS_3, 4 = CLASS_4 [0]?
        Call out anonymously (Y)es (N)o [N]?
        ATM Network Type: 0 = CAMPUS, 1 = WIDEAREA [0]?
        Shareable Connection Network Traffic (Y)es (N)o [N]?
        Shareable Other Protocol Traffic (Y)es (N)o [N]?
        Remote SAP(04-EC) [4]?
        Adjacent node type: 0 = APPN network node,
        1 = APPN end node or Unknown node type,
        2 = LEN end node [0]?
        TG Number (0-20) [0]?
        Allow CP-CP sessions on this link (Y)es (N)o [Y]?
        CP-CP session level security (Y)es (N)o [N]?
        Configure CP name of adjacent node: (Y)es (N)o [N]?
        LDLC Retry Count(1-255) [3]?
        LDLC Timer Period(1-255 seconds) [1]?
Would you like TG characteristics updated to recommended
values based on config changes: (Y)es (N)o [N]?
Edit TG Characteristics: (Y)es (N)o [N]?
Write this record? [Y]?
The record has been written.


nada205 APPN config>
```

Notes:

1. Define an APPN port with link type ATM
2. Define an APPN link station
3. Define a PVC
4. Define an SVC

Configuring HPR over IP

```
t 6
Q45 Config>p appn
APPN config>add port
APPN Port
Link Type: (P)PP, (FR)AME RELAY, (E)THERNET, (T)OKEN RING,
(S)DLC, (X)25, (D)LSw, (A)TM, (I)P  [ ]? ip
Port name (Max 8 characters) [IP255]?
Enable APPN on this port (Y)es (N)o [Y]?
Port Definition
      Service any node: (Y)es (N)o [Y]?
      Maximum BTU size (768-2048) [768]?
      UDP port number for XID exchange (1024-65535) [11000]?
      UDP port number for low priority traffic (1024-65535) [11004]?
      UDP port number for medium priority traffic (1024-65535) [11003]?
      UDP port number for high priority traffic (1024-65535) [11002]?
      UDP port number for network priority traffic (1024-65535) [11001]?
      IP Network Type: 0 = CAMPUS, 1 = WIDEAREA [0]?
      Local SAP address (04-EC) [4]?
      LDLC Retry Count(1-255) [3]?
      LDLC Timer Period(1-255 seconds) [15]?
Edit TG Characteristics: (Y)es (N)o [N]?
Write this record? [Y]?
The record has been written.
****3.3.3.3 is the router's internal IP address
APPN config>add link
APPN Station
Port name for the link station [ ]? ip255
Station name (Max 8 characters) [ ]? tonn
      Activate link automatically (Y)es (N)o [Y]?
      IP address of adjacent node  [0.0.0.0]? 3.3.3.3
      Adjacent node type: 0 = APPN network node,
      1 = APPN end node or Unknown node type  [0]?
      Allow CP-CP sessions on this link (Y)es (N)o [Y]?
      CP-CP session level security (Y)es (N)o [N]?
      Configure CP name of adjacent node: (Y)es (N)o [N]?
      Remote SAP(04-EC) [4]?
      IP Network Type: 0 = CAMPUS, 1 = WIDEAREA [0]?
      LDLC Retry Count(1-255) [3]?
      LDLC Timer Period(1-255 seconds) [15]?
Edit TG Characteristics: (Y)es (N)o [N]?
Write this record? [Y]?
The record has been written.
APPN config>
```

Configuring Connection Networks over HPR over IP

```
t 6
Config>p appn
APPN config>add connection network
Fully-qualified connection network name (netID.CNname) [ ]? supernet.cn1
Port Type: (E)thernet, (T)okenRing, (FR), (A)TM, (FD)DI, (I)P [ ]? ip
     Limited resource timer for HPR (1-2160000 seconds) [180]?
Edit TG Characteristics: (Y)es (N)o [N]?
Write this record? [Y]?
The record has been written.
APPN config>add additional port
APPN Connection Networks Port Interface
Fully-qualified connection network name (CPname.CNname) [ ]? supernet.cn1
Port name [ ]? "en000"
Write this record? [Y]?
The record has been written.
```

Chapter 39. Configuring and Monitoring APPN

This chapter describes the APPN configuration and monitoring commands. It includes the following sections:

- "APPN Configuration Command Summary"
- "APPN Configuration Command Detail" on page 39-2

Accessing the APPN Configuration Process

Use the following procedure to access the APPN *configuration* process.

1. At the * prompt, enter **talk 6**. The Config> prompt is displayed.

   (If this prompt is not displayed, press **Return** again.)
2. Enter **protocol appn**. The APPN Config> prompt is displayed.
3. Enter an APPN configuration command.

APPN Configuration Command Summary

Table 39-1 (Page 1 of 2). APPN Configuration Command Summary

Command	Function	See page:
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page xxvii.	
Enable/Disable	Enables/disables the following:	39-3
	APPN	
	Dependent LU Requestor	
	Port *port name*	
Set	Sets the following:	
	Node	39-3
	Traces	39-14
	HPR	39-6
	DLUR	39-8
	Management	39-23
	Tuning	39-11
	TN3270E	39-25
Add	Adds or updates the following:	
	Port *port name*	39-26
	Link—station *link station name*	39-41
	LU-Name *LU name*	39-53
	Connection-network *connection network name*	39-54
	Additional-port-to-connection-network	39-61

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Table 39-1 (Page 2 of 2). APPN Configuration Command Summary

Command	Function	See page:
	Mode	39-59
	Focal_point	39-62
	TN3270E implicit-pool	39-63
	TN3270E lu	39-63
	local-pu	39-62
Delete	Deletes the following: • Port *port name* • Link-station *link station name* • LU-Name *LU name* • Connection-network *connection network name* • Connection networks port interface (CN PORTIF) *CN name* • Mode *mode name* • Focal_point • TN3270E implicit-pool • TN3270E lu • local-pu	39-64
List	Lists the following from configuration memory: • All • Node • Traces • Management • HPR • DLUR • Port *port name* • Link-station *link name* • LU-Name *LU name* • Mode *mode name* • Connection-network *connection network name* • Focal_point • TN3270E	39-65
Activate_new_config	Reads the configuration into non-volatile configuration memory.	39-65
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.	

Note: APPN will respond to a dynamic **reset** command at the interface level.

APPN Configuration Command Detail

Enable/Disable

Use the **enable/disable** command to enable (or disable):

Syntax:

enable	appn
[or disable**]**	dlur
	port *port name*

Set

Use the **set** command to set:

Syntax:

set	node

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-2 (Page 1 of 4). Configuration Parameter List - APPN Routing

Parameter Information	
Parameter	Enable APPN
Valid Values	Yes, No
Default Value	Yes
Description	This parameter enables or disables the router as an APPN network node. This parameter enables both APPN and HPR routing capability for this network node which consists of defining the Network ID and CP name for this node. APPN, however, must be enabled on the particular ports on which you desire to support APPN routing. Additionally, support for HPR must be enabled on the particular APPN ports desired and must be supported by the particular link stations on those ports. **Note:** HPR only supported on LAN.
Parameter	Network ID (required)
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** A network identifier for an existing network, of which this router network node is to become a member, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new network IDs.
Default Value	None
Description	This parameter specifies the name of the APPN network to which this network node belongs. The network ID must be the same for all network nodes in the APPN network. Attached APPN end nodes and LEN end nodes can have different network IDs.

Table 39-2 (Page 2 of 4). Configuration Parameter List - APPN Routing	
Parameter Information	
Parameter	Control point name (required)
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing CP name that this node would be acquiring, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new CP names.
Default	None
Description	This parameter specifies the name of the CP for this APPN network node. The CP is responsible for managing the APPN network node and its resources. The CP name is the logical name of the APPN network node in the network. The CP name must be unique within the APPN network identified by the Network ID parameter.
Parameter	Enable Branch Extender
Valid Values	Yes or No
Default	No
Description	This parameter specifies whether the Branch Extender function will be enabled on this node. If *yes* is specified, the Branch Extender function will be enabled on this node. If *no* is specified, additional questions related to Branch Extender will not be asked during Node, Port, and Link Station definitions.
Parameter	Permit search for unregistered LUs
Valid Values	Yes or No
Default	No
Description	This parameter specifies whether this node (when acting as an End Node) can be searched for LUs even if the LUs were not registered with the network node server of the Branch Extender. If *yes* is specified, this node can be searched for LUs.
Parameter	Route addition resistance
Valid Values	0 to 255
Default Value	128
Description	This parameter indicates the desirability of routing through this node. This parameter is used in the class of service based route calculation. Lower values indicate higher levels of desirability.
Parameter	XID number for subarea connection (see table notes)
Valid Values	A string of 5 hexadecimal digits
Default	X'00000'
Description	This parameter specifies a unique ID number (identifier) for the network node. The XID number is combined with an ID block number (which identifies a specific IBM product) to form an XID node identification. Node identifications are exchanged between adjacent nodes when the nodes are establishing a connection. The router network node automatically appends an ID block number to this parameter during the XID exchange to create an XID node identification. The ID number you assign to this node must be unique within the APPN network identified by Network ID parameter. Contact your network administrator to verify that the ID number is unique.

Table 39-2 (Page 3 of 4). Configuration Parameter List - APPN Routing

Parameter Information	
Note: Node identifications are normally exchanged between T2.1 nodes during CP-CP session establishment. If the network node is communicating with the IBM Virtual Telecommunications Access Method (VTAM) product through a T2.1 LEN node and the LEN node has a CP name defined for it, the XID number parameter is not required. If the adjacent LEN node is not a T2.1 node or does not have an explicitly defined CP name, the XID number parameter must be specified to establish a connection with the LEN node. VTAM versions prior to Version 3 Release 2 do not allow CP names to be defined for LEN nodes.	
Parameter	Use enhanced BATCH COS
Valid Values	Yes or No
Default	Yes
Description	This parameter specifies whether to use the enhanced COS tables. The enhanced tables assign reasonable weights to ATM TGs based on cost, speed, and delay. For ATM, the order of preference is: • Campus Best Effort (SVC or PVC)/Reserved PVC (WAN or Campus) • Campus Reserved SVC • WAN Best Effort (SVC or PVC) • WAN Reserved SVC
Parameter	Use enhanced BATCHSC COS
Valid Values	Yes or No
Default	Yes
Description	This parameter specifies whether to use the enhanced COS tables. The enhanced tables assign reasonable weights to ATM TGs based on cost, speed, and delay. For ATM, the order of preference is: • Campus Best Effort (SVC or PVC)/Reserved PVC (WAN or Campus) • Campus Reserved SVC • WAN Best Effort (SVC or PVC) • WAN Reserved SVC
Parameter	Use enhanced INTER COS
Valid Values	Yes or No
Default	Yes
Description	This parameter specifies whether to use the enhanced COS tables. The enhanced tables assign reasonable weights to ATM TGs based on cost, speed, and delay. For ATM, the order of preference is: • Campus Reserved (SVC or PVC) • Campus Best Effort (SVC or PVC)/WAN reserved PVC • WAN Reserved SVC • WAN Best Effort (SVC or PVC)

Table 39-2 (Page 4 of 4). Configuration Parameter List - APPN Routing	
Parameter Information	
Parameter	Use enhanced INTERSC COS
Valid Values	Yes or No
Default	Yes
Description	This parameter specifies whether to use the enhanced COS tables. The enhanced tables assign reasonable weights to ATM TGs based on cost, speed, and delay. For ATM, the order of preference is: • Campus Reserved (SVC or PVC) • Campus Best Effort (SVC or PVC)/WAN reserved PVC • WAN Reserved SVC • WAN Best Effort (SVC or PVC)

Syntax:

set high-performance routing

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-3. Configuration Parameter List - High-Performance Routing (HPR)	
Parameter Information	
Parameter	Maximum sessions for HPR connections
Valid Values	1 to 65535
Default Value	100
Description	This parameter specifies the maximum number of sessions allowed on an HPR connection. An HPR connection is defined by the class of service (COS), the physical path (TGs), and the network connection end points.

Table 39-4 (Page 1 of 3). Configuration Parameter List - HPR Timer and Retry Options	
Parameter Information	
Low transmission priority traffic	
Parameter	RTP inactivity timer
Valid Values	1 to 3600 seconds
Default Value	180 seconds
Description	This parameter specifies RTP's inactivity interval for HPR connections that carry traffic with *low* transmission priority. This is an end-to-end version of the LLC inactivity timer, Ti. If no receptions occur during this interval, RTP transmits a poll. Idle periods are monitored to ensure the integrity of the connection.
Parameter	Maximum RTP retries
Valid Values	0 to 10
Default Value	6
Description	This parameter specifies the maximum number of retries before RTP initiates a path switch on an HPR connection that carries traffic with low transmission priority.

Table 39-4 (Page 2 of 3). Configuration Parameter List - HPR Timer and Retry Options

Parameter Information	
Parameter	Path switch timer
Valid Values	0 to 7200 seconds
Default Value	180 seconds
Description	This parameter specifies the maximum amount of time that a path switch may be attempted on an HPR connection carrying traffic with low transmission priority. A value of zero indicates that the path switch function is to be disabled, and a path switch will not be performed.
Medium transmission priority traffic	
Parameter	RTP inactivity timer
Valid Values	1 to 3600 seconds
Default Value	180 seconds
Description	This parameter specifies RTP's inactivity interval for HPR connections that carry traffic with *medium* transmission priority. This is an end-to-end version of the LLC inactivity timer, Ti. If no receptions occur during this interval, RTP transmits a poll. Idle periods are monitored to ensure the integrity of the connection.
Parameter	Maximum RTP retries
Valid Values	0 to 10
Default Value	6
Description	This parameter specifies the maximum number of retries before RTP initiates a path switch on an HPR connection that carries traffic with medium transmission priority.
Parameter	Path switch timer
Valid Values	0 to 7200 seconds
Default Value	180 seconds
Description	This parameter specifies the maximum amount of time that a path switch may be attempted on an HPR connection carrying traffic with medium transmission priority. A value of zero indicates that the path switch function is to be disabled, and a path switch will not be performed.
High transmission priority traffic	
Parameter	RTP inactivity timer
Valid Values	1 to 3600 seconds
Default Value	180 seconds
Description	This parameter specifies RTP's inactivity interval for HPR connections that carry traffic with *high* transmission priority. This is an end-to-end version of the LLC inactivity timer, Ti. If no receptions occur during this interval, RTP transmits a poll. Idle periods are monitored to ensure the integrity of the connection.
Parameter	Maximum RTP retries
Valid Values	0 to 10
Default Value	6
Description	This parameter specifies the maximum number of retries before RTP initiates a path switch on an HPR connection that carries traffic with high transmission priority.

Table 39-4 (Page 3 of 3). Configuration Parameter List - HPR Timer and Retry Options	
Parameter Information	
Parameter	Path switch timer
Valid Values	0 to 7200 seconds
Default Value	180 seconds
Description	This parameter specifies the maximum amount of time that a path switch may be attempted on an HPR connection carrying traffic with high transmission priority. A value of zero indicates that the path switch function is to be disabled, and a path switch will not be performed.
Network transmission priority traffic	
Parameter	RTP inactivity timer
Valid Values	1 to 3600 seconds
Default Value	180 seconds
Description	This parameter specifies RTP's inactivity interval for HPR connections that carry traffic with *network* transmission priority. This is an end-to-end version of the LLC inactivity timer, Ti. If no receptions occur during this interval, RTP transmits a poll. Idle periods are monitored to ensure the integrity of the connection.
Parameter	Maximum RTP retries
Valid Values	0 to 10
Default Value	6
Description	This parameter specifies the maximum number of retries before RTP initiates a path switch on an HPR connection that carries traffic with network transmission priority.
Parameter	Path switch timer
Valid Values	0 to 7200 seconds
Default Value	180 seconds
Description	This parameter specifies the maximum amount of time that a path switch may be attempted on an HPR connection carrying traffic with network transmission priority. A value of zero indicates that the path switch function is to be disabled, and a path switch will not be performed.

Syntax:

set dlur

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-5 (Page 1 of 4). Configuration Parameter List - Dependent LU Requester	
Parameter Information	
Parameter	Enable dependent LU requester (DLUR) on this network node
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether a dependent LU requester is to be functionally enabled on this node.

Table 39-5 (Page 2 of 4). Configuration Parameter List - Dependent LU Requester

Parameter Information	
Parameter	Default fully-qualified CP name of primary DLUS (required when DLUR is enabled)
Valid Values	A string of up to 17 characters in the form of *netID.CPname*, where: • *netID* is a network ID from 1 to 8 characters • *CPname* is a CP name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing fully-qualified CP name, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new CP names.
Default Value	None
Description	This parameter specifies the fully-qualified control point (CP) name of the dependent LU server (DLUS) that is used by default. The default primary server may be overridden on a link station basis. The default server is used for incoming requests from downstream PUs when a primary DLUS has not been specified for the associated link station.
Parameter	Default fully-qualified CP name of backup dependent LU server (DLUS)
Valid Values	A string of up to 17 characters in the form of *netID.CPname*, where: • *netID* is a network ID from 1 to 8 characters • *CPname* is a CP name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing fully-qualified CP name, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new CP names.
Default Value	Null
Description	This parameter specifies the fully-qualified CP name of the dependent LU server (DLUS) that is used as the default backup. A backup is not required, and the null value (representing no entry) indicates the absence of a default backup server. The default backup server may be overridden on a link station basis.
Parameter	Perform retries to restore disrupted pipe
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether DLUR will attempt to reestablish the pipe to a DLUS after a pipe failure. If DLUR receives a nondisruptive UNBIND and this parameter is No, DLUR waits indefinitely for a DLUS to reestablish the broken pipe. If the pipe fails for any other reason and this parameter is No, DLUR attempts to reach the primary DLUS once. If this is unsuccessful, DLUR attempts to reach the backup DLUS. If this attempt also fails, DLUR waits indefinitely for a DLUS to reestablish the pipe. See “DLUR Retry Algorithm” on page 38-26 for a description of the retry algorithm.

Table 39-5 (Page 3 of 4). Configuration Parameter List - Dependent LU Requester

Parameter Information	
Parameter	Delay before initiating retries
Valid Values	0 to 2 756 000 seconds
Default Value	120 seconds
Description	This parameter specifies an amount of time for two different cases when the pipe between the DLUR and its DLUS is broken. • For the case of receiving a nondisruptive UNBIND: This parameter specifies the amount of time the DLUR must wait before attempting to reach the primary DLUS. A value of 0 indicates immediate retry by the DLUR. • For all other cases of pipe failure: The DLUR will try the primary DLUS and then the backup DLUS immediately. If this fails, DLUR will wait for the amount of time specified by the minimum of the *short retry timer* and this parameter before attempting to reach the primary DLUS. See "DLUR Retry Algorithm" on page 38-26 for a complete description of the retry algorithm.
Parameter	Perform short retries to restore disrupted pipe
Valid Values	Yes, No
Default Value	If *Perform retries to restore disrupted pipes* is Yes, then the default value is Yes. Otherwise, the default is No.
Description	See "DLUR Retry Algorithm" on page 38-26 for a complete description of the retry algorithm.
Parameter	Short retry timer
Valid Values	0 to 2 756 000 seconds
Default Value	120 seconds
Description	In all cases of pipe failure other than nondisruptive UNBIND, the minimum of *Delay before initiating retries* and this parameter specifies the amount of time DLUR will wait before attempting to reach the primary DLUS after an attempt to establish this connection has failed. See "DLUR Retry Algorithm" on page 38-26 for a complete description of the retry algorithm.
Parameter	Short retry count
Valid Values	0 to 65 535
Default Value	5
Description	In all cases of pipe failure other than nondisruptive UNBIND, this parameter specifies the number of times the DLUR will attempt to perform short retries to reach the DLUS after an attempt to establish this connection has failed. See "DLUR Retry Algorithm" on page 38-26 for a complete description of the retry algorithm.
Parameter	Perform long retries to restore disrupted pipe
Valid Values	Yes, No
Default Value	If *Perform retries to restore disrupted pipes* is Yes, then the default value is Yes. Otherwise, the default is No
Description	See "DLUR Retry Algorithm" on page 38-26 for a complete description of the retry algorithm.

Table 39-5 (Page 4 of 4). Configuration Parameter List - Dependent LU Requester	
Parameter Information	
Parameter	Long retry timer
Valid Values	0 to 2 756 000 seconds
Default Value	300 seconds
Description	This parameter specifies the time DLUR will wait when performing long retries. See “DLUR Retry Algorithm” on page 38-26 for a complete description of the retry algorithm.

Syntax:

set tuning

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Note: You will have to re-boot in order for the changes you specify to take place.

Table 39-6 (Page 1 of 4). Configuration Parameter List - APPN Node Tuning	
Parameter Information	
Parameter	Maximum number of adjacent nodes
Valid Values	1 to 2 800
Default	100
Description	This parameter is an estimate of the maximum number of nodes that you expect to be logically adjacent to this router network node at any one time. This parameter is used along with the *Maximum number of ISR sessions* parameter by the automatic tuning algorithm to calculate the values for the *Maximum shared memory* and *Maximum cached directory entries* tuning parameters. This parameter is configurable using the Configuration Program only.
Parameter	Maximum number of network nodes sharing the same APPN network id
Valid Values	10 to 8 000
Default	50
Description	This parameter is an estimate of the maximum number of nodes that you expect in the sub-network (that is, in the topology known by this node). This parameter is configurable using the Configuration Program only.
Parameter	Maximum number of TGs connecting network nodes with the same APPN network id
Valid Values	9 to 64 000
Default	3 times the value of the *maximum number of network nodes in the sub-network*.
Description	This parameter is an estimate of the maximum number of TGs connecting network nodes in the sub-network (that is, in the topology known by this node). This parameter is configurable using the Configuration Program only.

Table 39-6 (Page 2 of 4). Configuration Parameter List - APPN Node Tuning

Parameter Information	
Parameter	Maximum number of ISR sessions
Valid Values	10 to 7500
Default Value	200
Description	This parameter specifies an estimate of the maximum number of intermediate session routing sessions (ISR) expected to be supported by this router network node at any one time. This parameter is used in conjunction with the Maximum number of adjacent nodes parameter by the automatic tuning algorithm to calculate the values for the Maximum shared memory and Maximum cached directory entries tuning parameters. This parameter is configurable using the Configuration Program only.
Parameter	Percent of adjacent nodes with CP-CP sessions using HPR
Valid Values	0 to 100%
Default Value	0 (none)
Description	This parameter specifies an estimate of the maximum number of adjacent EN and NN, with CP-CP sessions using option set 1402 (Control Flows over RTP option set). This parameter is configurable using the Configuration Program only.
Parameter	Maximum percent of ISR sessions using HPR data connections
Valid Values	0 to 100 percent
Default	0 percent
Description	This parameter specifies the largest percentage of ISR sessions that use ISR to HPR mappings. This parameter is configurable using the Configuration Program only.
Parameter	Percent adjacent nodes that function as DLUR PU nodes
Valid Values	0 to 100 percent
Default	0 percent
Description	This parameter specifies the largest percentage of adjacent nodes allowed to function as adjacent DLUR PU nodes. This parameter is configurable using the Configuration Program only.
Parameter	Maximum percent ISR sessions used by DLUR LUs
Valid Values	0 to 100 percent
Default	0 percent
Description	This parameter specifies the largest percentage of ISR sessions used by DLUR LUs. This parameter is configurable using the Configuration Program only.
Parameter	Maximum number of ISR accounting memory buffers
Valid Values	0 or 1
Default Value	0 (default is 1 if ISR session accounting is enabled)
Description	This parameter specifies a maximum number of buffers to be reserved for ISR session accounting. This parameter is configurable using the Configuration Program only.
Parameter	Maximum memory records per ISR accounting buffer
Valid Values	0 to 2000
Default Value	100
Description	This parameter specifies a maximum number of memory records per ISR accounting buffer. This parameter is configurable using the Configuration Program only.

Table 39-6 (Page 3 of 4). Configuration Parameter List - APPN Node Tuning

Parameter Information	
Parameter	Override tuning algorithm
Valid Values	Yes, No
Default Value	No
Description	When enabled, this parameter overrides the tuning calculations generated by the Command Line and enables you to specify explicit values for the Maximum shared memory parameter and the Maximum cached directory entries parameter. This parameter is configurable using the Configuration Program only.
Parameter	Number of local-pus for TN3270E support
Valid Values	
Default Value	
Description	This parameter specifies the number of local PUs that are available for TN3270 support. This parameter is configurable using the Configuration Program only.
Parameter	Total number of LUs for TN3270E
Valid Values	
Default Value	
Description	This parameter specifies the total number of LUs available for TN3270E support. This parameter is configurable using the Configuration Program only.
Parameter	Maximum shared memory
Valid Values	1280 - 100 000 KB
Default Value	5 108 KB
Description	This parameter specifies the amount of shared memory within the router that is allocated to the APPN network node. APPN uses its shared memory allocation to perform network operations and to maintain required tables and directories. You can allow APPN to have a 4K RU size by setting *percent of APPN shared memory used for buffers* to a sufficiently large value to allow at least 1 Megabyte of memory to be available to the buffer manager. This parameter is configurable using the Configuration Program and from **talk 6**
Parameter	Percent of APPN shared memory to be used for buffers
Valid Values	10 to 50
Default	10% or 512 Kilobytes, whichever is larger.
Description	This parameter specifies the amount of shared memory that APPN will use for buffers. You can allow APPN to have a 4K RU size by setting *maximum shared memory* to at least 1 Megabyte and setting *percent of APPN shared memory used for buffers* to a sufficiently large value to allow at least 1 Megabyte of memory to be available to the buffer manager. This parameter is configurable using the Configuration Program and from **talk 6**

Table 39-6 (Page 4 of 4). Configuration Parameter List - APPN Node Tuning	
Parameter Information	
Parameter	Maximum cached directory entries
Valid Values	0 to 65535
Default	4000
Description	This parameter specifies the number of directory entries to be stored or cached by the router network node. If a directory entry for a node is cached, the router does not need to broadcast a search request to locate the node. This reduces the time it takes to initiate sessions with the node. This parameter is configurable using the Configuration Program and from **talk 6**

Syntax:

set traces

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-7 (Page 1 of 3). Configuration Parameter List - Node Level Traces	
Parameter Information	
Parameter	Process management
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about the management of processes within the APPN network node, including the creation and termination of processes, processes entering a wait state, and the posting of processes.
Parameter	Process to process communication
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about messages exchanged between processes in the APPN network node, including the queuing and receipt of such messages.
Parameter	Locking
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about locks that were obtained and released on processes in the APPN network node.
Parameter	Miscellaneous tower activities
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about miscellaneous activities within the APPN network node.

Table 39-7 (Page 2 of 3). Configuration Parameter List - Node Level Traces

Parameter Information	
Parameter	I/O to and from the system
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about the flow of messages entering and exiting the APPN network node.
Parameter	Storage management
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about any shared memory that was obtained and released by the APPN network node.
Parameter	Queue data type management
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about all calls in the APPN network node that manage general purpose queues.
Parameter	Table data type management
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about all calls in the APPN network node that manage general purpose tables, including calls to add table entries and calls to query tables for specific entries.
Parameter	Buffer management
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about buffers in the APPN network node that were obtained and released.
Parameter	Configuration control
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about the activities of the configuration control component of the APPN network node. The configuration control component manages information about node resources.
Parameter	Timer service
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about requests for timer service from the APPN network node.

Table 39-7 (Page 3 of 3). Configuration Parameter List - Node Level Traces	
Parameter Information	
Parameter	Service provider management
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about the definition and enabling or disabling of services within the APPN network node.
Parameter	Interprocess message segmenting
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about the buffer transfer and freeing of chained messages within the APPN network node.
Parameter	Control of processes outside scope of this tower
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about the definition and activation of processes external to this APPN network node, such as when the node operator facility (NOF) defines the external process configuration control.
Parameter	Monitoring existence of processes, services, towers
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about requests that start or stop the monitoring of processes or services within the APPN network node.
Parameter	Distributed environment control
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about requests within the APPN network node that define subsystems and create environments.
Parameter	Process to service dialogs
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this trace option causes the router trace facility to gather data about all calls within the APPN network node that open, close, or send data on a dialog.
Parameter	AVL Tree Support
Valid Values	Yes, No
Default	No
Description	This parameter enables or disables this APPN trace option. When enabled, the trace option causes the router trace facility to gather data about all calls that manage AVL trees.

Table 39-8 (Page 1 of 3). Configuration Parameter List - Interprocess Signals Traces	
Parameter Information	
Parameter	Address space manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the address space manager component.
Parameter	Attach manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the attach manager component.
Parameter	Configuration services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the configuration services component.
Parameter	Dependent LU requester
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the dependent LU requester component.
Parameter	Directory services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the directory services component.
Parameter	Half Session
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the half session component.
Parameter	HPR Path Control
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the HPR path control component.
Parameter	LUA RUI
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the LUA RUI component.

Table 39-8 (Page 2 of 3). Configuration Parameter List - Interprocess Signals Traces	
Parameter Information	
Parameter	Management Services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the management services component.
Parameter	Node Operator Facility
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the node operator facility component.
Parameter	Path Control
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the path control component.
Parameter	Presentation Services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the presentation services component.
Parameter	Resource manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the resource manager component.
Parameter	Session connector manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the session connector manager component.
Parameter	Session connector
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the session connector component.
Parameter	Session manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the session manager component.

Table 39-8 (Page 3 of 3). Configuration Parameter List - Interprocess Signals Traces

Parameter Information	
Parameter	Session services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the session services component.
Parameter	Topology and routing services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about interprocess signals from the topology and routing services component.

Table 39-9 (Page 1 of 2). Configuration Parameter List - Module Entry and Exit Traces

Parameter Information	
Parameter	Attach manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the attach manager component.
Parameter	Half session
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the half session component.
Parameter	LUA RUI
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the LUA RUI component.
Parameter	Node operator facility
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the node operator facility component.
Parameter	Presentation services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the presentation services component.

Table 39-9 (Page 2 of 2). Configuration Parameter List - Module Entry and Exit Traces

Parameter Information	
Parameter	Rapid transport protocol
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the rapid transport control component.
Parameter	Resource manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the resource manager component.
Parameter	Session manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about module entry and exit information from the session manager component.

Table 39-10 (Page 1 of 3). Configuration Parameter List - General Component Level Traces

Parameter Information	
Parameter	Accounting services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the accounting services component.
Parameter	Address space manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the address space manager component.
Parameter	Architected transaction programs
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the architected transaction programs component.
Parameter	Configuration services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the configuration services component.

Table 39-10 (Page 2 of 3). Configuration Parameter List - General Component Level Traces

Parameter Information	
Parameter	Dependent LU requester
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the dependent LU requester component.
Parameter	Directory services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the directory services component.
Parameter	HPR path control
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the HPR path control component.
Parameter	LUA RUI
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the LUA RUI component.
Parameter	Management services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the management services component.
Parameter	Node operator facility
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the node operator facility component.
Parameter	Path control
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the path control component.
Parameter	Problem determination services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the problem determination component.

Table 39-10 (Page 3 of 3). Configuration Parameter List - General Component Level Traces

Parameter Information	
Parameter	Rapid transport protocol
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the rapid transport control component.
Parameter	Session connector manager
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the session connector manager component.
Parameter	Session connector
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the session connector component.
Parameter	Session services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the session services component.
Parameter	SNMP subagent
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the SNMP subagent component.
Parameter	TN3270E Server
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the TN3270E Server component.
Parameter	Topology and routing services
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables this APPN trace option. When enabled, this parameter informs the trace facility to include trace data about general information from the topology and routing services component.

Table 39-11. Configuration Parameter List - Miscellaneous Traces	
Parameter Information	
Parameter	Data link control transmissions and receptions
Valid Values	Yes, No
Default Value	No
Description	If this parameter is enabled, the APPN trace facility will trace all XIDs and PIUs transmitted and received by the APPN node.

Syntax:

set management

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-12 (Page 1 of 2). Configuration Parameter List - APPN Node Management	
Parameter Information	
Parameter	Collect intermediate session information
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether the APPN node should collect data on intermediate sessions passing through this node (session counters and session characteristics). The data is captured in SNMP MIB variables for APPN.
Parameter	Save RSCV information for intermediate sessions
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether the APPN node should save the Route Selection control vector (RSCV) for an intermediate session. The data is captured in an associated SNMP MIB variable for APPN. The session RSCV is carried in the BIND request used to activate a session between two LUs. It describes the optimum route through an APPN network for a particular LU-LU session. The session RSCV contains the CP names and TG associated with each pair of adjacent nodes along a route from an origin node to a destination node.
Parameter	Create intermediate session records
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables the creation of data records for intermediate sessions passing through this node. The records contain information about session counters and session characteristics. RSCV information is also included in the data records if the Save RSCV information for intermediate sessions parameter is enabled. If this parameter is set to yes, the setting of *collect intermediate session information* is overridden.
Parameter	Record creation threshold
Valid Values	0 to 4 294 967, in 1 KB increments
Default Value	0
Description	This parameter specifies a byte threshold for creating intermediate session records. When session data exceeds the value in this byte counter by an even multiple, a record is created.

Table 39-12 (Page 2 of 2). Configuration Parameter List - APPN Node Management	
Parameter Information	
Parameter	Held alert queue size
Valid Values	0 — 255
Default Value	10
Description	This parameter sets the size of the configurable held alert queue. This queue is used to save APPN alerts prior to sending them to a focal point. If the queue overflows, the oldest alerts are discarded.

Table 39-13 (Page 1 of 2). Configuration Parameter List - APPN ISR Recording Media	
Parameter Information	
Memory Parameters	
Parameter	Memory (see table notes)
Valid Values	Yes, No
Default Value	No
Description	This parameter enables or disables the collection of intermediate session data in the router's local memory.
Parameter	Maximum memory buffers
Valid Values	0 to 1
Default Value	1
Description	This parameter specifies the number of buffers to be allocated in the router's local memory for storing intermediate session records.
Parameter	Maximum memory records per buffer
Valid Values	0 to 2000
Default Value	100
Description	This parameter specifies the maximum number of intermediate session records that may be stored in the memory buffer on the router.
Parameter	Memory buffers full
Valid Values	Stop recording (0), Wrap (1)
Default Value	Stop recording (0)
Description	This parameter specifies the action to take when the memory buffer allocated to store intermediate session records becomes full. Select **Stop recording** to instruct the router to discard any new intermediate session records. Select **Wrap** to allow new records to overwrite existing records in the buffer. The oldest records in the buffer are overwritten first.
Parameter	Memory record format
Valid Values	ASCII (0), Binary (1)
Default Value	ASCII (0)
Description	This parameter specifies the format in which intermediate session records are to be stored in the router's local memory.
Parameter	Time between database updates
Valid Values	60 — 1440 minutes
Default Value	60
Description	This parameter sets the time in minutes between topology database updates.

Table 39-13 (Page 2 of 2). Configuration Parameter List - APPN ISR Recording Media
Parameter Information
Note: • When you enable the collection of intermediate session records, the data associated with the records also is collected, by default, in SNMP • MIB variables for APPN. The MIB variables are updated, in this case, whether or not the Collect intermediate session information parameter (in Table 39-12 on page 39-23) has been enabled. • Intermediate session data can be stored in router memory.

Syntax:

set tn3270e

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-14 (Page 1 of 2). Configuration Parameter List - APPN TN3270E	
Parameter Information	
Parameter **Valid Values** **Default Value** **Description**	Enable TN3270E Server Yes, No Yes This parameter specifies whether TN3270E Server support will be enabled.
Parameter TN3270E Server IP Address **Valid values** Any IP address **Default Value** None **Description** This parameter is the IP address associated with the TN3270E Server.	
Parameter **Valid Values** **Default Value** **Description**	Port number This parameter specifies the port number associated with the TN3270E Server.
Parameter **Valid Values** **Default Value** **Description**	Keepalive type **0** None **1** Timing mark **2** NOP 0 This parameter specifies the Keepalive type. A Keepalive type of *Timing mark* requires responses from the client within the amount of time specified using the **Timer** parameter . A Keepalive type of *NOP* specifies that the client will not send back a response to the Keepalive message. Notification that the client is no longer there will come from TCP.
Parameter **Valid Values** **Default Value** **Description**	Frequency 1 - 65535 seconds 60 This parameter specifies how often the Keepalive message is sent to the client.

Table 39-14 (Page 2 of 2). Configuration Parameter List - APPN TN3270E	
Parameter Information	
Parameter	Timer
Valid Values	1 - 65536 seconds
Default Value	10
Description	This parameter sets the timer value to be used with the Keepalive function.
Parameter	Automatic logoff
Valid Values	Yes or No
Default Value	No
Description	This parameter specifies whether automatic logoff will be enabled.
Parameter	Time
Valid Values	1 - 65535 minutes
Default Value	30
Description	This parameter sets the time that the TN3270E link can be idle before being automatically logged off.

Add

Use the **add** command to add:

Syntax:

add port

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-15 (Page 1 of 2). Configuration Parameter List - Port Configuration	
Parameter Information	
Parameter	Link type
Valid Values	Ethernet (E) Token ring (T) ATM (A) DLSw (D) FDDI IP
Default Value	None
Description	This parameter specifies the type of link associated with this port.
Parameter	Interface number
Valid Values	0 to 65533
Default Value	0
Description	This parameter defines the physical interface number of the hardware interface to which this device is attached.

Table 39-15 (Page 2 of 2). Configuration Parameter List - Port Configuration

Parameter Information	
Parameter	Port name
Valid Values	A string of 1 to 8 characters, where the first character is alphabetic and the 2nd through 8th characters are alphanumeric.
Default Value	A unique unqualified name that is automatically generated. The name will consist of: • TR (token-ring) • EN (Ethernet) • DLS (DLSw) • IP255 • ATM • FDD (FDDI) • IP followed by the interface number. You can change the port name to a name of your choice.
Description	This parameter specifies the name representing this port.
Parameter	Enable APPN routing on this port
Valid Values	Yes, No
Default Value	Yes
Description	This parameter specifies whether APPN routing is to be enabled on this port.
Parameter	Service any node
Valid Values	Yes No
Default Value	Yes
Description	This parameter specifies how the router network node responds to a request from another node to establish a connection over this port. When this parameter is enabled, the network node accepts any request it receives from another node to establish a connection. When this parameter is disabled, the network node accepts connection requests only from nodes that you explicitly define (via link station definitions). This option provides an added level of security for the router network node. **Note:** When you disable this parameter, a connection request from an adjacent node will be accepted only if the node's fully-qualified CP name parameter has been configured for a link station defined on this port. When this parameter is enabled (the default), you may still want this network node to be able to initiate connections with specific nodes over this port.
Parameter	High-performance routing (HPR) supported
Valid Values	Yes, No
Default Value	Disabled for all other port types (Cannot be changed).
Description	This parameter indicates whether link stations on this port will support HPR. This value may be overridden on the link station definition.

Table 39-16 (Page 1 of 3). Configuration Parameter List - Port Configuration for ATM

Parameter Information	
Parameter	Local ATM Address
Valid Values	Any 14-hexadecimal character string
Default Value	None
Description	This parameter specifies the 7-byte string that comprises the user part of the local ATM address. The user part is the 6-byte ESI and the 1-byte selector field. This user-part must be unique with respect to the network part of the ATM address, which is retrieved from the ATM adapter. The selector must be unique for each protocol type.
Parameter	Enable incoming calls
Valid Values	Yes or No
Default Value	Yes
Description	This parameter determines whether calls will be rejected at the ATM level.
Parameter	ATM Network Type
Valid Values	Campus or Widearea
Default Value	Campus
Description	This parameter specifies the network type used for default values for connection networks and other link stations defined on this port.
Parameter	Shareable connection network traffic
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether connection network traffic can be routed on the ATM VC set up for a link station on this port.
Parameter	Shareable other protocol traffic
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether other higher level protocol traffic can be routed on the ATM VC set up for a link station on this port.
Parameter	Broadband Bearer Class
Valid Values	Class_A, Class_C, Class_X
Default Value	Class_X
Description	This parameter specifies the bearer class requested from the ATM network. The classes are defined: **Class A** Constant bit rate (CBR) with end-to-end timing requirements **Class C** Variable bit rate (VBR) with no end-to-end timing requirements **Class X** Service allowing user-defined traffic type and timing requirements
Parameter	Best Effort Indicator
Valid Values	Yes, No
Default Value	No
Description	This parameter indicates if a throughput guarantee is required on this SVC. If the value of this parameter is *yes*, then VCCs associated with this interface will be allocated based upon the available bandwidth.
Note: The following parameters are forward traffic parameters.	
Parameter	Forward Traffic Peak Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Port's Default Effective Capacity/48
Description	This parameter indicates an upper bound on the cell transmission rate.

Table 39-16 (Page 2 of 3). Configuration Parameter List - Port Configuration for ATM

Parameter Information	
Parameter	Forward Traffic Sustained Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Port's Default Effective Capacity/48
Description	This parameter indicates an upper bound on the average cell transmission rate. You cannot specify this parameter if you are using a Best Effort connection.
Parameter	Forward Traffic Tagging
Valid Values	Yes, No
Default Value	Yes
Description	This parameter indicates that cells that are nonconforming to cell loss priority 0 traffic specification but are conforming to cell loss priority 1 traffic specification are marked and allowed into the ATM network. You cannot specify this parameter if you are using a Best Effort connection.
Parameter	Forward QOS
Valid Values	CLASS_0, CLASS_1, CLASS_2, CLASS_3, CLASS_4, where **CLASS_0** The unspecified class. The network does not specify any QoS. **CLASS_1** Performance is comparable to current digital private line performance. **CLASS_2** Intended for packetized video and audio in teleconferencing and multimedia applications. **CLASS_3** Intended for interoperation of connection-oriented protocols, such as Frame Relay. **CLASS_4** Intended for interoperation of connectionless protocols, such as IP.
Default Value	CLASS_0
Description	This parameter indicates which class of service is provided to an ATM virtual connection. This parameter is always CLASS_0 for a Best Effort connection.
Note: The following parameters are backward traffic parameters.	
Parameter	Backward Traffic Peak Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Port's Default Effective Capacity/48
Description	This parameter indicates an upper bound on the cell transmission rate.
Parameter	Backward Traffic Sustained Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Port's Default Effective Capacity/48
Description	This parameter indicates an upper bound on the average cell transmission rate. You cannot specify this parameter for a Best Effort connection.
Parameter	Backward Traffic Tagging
Valid Values	Yes, No
Default Value	Yes, unless Best Effort connection
Description	This parameter indicates that cells that are nonconforming to cell loss priority 0 traffic specification but are conforming to cell loss priority 1 traffic specification are marked and allowed into the ATM network. You cannot specify this parameter for a Best Effort connection.

Table 39-16 (Page 3 of 3). Configuration Parameter List - Port Configuration for ATM

Parameter Information	
Parameter	Backward QOS
Valid Values	CLASS_0, CLASS_1, CLASS_2, CLASS_3, CLASS_4, where **CLASS_0** The unspecified class. The network does not specify any QoS. **CLASS_1** Performance is comparable to current digital private line performance. **CLASS_2** Intended for packetized video and audio in teleconferencing and multimedia applications. **CLASS_3** Intended for interoperation of connection-oriented protocols, such as Frame Relay. **CLASS_4** Intended for interoperation of connectionless protocols, such as IP.
Default Value	CLASS_0
Description	This parameter indicates which class of service is provided to an ATM virtual connection. You cannot specify this parameter for a Best Effort connection.
Parameter	LDLC retry count
Valid Values	1 — 255
Default Value	3
Description	This parameter is used in conjunction with the LDLC timer period to provide reliable delivery of XIDs. The retry count is initialized when a command or request is first transmitted over the link. If the LDLC timer period expires before a response is received, the command or request is retransmitted, the retry count is decremented, and the LDLC timer period is restarted. If the timer expires with the retry count at 0, the link is assumed to be inoperative.
Parameter	LDLC Timer Period
Valid Values	1 — 255 seconds
Default Value	For ATM:1 second For IP: 15 seconds
Description	This parameter specifies the timer period used with the **LDLC retry count**.

Table 39-17 (Page 1 of 3). Configuration Parameter List - Port Definition

Parameter Information	
Parameter	Maximum BTU size
Valid Values	768 to 1496 bytes for Ethernet 768 to 17745 bytes for token-ring 768 to 17745 bytes for FDDI 768 to 4096 bytes for ATM
Default Value	1289 bytes for Ethernet 2048 bytes for token-ring 2048 bytes for FDDI 2048 for ATM 1469 bytes for IP
Description	This parameter specifies the number of bytes in the largest basic transmission unit (BTU) that can be processed (transmitted or received) by a link station defined on this port. **Note:** If a negotiable BIND with an RU size greater than 2048 is received, the device will normally choose a maximum RU size of 2048. If a non-negotiable BIND with an RU size greater than 2048 is received, the device will support the larger RU size up to a maximum size of 4096.
Parameter	Maximum number of link stations
Valid Values	1 to 976
Default Value	512 for all ports
Description	This parameter specifies the maximum number of link stations that will be allowed to use this port. This parameter allows the resources for the APPN node and this port to be constrained.
Parameter	Percent of link stations reserved for incoming calls
Valid Values	0 to 100 The sum of the percent of link stations reserved for incoming calls and the percent of link stations reserved for outgoing calls cannot exceed 100%.
Default Value	0
Description	This parameter specifies the percentage of the maximum number of link stations that will be reserved for incoming calls. Link stations that are not reserved for incoming or outgoing calls are available for either purpose on a demand basis.

Table 39-17 (Page 2 of 3). Configuration Parameter List - Port Definition

Parameter Information	
Parameter	Percent of link stations reserved for outgoing calls
Valid Values	0 to 100 The sum of the percent of link stations reserved for incoming calls and the percent of link stations reserved for outgoing calls cannot exceed 100%.
Default Value	0
Description	This parameter specifies the percentage of the maximum number of link stations that will be reserved for outgoing calls. Fractions resulting from the computation are truncated. Link stations that are not reserved for incoming or outgoing calls are available for either purpose on a demand basis.
Parameter	UDP port number for XID exchange
Valid Values	1024 to 65535
Default Value	11000
Description	This parameter specifies the UDP port number to be used for XID exchange and is used during IP port definition. This port number must be the same as the one defined on other devices in the network.
Parameter	UDP port number for network priority traffic
Valid Values	1024 to 65535
Default Value	11001
Description	This parameter specifies the UDP port number to be used for network priority traffic.
Parameter	UDP port number for high priority traffic
Valid Values	1024 to 65535
Default Value	11002
Description	This parameter specifies the UDP port number to be used for high priority traffic.
Parameter	UDP port number for medium priority traffic
Valid Values	1024 to 65535
Default Value	11003
Description	This parameter specifies the UDP port number to be used for medium priority traffic.
Parameter	UDP port number for low priority traffic
Valid Values	1024 to 65535
Default Value	11004
Description	This parameter specifies the UDP port number to be used for low priority traffic.
Parameter	IP network type
Valid Values	Campus or Widearea
Default Value	Widearea
Description	This parameter specifies the IP network type.
Parameter	Local APPN SAP address
Valid Values	Multiples of four in the hexadecimal range X'04' to X'EC'
Default Value	X'04'
Description	This parameter specifies the local SAP address to be used for communicating with APPN link stations defined on this port.
Parameter	Local HPR SAP address
Valid Values	Multiples of four in the hexadecimal range X'04' to X'EC'
Default Value	X'C8'
Description	This parameter indicates the local service access point to be used for communicating with HPR link stations defined on this port.

Table 39-17 (Page 3 of 3). Configuration Parameter List - Port Definition

Parameter Information	
Parameter	Branch uplink
Valid Values	Yes or No
Default Value	No
Description	This parameter indicates whether the default for link stations using this port will be uplink or downlink. If *yes* is specified, link stations using this port will default **Branch uplink** to *yes*. **Notes:** 1. This question is asked only if the node-level parameter **Enabled Branch Extender** is *yes*. 2. If **Branch uplink** is yes, the Branch Extender will present its end node appearance to this link station. Otherwise, the Branch Extender will present its network node appearance. 3. Typically, **Branch uplink** is yes for WAN-attached network nodes and is no for LAN-attached end nodes.

Table 39-18 (Page 1 of 6). Configuration Parameter List - Port Default TG Characteristics

Parameter Information	
Parameter	Cost per connect time
Valid Values	0 to 255
Default Value	For ATM SVCs: **Campus ATM best effort** 0 **Campus ATM reserved** 64 **WAN ATM best effort** 0 **WAN ATM reserved** 128 For ATM PVCs: **Campus ATM best effort** 0 **Campus ATM reserved** 0 **WAN ATM best effort** 0 **WAN ATM reserved** 0 For IP: 0 for Campus and WAN For all other: 0
Description	This parameter specifies the cost per connect time TG characteristic for all link stations on this port. The cost per connect time TG characteristic expresses the relative cost of maintaining a connection over the associated TG. The units are user-defined and are typically based on the applicable tariffs of the transmission facility being used. The assigned values should reflect the actual expense of maintaining a connection over the TG relative to all other TGs in the network. A value of zero means that connections over the TG may be made at no additional cost (as in the case of many nonswitched facilities). Higher values represent higher costs.

Table 39-18 (Page 2 of 6). Configuration Parameter List - Port Default TG Characteristics

Parameter Information	
Parameter	Cost per byte
Valid Values	0 to 255
Default Value	For ATM SVCs: **Campus ATM best effort** 0 **Campus ATM reserved** 0 **WAN ATM best effort** 128 **WAN ATM reserved** 0 For ATM PVCs: **Campus ATM best effort** 0 **Campus ATM reserved** 0 **WAN ATM best effort** 128 **WAN ATM reserved** 0 For IP: 0 for Campus and WAN For all other: 0
Description	This parameter specifies the cost per byte TG characteristic for all link stations defined on this port. The cost per byte TG characteristic expresses the relative cost of transmitting a byte over the associated TG. The units are user-defined and the assigned value should reflect the actual expenses incurred for transmitting over the TG relative to all other TGs in the network. A value of zero means that bytes may be transmitted over the TG at no additional cost. Higher values represent higher costs.

Table 39-18 (Page 3 of 6). Configuration Parameter List - Port Default TG Characteristics

Parameter Information	
Parameter Valid Values	Security **Nonsecure** all else (for example, satellite-connected, or located in a nonsecure country). **Public switched network** secure in the sense that route is not predetermined **Underground cable** located in secure country (as determined by the network administrator) **Secure conduit** Not guarded, (for example, pressurized pipe) **Guarded conduit** protected against physical tapping **Encrypted** link-level encryption is provided **Guarded radiation** guarded conduit containing the transmission medium; protected against physical and radiation tapping
Default Value	For ATM SVCs: **Campus ATM best effort** Nonsecure **Campus ATM reserved** Nonsecure **WAN ATM best effort** Public switched network **WAN ATM reserved** Public switched network For ATM PVCs: **Campus ATM best effort** Nonsecure **Campus ATM reserved** Nonsecure **WAN ATM best effort** Public switched network **WAN ATM reserved** Public switched network For IP: **Campus** Nonsecure **WAN** Public switched network For all other: Nonsecure
Description	This parameter specifies the security TG characteristic for all link stations defined on this port. The security TG characteristic indicates the level of security protection associated with the TG. If security attributes other than the architecturally-defined ones are needed, one of the user-defined TG characteristics may be used to specify additional values.

Table 39-18 (Page 4 of 6). Configuration Parameter List - Port Default TG Characteristics

Parameter Information	
Parameter Valid Values	Propagation delay **Minimum LAN** less than 480 microseconds **Telephone** between .48 and 49.152 milliseconds **Packet switched** between 49.152 and 245.76 milliseconds **Satellite** greater than 245.76 milliseconds maximum
Default Value	For LAN: **For token-ring and Ethernet/802.3 ports** LAN **For frame-relay ports** Packet switched **For all other ports** Telephone For ATM SVCs: **Campus ATM best effort** Telephone **Campus ATM reserved** Minimum LAN **WAN ATM best effort** Packet switched **WAN ATM reserved** Telephone For ATM PVCs: **Campus ATM best effort** Telephone **Campus ATM reserved** Minimum LAN **WAN ATM best effort** Packet switched **WAN ATM reserved** Telephone For IP: **Campus** Telephone **WAN** Packet switched
Description	This parameter specifies the propagation delay TG characteristic for all link stations defined on this port. The propagation delay TG characteristic specifies the approximate range for the length of time that it takes for a signal to propagate from one end of the TG to the other.

Table 39-18 (Page 5 of 6). Configuration Parameter List - Port Default TG Characteristics

Parameter Information	
Parameter	Effective capacity
Valid Values	2 hexadecimal digits in the range X'00' to X'FF'
Default Value	token-ring ports: dependent upon minimum data rate specified. • X'75' when minimum is 4 Mbps • X'85' when minimum is 16 Mbps • DLSw:X'75' (4 Mbps) • FDDI: X'9A' Ethernet/802.3 ports: • X'80' for 10 Mbps For ATM SVCs (155 Mbps): **Campus ATM best effort** X'9F' **Campus ATM reserved** X'9F' **WAN ATM best effort** X'9F' **WAN ATM reserved** X'9F' For ATM PVCs (155Mbps): **Campus ATM best effort** X'9F' **Campus ATM reserved** X'9F' **WAN ATM best effort** X'9F' **WAN ATM reserved** X'9F' For IP: **Campus** X'75' **WAN** X'43'
Description	This parameter specifies the effective capacity TG characteristic for all associated connections (TGs) on this port. This parameter specifies the maximum bit transmission rate for both physical links and logical links. Note that the effective capacity for a logical link may be less than the physical link speed. The rate is represented in COS files as a floating-point number encoded in a single byte with units of 300 bps. The effective capacity is encoded as a single-byte representation. The values X'00' and X'FF' are special cases used to denote minimum and maximum capacities. The range of the encoding is very large; however, only 256 values in the range may be specified. This parameter provides the default value for the Effective capacity parameter on the Modify TG Characteristics Command Line option. The Modify TG Characteristics Command Line option enables you to override the .*default values assigned to TG characteristics on the individual link stations you define.

Table 39-18 (Page 6 of 6). Configuration Parameter List - Port Default TG Characteristics

Parameter Information	
Parameter	First user-defined TG characteristic
Valid Values	0 to 255
Default Value	128
Description	This parameter specifies the first user-defined TG characteristic for all link stations defined on this port. The first user-defined TG characteristic specifies the first of three additional characteristics that users can define to describe the TGs in a network. The default value of 128 allows a subset of TGs to be defined as more or less desirable than the rest without defining values for all TGs.
Parameter	Second user-defined TG characteristic
Valid Values	0 to 255
Default Value	128
Description	This parameter specifies the second user-defined TG characteristic for all link stations defined on this port. The second user-defined TG characteristic specifies the second of three additional characteristics that users can define to describe the TGs in a network.
Parameter	Third user-defined TG characteristic
Valid Values	0 to 255
Default Value	128
Description	This parameter specifies the third user-defined TG characteristic for all link stations defined on this port. The third user-defined TG characteristic specifies the third of three additional characteristics that users can define to describe the TGs in a network.

Table 39-19 (Page 1 of 3). Configuration Parameter List - Port default LLC Characteristics

Parameter Information	
Parameter	Remote APPN SAP
Valid Values	Multiples of four in the hexadecimal range of X'04' to X'EC'
Default Value	X'04'
Description	This parameter specifies the SAP associated with an adjacent node's APPN link station.
Parameter	Maximum number of outstanding I-format LPDUs (TW)
Valid Values	1 to 127
Default Value	26
Description	This parameter specifies the LLC maximum number of outstanding I-format LPDUs (TW) for all link stations on this port. The maximum number of outstanding I-format LPDUs defines the transmit Command Line option (TW) which is the maximum number of sequentially numbered I-format LPDUs that the link station may have unacknowledged at any given time.

Table 39-19 (Page 2 of 3). Configuration Parameter List - Port default LLC Characteristics

Parameter Information	
Parameter	Receive window size
Valid Values	1 to 127
Default Value	26
Description	This parameter specifies the LLC receive Command Line option size (RW) for all link stations on this port. The RW parameter specifies the maximum number of unacknowledged sequentially numbered I-format LPDUs that the link station can receive from the remote link station. RW is advertised in SNA XID frames and IEEE 802.2 XID frames. The XID receiver should set its effective TW to a value less than or equal to the value of the received RW to avoid overruns.
Parameter	Inactivity timer (Ti)
Valid Values	1 to 254 seconds
Default Value	30 seconds
Description	This parameter specifies the LLC inactivity timer (Ti) for all link stations on this port. An LLC link station uses Ti to detect an inoperative condition in either the remote link station or in the transmission media. If an LPDU is not received in the time interval specified by Ti, an S-format command LPDU with the poll bit set is transmitted to solicit remote link station status. Recovery is then based on the reply timer (T1).
Parameter	Reply timer (T1)
Valid Values	1 to 254 half-seconds
Default Value	2 half-seconds
Description	This parameter specifies the LLC reply timer (T1) for all link stations on this port. An LLC link station uses T1 to detect a failure to receive a required acknowledgement or response from the remote link station. When T1 expires, the link station sends an S-format command link layer protocol data unit (LPDU) with the poll bit set to solicit remote link station status or any U-format command LPDUs that have not been responded to. The duration of T1 should take into account any delays introduced by underlying layers.
Parameter	Maximum number of retransmissions (N2)
Valid Values	1 to 254
Default Value	8
Description	This parameter specifies the maximum number of retransmissions (N2) for all link stations on this port. The N2 parameter specifies the maximum number of times an LPDU will be retransmitted following expiration of the reply timer (T1).

Table 39-19 (Page 3 of 3). Configuration Parameter List - Port default LLC Characteristics

Parameter Information	
Parameter	Receive acknowledgement timer (T2)
Valid Values	1 to 254 half-seconds
Default Value	1 half-second
Description	This parameter specifies the LLC receiver acknowledgement timer (T2) for all link stations on this port. The T2 parameter may be used with the N3 counter to reduce acknowledgement traffic. A link station uses T2 to delay the sending of an acknowledgement for a received I-format LPDU. T2 is started when an I-format LPDU is received, and reset when an acknowledgement is sent in an I-format or S-format LPDU. If T2 expires, the link station must send an acknowledgement as soon as possible. The value of T2 must be less than that of T1, to ensure that the remote link station will receive the delayed acknowledgement before its T1 expires.
Parameter	Acknowledgements needed to increment working window
Valid Values	0 to 127
Default Value	1
Description	When the working window (Ww) is not equal to the Maximum Transmit Window Size (Tw), this parameter is the number of transmitted I-format LPDUs that must be acknowledged before the working window can be incremented (by 1). When congestion is detected, by the loss of I-format LPDUs, Ww is set to 1.

Table 39-20. Configuration Parameter List - HPR Override Defaults

Parameter Information	
Parameter	Inactivity timer override for HPR (HPR Ti)
Valid Values	1 to 254 seconds
Default Value	2 seconds
Description	This parameter specifies the LLC inactivity timer (HPR Ti) that is to be used for all link stations on this port supporting HPR when the HPR supported parameter is enabled on this port. This default overrides the value of the default LLC inactivity timer (Ti) parameter specified on the default LLC characteristics parameter.
Parameter	Reply timer override for HPR (HPR T1)
Valid Values	1 to 254 half-seconds
Default Value	2 half-seconds
Description	This parameter specifies the LLC reply timer (HPR T1) that is to be used for all link stations on this port supporting HPR when the HPR supported parameter is enabled on this port. This default overrides the value of the default LLC reply timer (T1) parameter specified on the default LLC characteristics parameter.
Parameter	Maximum number of retransmissions for HPR (HPR N2)
Valid Values	1 to 254
Default Value	3
Description	This parameter specifies the LLC maximum number of retransmissions (HPR N2) that is to be used for all link stations on this port supporting HPR when the HPR supported parameter is enabled on this port. This default overrides the value of the default LLC maximum number of retransmissions (N2) parameter specified on the default LLC Characteristics parameter.

Syntax:

add link

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-21 (Page 1 of 5). Configuration Parameter List - Link Station - Detail

Parameter Information	
Parameter	Does link support APPN function
Valid Values	Yes or No
Default Value	Yes
Description	This parameter specifies whether this link station will support APPN function. If the answer is *no*, questions concerning CP-CP sessions, security, encryption, CP name, adjacent node type, branch extender, and extended border node will not be asked and all of these functions will be disabled. Also, HPR will be disabled and no HPR questions will be asked.
Parameter	Link station name (required)
Valid Values	A string of 1 to 8 characters : • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name of a link station that represents the TG (link) between the router network node and the adjacent node. The link station name must be unique within this network node.
Parameter	Port name
Valid Values	A unique unqualified name that is automatically generated. The name will consist of: • TR (token-ring) • EN (Ethernet) • DLS (DLSw) • PPP (point-to-point) • IP • FDD (FDDI) followed by the interface number.
Default Value	The name of the port that this link station is defined on.
Description	This parameter specifies the name representing the port this link station is defined on. The port must already have been configured for APPN.

Table 39-21 (Page 2 of 5). Configuration Parameter List - Link Station - Detail	
Parameter Information	
Parameter **Valid Values**	MAC address of adjacent node (required) Token-ring 12 hexadecimal digits in the range X'000000000001' to X'7FFFFFFFFFFF' Ethernet/802.3 ports: 12 hexadecimal digits in the form *X'xyxxxxxxxxxx'* where: *x* is any hexadecimal digit *y* is a hexadecimal digit in the set {0, 2, 4, 6, 8, A, C, E} DLSw ports: • 12 hexadecimal digits in the range X'000000000001' to X'7FFFFFFFFFFF'
Default Value	None
Description	This parameter specifies the medium access control (MAC) layer address of the adjacent node. Different formats are used for token-ring and Ethernet/802.3: Token-ring and DLSw ports: The MAC address is specified in noncanonical form. In the noncanonical address format, the bit within each octet that is to be transmitted first is represented as the most significant bit. Ethernet/802.3 ports: The MAC address is specified in canonical form. In the canonical address format, the bit within each octet that is to be transmitted first is represented as the least significant bit.
Parameter **Valid Values** **Default Value** **Description**	IP address of adjacent node Any valid IP address none Each link on the HPR/IP port must have a unique destination IP address.
Parameter **Valid Values** **Default Value** **Description**	Adjacent node type APPN network node, APPN end node, LEN end node APPN network node This parameter identifies whether the adjacent node is an APPN node, a low-entry networking (LEN) end node. When *APPN end node* is selected and *Limited resource* is No, APPN changes the adjacent node type internally to *learn* and will work with any node type. When *APPN end node* is selected and *Limited resource* is Yes, the adjacent node type is unchanged. When you select *LEN end node*, the fully-qualified control point name parameter is a required parameter. If this network node is communicating with the IBM Virtual Telecommunications Access Method (VTAM) product through the LEN node, and the LEN node is not a T2.1 node or does not have an explicitly defined control point (CP) name, then the router network node's XID number for the Subarea connection parameter also must be specified to establish a connection. **Note:** *LEN end node* is not a valid node type for HPR/IP interface.

Table 39-21 (Page 3 of 5). Configuration Parameter List - Link Station - Detail

Parameter Information	
Parameter	fully-qualified CP name of adjacent node
Valid Values	A string of up to 17 characters in the form of *netID.CPname*, where: • *netID* is a network ID from 1 to 8 characters • *CPname* is a control point name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing fully-qualified CP name, using the special characters @, $, and from the character set A, continues to be supported; however, these characters should not be used for new CP names.
Default Value	None
Description	This parameter specifies the fully-qualified CP name of the adjacent node. For the cases where this parameter is not required, the adjacent node's CP name may be learned dynamically during XID exchange; however, if a CP name is specified, it must match the adjacent node's definition for the link to be successfully activated. **Note:** This parameter is required when any of the following occur: • The *Service any node* parameter is set to Disable. • The *Adjacent node type* parameter is set to LEN end node. • The *CP-CP session level security* parameter is set to Enable. • The link is a limited resource.
Parameter	Activate link automatically If limited resource, then this parameter is set to No and is not configurable.
Valid Values	Yes, No
Default Value	Yes
Description	When this parameter is enabled, the router network node automatically activates the link to the adjacent node and initiates a connection.
Parameter	Allow CP-CP sessions on this link
Valid Values	Yes, No
Default Value	Yes, if adjacent node type is APPN network node or APPN end node. No for all other adjacent node types
Description	This parameter specifies whether sessions between control points are to be activated over this link station. This parameter allows control of CP-CP session establishment between adjacent network nodes so that the overhead associated with topology database updates (TDUs) may be constrained. **Note:** Every APPN network node must have at least one CP-CP session established to another APPN network node in order to maintain the minimum connectivity necessary to update the topology database. In addition, more than minimum connectivity could be desired to eliminate single points of failure and to improve network dynamics.

Table 39-21 (Page 4 of 5). Configuration Parameter List - Link Station - Detail	
Parameter Information	
Parameter	CP-CP session level security
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether session level security is enforced for CP-CP sessions established over this link station. When session level security is enabled, encrypted data is exchanged and compared during the BIND flows (which includes the BIND, the BIND response, and an FMH-12 Security RU). To successfully establish a CP-CP session with session level security enabled, both partners must be configured with the same encryption key. Currently, session level security support is limited to the basic LU-LU verification protocol.
Parameter	Encryption key
Valid Values	Up to 16 hexadecimal digits. If fewer than 16 digits are specified, the value is padded on the right with zeros.
Default Value	None
Description	This parameter is used to encrypt data exchanged during BIND flows. Both partners must be configured with the same key to establish a CP-CP session.
Parameter	Use enhanced session security (If security is enabled)
Valid Values	Yes, No
Default Value	No
Parameter	High-performance routing (HPR) supported
Valid Values	Yes, No
Default Value	APPN network node, APPN end node or LEN end node: the value specified in the default HPR supported parameter for this port All other adjacent node types: No
Description	This parameter indicates whether this link station supports HPR. The user should disable HPR support if the underlying link is unreliable. An HPR connection will not be established unless both link stations advertise HPR support during XID exchange.
Parameter	Branch Uplink
Valid Values	Yes or No
Default Value	The value specified for **Branch Uplink** on the port.
Description	This parameter indicates whether this link will be a Branch uplink (to WAN) or Branch downlink (to LAN). This question is asked only if **Enabled Branch Extender** has been set to *yes* and if this link station is not a network node. If **Enabled Branch Extender** has been set to *yes* and this link station is a network node, then **Branch Uplink** defaults to *yes*
Parameter	Is uplink to another Branch Extender node
Valid Values	Yes or No
Default Value	No
Description	This parameter indicates whether or not the adjacent node has the Branch Extender function enabled. This question is asked only if **Branch Extender** is enabled on this node, this is an uplink, and the uplink is a limited resource.

Table 39-21 (Page 5 of 5). Configuration Parameter List - Link Station - Detail

Parameter Information	
Parameter	Preferred Network Node Server
Valid Values	Yes or No
Default Value	No
Description	This parameter indicates whether this uplink is to a network node server that is to be used as the network node server for the node supporting Branch Extender function and acting as an end node. If *yes* is specified, this uplink will be used as the network node server for this node. This question will be asked only if: • **Enabled Branch Extender** is *yes,* • This station is a network node, • **Branch Uplink** is *yes*, and • CP-CP sessions are supported on this link.

Table 39-22 (Page 1 of 4). Configuration Parameter List - Station Configuration for ATM

Parameter Information	
Parameter	Virtual Channel Type
Valid Values	SVC, PVC
Default Value	SVC
Description	This parameter identifies the ATM channel type as switched virtual circuit (SVC) or permanent virtual circuit (PVC).
Note:	The following parameters are common for SVCs and PVCs.
Parameter	Destination ATM Address
Valid Values	A 40- hexadecimal character string
Default Value	None
Description	This parameter specifies the 20–byte string that comprises the entire destination ATM address.
Parameter	ATM network type
Valid Values	Campus, Widearea
Default Value	Campus
Description	This parameter specifies the ATM network type.
Parameter	Shareable connection network traffic
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether connection network traffic can be routed on the ATM VC set up this TG.
Parameter	Shareable other protocol traffic
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether other higher level protocol traffic can be routed on the ATM VC set up for this TG.
Parameter	TG Number
Valid Values	0 - 20
Default Value	0
Description	This parameter specifies the TG number for the ATM VC.

Table 39-22 (Page 2 of 4). Configuration Parameter List - Station Configuration for ATM

Parameter Information	
Parameter	LDLC retry count
Valid Values	1 — 255
Default Value	3
Description	This parameter is used in conjunction with the LDLC timer period to provide reliable delivery of XIDs. The retry count is initialized when a command or request is first transmitted over the link. If the LDLC timer period expires before a response is received, the command or request is retransmitted, the retry count is decremented, and the LDLC timer period is restarted. If the timer expires with the retry count at 0, the link is assumed to be inoperative.
Parameter	LDLC Timer Period
Valid Values	1 — 255 seconds
Default Value	For ATM: 1 second For IP: 15 seconds
Description	This parameter specifies the timer period used with the **LDLC retry count**.
Parameter	VPI
Valid Values	0 — 255
Default Value	0
Description	This parameter identifies the VPI of the PVC at the interface.
Parameter	VCI
Valid Values	0 —65535
Default Value	0
Description	This parameter identifies the VCI of the PVC at the interface.
Parameter	Broadband Bearer Class
Valid Values	Class_A, Class_C, Class_X
Default Value	Class_X
Description	This parameter specifies the bearer class requested from the ATM network. The classes are defined: **Class A** Constant bit rate (CBR) with end-to-end timing requirements **Class C** Variable bit rate (VBR) with no end-to-end timing requirements **Class X** Service allowing user-defined traffic type and timing requirements
Parameter	Best Effort Indicator
Valid Values	Yes, No
Default Value	No
Description	This parameter indicates if a throughput guarantee is required on this SVC. If the value of this parameter is *yes*, then VCCs associated with this interface will be allocated based upon the available bandwidth.
Note: The following parameters are forward traffic parameters.	
Parameter	Forward Peak Cell Rate
Valid Values	85% of line speed
Default Value	Port's Default Effective Capacity/48
Description	This parameter indicates an upper bound on the cell transmission rate.

Table 39-22 (Page 3 of 4). Configuration Parameter List - Station Configuration for ATM

Parameter Information	
Parameter	Forward Sustained Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Port's Default Effective Capacity/48
Description	This parameter indicates an upper bound on the average cell transmission rate. You cannot specify this parameter for Best Effort connections.
Parameter	Forward Tagging
Valid Values	Yes, No
Default Value	Yes
Description	This parameter indicates that cells that are nonconforming to cell loss priority 0 traffic specification but are conforming to cell loss priority 1 traffic specification are marked and allowed into the ATM network. You cannot specify this parameter for Best Effort connections.
Parameter	QOS
Valid Values	CLASS_0, CLASS_1, CLASS_2, CLASS_3, CLASS_4, where **CLASS_0** The unspecified class. The network does not specify any QoS. **CLASS_1** Performance is comparable to current digital private line performance. **CLASS_2** Intended for packetized video and audio in teleconferencing and multimedia applications. **CLASS_3** Intended for interoperation of connection-oriented protocols, such as Frame Relay **CLASS_4** Intended for interoperation of connectionless protocols, such as IP.
Default Value	CLASS_0
Description	This parameter indicates which class of service is provided to an ATM virtual connection. You cannot specify this parameter for Best Effort connections.
Note: The following parameters are backward traffic parameters.	
Parameter	Backward Peak Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Taken from the port definition
Description	This parameter indicates an upper bound on the cell transmission rate.
Parameter	Backward Sustained Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Taken from the port definition
Description	This parameter indicates an upper bound on the average cell transmission rate. You cannot specify this parameter for Best Effort connections.
Parameter	Backward Tagging
Valid Values	Yes, No
Default Value	Yes
Description	This parameter indicates that cells that are nonconforming to cell loss priority 0 traffic specification but are conforming to cell loss priority 1 traffic specification are marked and allowed into the ATM network. You cannot specify this parameter for Best Effort connections.

Table 39-22 (Page 4 of 4). Configuration Parameter List - Station Configuration for ATM

Parameter Information	
Parameter	QOS
Valid Values	CLASS_0, CLASS_1, CLASS_2, CLASS_3, CLASS_4, where **CLASS_0** The unspecified class. The network does not specify any QoS. **CLASS_1** Performance is comparable to current digital private line performance. **CLASS_2** Intended for packetized video and audio in teleconferencing and multimedia applications. **CLASS_3** Intended for interoperation of connection-oriented protocols, such as Frame Relay **CLASS_4** Intended for interoperation of connectionless protocols, such as IP.
Default Value	CLASS_0
Description	This parameter indicates which class of service is provided to an ATM virtual connection. You cannot specify this parameter for Best Effort connections.

Table 39-23 (Page 1 of 2). Configuration Parameter List - Modify TG Characteristics

Parameter Information	
Parameter	Cost per connect time
Valid Values	0 to 255
Default Value	Default value is taken from the associated port parameter.
Description	This parameter expresses the relative cost of maintaining a connection over the associated TG. The units are user-defined and are typically based on the applicable tariffs of the transmission facility being used. The assigned values should reflect the actual expense of maintaining a connection over the TG relative to all other TGs in the network. A value of zero means that connections over the TG may be made at no additional cost (as in the case of many nonswitched facilities). Higher values represent higher costs.
Parameter	Cost per byte
Valid Values	0 to 255
Default Value	Default value is taken from the associated port parameter.
Description	This parameter expresses the relative cost of transmitting a byte over the associated TG. The units are user-defined and the assigned value should reflect the actual expenses incurred for transmitting over the TG relative to all other TGs in the network. A value of zero means that bytes may be transmitted over the TG at no additional cost. Higher values represent higher costs.

Table 39-23 (Page 2 of 2). Configuration Parameter List - Modify TG Characteristics

Parameter Information	
Parameter	Security
Valid Values	• Nonsecure - all else (for example, satellite-connected, or located in a nonsecure country). • Public switched network - secure in the sense that route is not predetermined. • Underground cable - located in secure country (as determined by the network administrator). • Secure conduit - Not guarded, (for example, pressurized pipe). • Guarded conduit - protected against physical tapping. • Encrypted - link-level encryption is provided. • Guarded radiation - guarded conduit containing the transmission medium; protected against physical and radiation tapping.
Default Value	Default value is taken from the associated port parameter.
Description	This parameter indicates the level of security protection associated with the TG. If security attributes other than the architecturally-defined ones are needed, one of the user-defined TG characteristics may be used to specify additional values.
Parameter	Propagation delay
Valid Values	Minimum LAN - less than 480 microseconds Telephone - between .48 and 49.152 milliseconds Packet switched - between 49.152 and 245.76 milliseconds Satellite - greater than 245.76 milliseconds Maximum
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the approximate range for the length of time that it takes for a signal to propagate from one end of the TG to the other.
Parameter	Effective capacity
Valid Values	2 hexadecimal digits in the range X'00' to X'FF'
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the maximum bit transmission rate for both physical links and logical links. Note that the effective capacity for a logical link may be less than the physical link speed. The effective capacity is encoded as a single-byte representation. The values X'00' and X'FF' are special cases used to denote minimum and maximum capacities. The range of the encoding is very large; however, only 256 values in the range may be specified.
Parameter	First user-defined TG characteristic
Valid Values	0 to 255
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the first of three additional characteristics that users can define to describe the TGs in a network.
Parameter	Second user-defined TG characteristic
Valid Values	0 to 255
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the second of three additional characteristics that users can define to describe the TGs in a network.
Parameter	Third user-defined TG characteristic
Valid Values	0 to 255
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the third of three additional characteristics that users can define to describe the TGs in a network.

Table 39-24. Configuration Parameter List - Modify Dependent LU Server

Parameter Information	
Parameter	fully-qualified CP name of primary DLUS
Valid Values	A string of up to 17 characters in the form of *netID.CPname*, where: • *netID* is a network ID from 1 to 8 characters • *CPname* is a control point name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing fully-qualified CP name, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new CP names.
Default Value	The value specified in the default fully-qualified CP name of primary dependent LU server parameter.
Description	This parameter specifies the fully-qualified CP name of the dependent LU server (DLUS) that is to be used for incoming requests from the downstream PU associated with this link station.
Parameter	fully-qualified CP name for backup DLUS
Valid Values	A string of up to 17 characters in the form of *netID.CPname*, where: • *netID* is a network ID from 1 to 8 characters • *CPname* is a control point name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing fully-qualified CP name, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new CP names.
Default Value	The value specified in the default fully-qualified CP name of backup dependent LU server parameter.
Description	This parameter specifies the fully-qualified CP name of the dependent LU server (DLUS) that is to be used as a backup for the downstream PU associated with this link station. This parameter allows the default backup server to be overridden. A backup is not required, and the NULL value indicates the absence of a backup server. Note that NULL can be specified even when a default backup server has been defined (by erasing the default value that appears for this parameter).

Table 39-25 (Page 1 of 3). Configuration Parameter List - Modify LLC Characteristics

Parameter Information	
Parameter	Remote APPN SAP
Valid Values	Multiples of four in the hexadecimal range of X'04' to X'EC'.
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the Destination SAP (DSAP) address on the destination node to which data will be sent. This DSAP address value will appear in the LLC frame to identify the service access point (SAP) address associated with the adjacent node's APPN link station.

Table 39-25 (Page 2 of 3). Configuration Parameter List - Modify LLC Characteristics

Parameter Information	
Parameter	Maximum number of outstanding I-format LPDUs (TW)
Valid Values	1 to 127
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the transmit Command Line option which is the maximum number of sequentially numbered I-format LPDUs that the link station may have unacknowledged at any given time.
Parameter	Receive window size
Valid Values	1 to 127
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the maximum number of unacknowledged sequentially numbered I-format LPDUs that the LLC link station can receive from the remote link station. RW is advertised in SNA XID frames and IEEE 802.2 XID frames. The XID receiver should set its effective TW to a value less than or equal to the value of the received RW to avoid overruns.
Parameter	Inactivity timer (Ti)
Valid Values	1 to 254 seconds
Default Value	Default value is taken from the associated port parameter.
Description	A link station uses Ti to detect an inoperative condition in either the remote link station or in the transmission media. If an LPDU is not received in the time interval specified by Ti, an S-format command LPDU with the poll bit set is transmitted to solicit remote link station status. Recovery is then based on the reply timer (T1).
Parameter	Reply timer (T1)
Valid Values	1 to 254 half-seconds
Default Value	Default value is taken from the associated port parameter.
Description	A link station uses T1 to detect a failure to receive a required acknowledgement or response from the remote link station. When T1 expires, the link station sends an S-format command link layer protocol data unit (LPDU) with the poll bit set to solicit remote link station status or any U-format command LPDUs that have not been responded to. The duration of T1 should take into account any delays introduced by underlying layers.
Parameter	Maximum number of retransmissions (N2)
Valid Values	1 to 254
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the maximum number of times an LPDU will be retransmitted following the expiration of the reply timer (T1).
Parameter	Receive acknowledgement timer (T2)
Valid Values	1 to 254 half-seconds
Default Value	Default value is taken from the associated port parameter.
Description	This parameter may be used in conjunction with the N3 counter to reduce acknowledgement traffic. A link station uses T2 to delay the sending of an acknowledgement for a received I-format LPDU. T2 is started when an I-format LPDU is received, and reset when an acknowledgement is sent in an I-format or S-format LPDU. If T2 expires, the link station must send an acknowledgement as soon as possible. The value of T2 must be less than that of T1, to ensure that the remote link station will receive the delayed acknowledgement before its T1 expires.

Table 39-25 (Page 3 of 3). Configuration Parameter List - Modify LLC Characteristics	
Parameter Information	
Parameter	Acknowledgement needed to increment working window
Valid Values	0 to 127 acknowledgements
Default Value	Default value is taken from the associated port parameter.
Description	When the working window (Ww) is not equal to the Maximum Transmit Window Size (Tw), this parameter is the number of transmitted I-format LPDUs that must be acknowledged before the working window can be incremented (by 1). When congestion is detected, by the lost of I-format LPDUs, Ww is set to 1.

Table 39-26. Configuration Parameter List - Modify HPR Defaults	
Parameter Information	
Parameter	Inactivity timer override for HPR (HPR Ti)
Valid Values	1 to 254 seconds
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the HPR override LLC inactivity timer (HPR Ti) that is to be used when HPR is supported by this link station. This parameter overrides the value taken from the default inactivity timer override for the HPR parameter. This parameter supersedes the value of the LLC inactivity timer (Ti) parameter specified on the Modify Logical Link Control (LLC) Characteristics parameter when HPR is supported.
Parameter	Reply timer override for HPR (HPR T1)
Valid Values	1 to 254 half-seconds
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the HPR override LLC reply timer (HPR T1) that is to be used when HPR is supported by this link station. This parameter overrides the value taken from the default reply timer override for HPR parameter specified on HPR Defaults. This parameter supersedes the value of the LLC reply timer (T1) parameter specified on the Modify Logical Link Control (LLC) Characteristics parameter when HPR is supported.
Parameter	Maximum number retransmission (HPR N2)
Valid Values	1 to 2 160 000
Default Value	Default value is taken from the associated port parameter.
Description	This parameter specifies the HPR override LLC maximum number of retransmissions (HPR N2) that is to be used when HPR is supported by this link station. This parameter overrides the value taken from the default maximum number of retransmissions for HPR parameter specified on the HPR LLC Override defaults. This parameter supersedes the value of the LLC maximum number of retransmissions (N2) parameter specified on the Modify Logical Link Control (LLC) Characteristics parameter when HPR is supported.

Syntax:

add lu-name

You will be prompted to enter a station name to associate this LU with.

You will be prompted to enter a value for the following parameter. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-27. Configuration Parameter List - LEN End Node LU Name

Parameter Information	
Parameter	fully-qualified LU name
Valid Values	fully-qualified (explicit) LU name Generic (partially explicit) LU name Wildcard entry A string of up to 17 characters in the form of *netID.LUname*, where: • *netID* is a network ID from 1 to 8 characters • *LUname* is a control point name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing fully-qualified LU name, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new LU names. To reduce the number of fully-qualified LU names you need to specify, you can define a generic LU name using the wildcard character (*) to represent a portion of the LU name (*LUname*). You can also define a wildcard entry by using the wildcard character as the whole LU name.
Default Value	None
Description	This parameter specifies the fully-qualified names of LUs associated with a LEN end node. The specified LU names are registered in the network node's directory services database. If a name is not registered, the network node cannot locate the LU (unless the LU name is the same as the CP name of the LEN end node). You need to specify a fully-qualified LU name, which consists of a network ID and the LU name. The network ID is the name of the network that contains the adjacent LEN end node. The LU name is the name of a logical unit accessible through the adjacent LEN end node.

Syntax:

add connection-network

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-28 (Page 1 of 2). Configuration Parameter List - Connection Network - Detail	
Parameter Information	
Parameter	Fully-qualified Connection network name (required for each connection network defined)
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing connection network of which this node desires to become a member, named using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new connection network names.
Default Value	None
Description	This parameter specifies the fully-qualified name of the connection network being defined on this router network node. Since this name becomes the CP name of the virtual routing node (VRN), the name must be unique among all CP and LU names in the APPN network (same as in the local Control Point Name). All nodes that are members of a given connection network must use the same VRN Name. The fully-qualified VRN Name (CP name of VRN) has the form: *NetworkID.ConnectionNetworkName* where *NetworkID* is this router network node's network identifier.
Parameter	Port type (required)
Valid Values	Token-ring, Ethernet, Frame Relay BAN, ATM, IP **Note:** If the **port type** is IP, no **port name** will be specified since there is only one IP port.
Default Value	None
Description	This parameter specifies the type of ports providing connectivity to the SATF for the connection network being defined. A given connection network only supports one type of port with one set of characteristics.

Table 39-28 (Page 2 of 2). Configuration Parameter List - Connection Network - Detail

Parameter Information	
Parameter	Port name (required)
Valid Values	Name of port on which APPN routing has been enabled. **Note:** If the **port type** is IP, no **port name** will be specified since there is only one IP port.
Default Value	None
Description	This parameter specifies the name of a port providing connectivity to the shared access transport facility (SATF) for the connection network being defined. All ports defined for a given connection network must be the same type and have the same characteristics. **Note:** For a **port type** of IP, additional ports added to an IP connection network can be any port that IP has been defined to use. At least one additional port besides the IP port must be added for the connection network to be used. Since the IP port is a pseudo port that always comes up when the node is initialized, real ports that IP is defined on (TR, ATM, FR, ...) must be added to the CN. When at least one of these real ports is up, the connection network link is assumed active. When all of these real ports is down, the connection network link is assumed to be inactive.

Table 39-29 (Page 1 of 3). Configuration Parameter List - Connection Network Configuration for ATM

Parameter Information	
Parameter	Port name (required)
Valid Values	Name of port on which APPN routing has been enabled.
Default Value	None
Description	This parameter specifies the name of a port providing connectivity to the shared access transport facility (SATF) for the connection network being defined. All ports defined for a given connection network must be the same type and have the same characteristics.
Parameter	fully-qualified connection network name
Valid Values	A string of 3 to 17 characters in the form of *netID.CNname*, where: • *netID* is a network ID from 1 to 8 characters • *CNname* is a connection network name from 1 to 8 characters Each name must conform to the following rules: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the fully-qualified CN name to which this TG is defined.
Parameter	Connection network TG number
Valid Values	1 — 239
Default Value	None
Description	This parameter specifies the TG number uniquely identifying this connection from the local port to the CN. The CN name and TG number pair must be unique.

Table 39-29 (Page 2 of 3). Configuration Parameter List - Connection Network Configuration for ATM

Parameter Information	
Parameter	Limited Resource
Valid Values	Yes or No
Default Value	Yes
Description	This parameter indicates if this TG should be brought down when not in use by session traffic.
Parameter	Limited Resource Timer
Valid Values	1 — 2160000 seconds
Default Value	180 seconds
Description	This parameter indicates the time limit after which this CN TG should be brought down when not in use by session traffic.
Parameter	LDLC retry count
Valid Values	1 — 255
Default Value	3
Description	This parameter is used in conjunction with the LDLC timer period to provide reliable delivery of XIDs. The retry count is initialized when a command or request is first transmitted over the link. If the LDLC timer period expires before a response is received, the command or request is retransmitted, the retry count is decremented, and the LDLC timer period is restarted. If the timer expires with the retry count at 0, the link is assumed to be inoperative.
Parameter	LDLC Timer Period
Valid Values	1 — 255 seconds
Default Value	For ATM: 1 second For IP: 15 seconds
Description	This parameter specifies the timer period used with the **LDLC retry count**.
Parameter	Broadband Bearer Class
Valid Values	Class_A, Class_C, Class_X
Default Value	Class_X
Description	This parameter specifies the bearer class requested from the ATM network. The classes are defined: **Class A** Constant bit rate (CBR) with end-to-end timing requirements **Class C** Variable bit rate (VBR) with no end-to-end timing requirements **Class X** Service allowing user-defined traffic type and timing requirements
Parameter	Shareable Regular Network traffic
Valid Values	Yes, No
Default Value	Yes, if this is a Best Effort CN. No, otherwise.
Description	This parameter specifies whether traffic on this connection network TG can be routed on an ATM VC set up for a a regular TG or another CN TG.
Parameter	Shareable other protocol traffic
Valid Values	Yes, No
Default Value	No
Description	This parameter specifies whether the ATM VC established for this CN TG may be shared with other higher level protocols in the router.
Note: The following parameters are forward traffic parameters.	

Table 39-29 (Page 3 of 3). Configuration Parameter List - Connection Network Configuration for ATM

Parameter Information	
Parameter	Forward Peak Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Taken from the port definition
Description	This parameter indicates an upper bound on the cell transmission rate.
Parameter	Forward Sustained Cell Rate
Valid Values	1 - 85% of line speed
Default Value	Taken from the port definition
Description	This parameter indicates an upper bound on the average cell transmission rate.
Parameter	Forward Tagging
Valid Values	Yes, No
Default Value	Yes
Description	This parameter indicates that cells that are nonconforming to cell loss priority 0 traffic specification but are conforming to cell loss priority 1 traffic specification are marked and allowed into the ATM network.
Parameter	QOS
Valid Values	CLASS_0, CLASS_1, CLASS_2, CLASS_3, CLASS_4, where **CLASS_0** The unspecified class. The network does not specify any QoS. **CLASS_1** Performance is comparable to current digital private line performance. **CLASS_2** Intended for packetized video and audio in teleconferencing and multimedia applications. **CLASS_3** Intended for interoperation of connection-oriented protocols, such as Frame Relay. **CLASS_4** Intended for interoperation of connectionless protocols, such as IP.
Default Value	CLASS_3
Description	This parameter indicates which class of service is provided to an ATM virtual connection.

Table 39-30 (Page 1 of 3). Configuration Parameter List - TG Characteristics (Connection Network)

Parameter Information	
Parameter	Cost per connect time
Valid Values	0 to 255
Default Value	0
Description	This parameter expresses the relative cost of maintaining a connection over the associated TG. The units are user-defined and are typically based on the applicable tariffs of the transmission facility being used. The assigned values should reflect the actual expense of maintaining a connection over the TG relative to all other TGs in the network. A value of zero means that connections over the TG may be made at no additional cost (as in the case of many nonswitched facilities). Higher values represent higher costs.

Table 39-30 (Page 2 of 3). Configuration Parameter List - TG Characteristics (Connection Network)

Parameter Information	
Parameter	Cost per byte
Valid Values	0 to 255
Default Value	0
Description	This parameter expresses the relative cost of transmitting a byte over the associated TG. The units are user-defined and the assigned value should reflect the actual expenses incurred for transmitting over the TG relative to all other TGs in the network. A value of zero means that bytes may be transmitted over the TG at no additional cost. Higher values represent higher costs.
Parameter	Security
Valid Values	Nonsecure - all else (for example, satellite-connected, or located in a nonsecure country). Public switched network - secure in the sense that route is not predetermined. Underground cable - located in secure country (as determined by the network administrator). Secure conduit - Not guarded, (for example, pressurized pipe). Guarded conduit - protected against physical tapping. Encrypted - link-level encryption is provided. Guarded radiation - guarded conduit containing the transmission medium; protected against physical and radiation tapping.
Default Value	Nonsecure
Description	This parameter indicates the level of security protection associated with the TG. If security attributes other than the architecturally-defined ones are needed, one of the user-defined TG characteristics may be used to specify additional values.
Parameter	Propagation delay
Valid Values	• Minimum LAN - less than 480 microseconds • Telephone - between .48 and 49.152 milliseconds • Packet switched - between 49.152 and 245.76 milliseconds • Satellite - greater than 245.76 milliseconds Maximum
Default Value	LAN
Description	This parameter specifies the approximate range for the length of time that it takes for a signal to propagate from one end of the TG to the other.
Parameter	Effective capacity
Valid Values	2 hexadecimal digits in the range X'00' to X'FF'
Default Value	X'75'
Description	This parameter specifies the effective maximum bit transmission rate for this connection network TG. Effective capacity specifies the maximum effective rate for both physical links and logical links. The effective capacity is encoded as a single-byte representation. The values X'00' and X'FF' are special cases used to denote minimum and maximum capacities. The range of the encoding is very large; however, only 256 values in the range may be specified.

Table 39-30 (Page 3 of 3). Configuration Parameter List - TG Characteristics (Connection Network)

Parameter Information	
Parameter	First user-defined characteristic
Valid Values	0 to 255
Default Value	128
Description	This parameter specifies the first of three additional characteristics that users may define to describe the TGs in the network. The default value of 128 allows a subset of TGs to be defined as more or less desirable than the rest without defining values for all TGs.
Parameter	Second user-defined characteristic
Valid Values	0 to 255
Default Value	128
Description	This parameter specifies the second of three additional characteristics that users may define to describe the TGs in the network. The default value of 128 allows a subset of TGs to be defined as more or less desirable than the rest without defining values for all TGs.
Parameter	Third user-defined characteristic
Valid Values	0 to 255
Default Value	128
Description	This parameter specifies the third of three additional characteristics that users may define to describe the TGs in the network. The default value of 128 allows a subset of TGs to be defined as more or less desirable than the rest without defining values for all TGs.

Syntax:

add mode

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-31 (Page 1 of 2). Configuration Parameter List - APPN COS - Mode Name to COS Name Mapping - Detail

Parameter Information	
Parameter	Mode name (required)
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing mode name for an existing network, of which this router network node is to become a member, using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new mode names.
Default Value	None
Description	This parameter specifies the Mode name for the Mode name to COS name mapping being defined. See “COS Options” on page 38-23 for additional information about Mode name to COS mapping.

Table 39-31 (Page 2 of 2). Configuration Parameter List - APPN COS - Mode Name to COS Name Mapping - Detail

Parameter Information	
Parameter	COS name (required)
Valid Values	The name of a previously defined COS definition, selected from the list of COS names defined for this router network node.
Default Value	None
Description	This parameter specifies the COS Name to be associated with the Mode name being defined for this mode name to COS name mapping.
Parameter	Session-level pacing Command Line option size
Valid Values	1 to 63
Default Value	7
Description	This parameter specifies the session-level pacing Command Line option size. This parameter has different definitions depending upon the type of pacing used: • For fixed session-level pacing: – The session-level pacing Command Line option size parameter specifies the receive pacing Command Line option for this node. – The value of this parameter is the suggested receive pacing Command Line option for the adjacent node. • For adaptive session-level pacing: – The session-level pacing Command Line option size parameter specifies a tuning parameter to be used as the minimum size for Isolated Pacing Messages sent by the adjacent nodes.

Syntax:

add additional-port-to-connection-network

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Note: You can have a maximum of 5 ports per connection network definition.

Table 39-32. Configuration Parameter List - APPN Additional port to Connection Network

Parameter Information	
Parameter	Connection network name (fully-qualified) (required for each connection network defined)
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9 **Note:** An existing connection network of which this node desires to become a member, named using the special characters @, $, and # from the character set A, continues to be supported; however, these characters should not be used for new connection network names.
Default Value	None
Description	This parameter specifies the name of the connection network being defined on this router network node. Since this name becomes the CP name of the virtual routing node (VRN), the name must be unique among all CP and LU names in the APPN network (same as in the local Control Point Name). All nodes that are members of a given connection network must use the same VRN Name. The fully-qualified VRN Name (CP name of VRN) has the form: *NetworkID.ConnectionNetworkName* where *NetworkID* is this router network node's network identifier.
Parameter	Port name
Valid Values	A unique unqualified name that is automatically generated by the Command Line. The name will consist of: • TR (token-ring) • EN (Ethernet)
Default Value	Unqualified name generated by the Command Line.
Description	This parameter specifies the name representing this port. When the connection network that the port is being added to is IP, only ports that IP is defined to have an interface on will be permitted to be added to the IP CN. At least one real port that has IP defined must be added to the IP CN for the CN to become active and to be used.

Syntax:

add focal_point

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-33. Configuration Parameter List - APPN Implicit Focal Point	
Parameter Information	
Parameter	focal point
Valid Values	A fully-qualified CP name
Default Value	Blanks
Description	This parameter specifies the fully-qualified CP name representing this focal point. The first focal point added is the primary implicit focal point. Up to 8 additional backup implicit focal points may be added by invoking **Add focal_point** multiple times. If the primary implicit focal point is taken off the focal point list with **Delete focal_point**, the first backup implicit focal point, if there is one, becomes the primary implicit focal point.

Syntax:

add local-pu

You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-34. Configuration Parameter List - APPN Local PU	
Parameter Information	
Parameter	Station name
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name representing the link between the DLUR and the PU.
Parameter	Primary DLUS name
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name to be used to override the primary DLUS configured for this node.
Parameter	Secondary DLUS name
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name to be used to override the secondary DLUS configured for this node.
Parameter	Autoactivate
Valid Values	Yes or No
Default Value	Yes
Description	This parameter specifies whether to activate this link at start-up.

Syntax:

add tn3270e implicit-pool

This command defines a pool of LUs as opposed to the **add tn3270 lu** command which adds a single LU.You will be

prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-35. Configuration Parameter List - APPN TN3270E Implicit

Parameter Information	
Parameter	Station name
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name representing the link between the DLUR and the PU or the subarea link over which SNA data will flow.
Parameter	LU Name Mask
Valid Values	A string of 1 to 5 characters: • First character: A to Z, @, $, and # • Second to eighth characters: A to Z, 0 to 9
Default Value	@LUA
Description	This parameter specifies the mask to be used to ensure that the LU names will not duplicate other names in the network.
Parameter	Number of implicit workstation definitions
Valid Values	1 - 253
Default Value	1
Description	This parameter specifies the number of dependent LUs to be added to the implicit pool.

Syntax:

add tn3270e lu

This command adds a specific LU. You will be prompted to enter values for the following parameters. The parameter range will be shown in parentheses ( ). The parameter default will be shown in square brackets [ ].

Table 39-36 (Page 1 of 2). Configuration Parameter List - APPN TN3270E LU

Parameter Information	
Parameter	LU name
Valid Values	A string of 1 to 8 characters: • First character: A to Z,@, $, and # • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the LU name of the dependent LU being defined.
Parameter	NAU address
Valid Values	2 — 254
Default Value	None
Description	This parameter specifies the NAU address of the LU being defined.

Table 39-36 (Page 2 of 2). Configuration Parameter List - APPN TN3270E LU	
Parameter Information	
Parameter	Station name
Valid Values	A string of 1 to 8 characters: • First character: A to Z • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name representing either the link between the DLUR and the PU defined using the **add local-pu** command or the subarea link over which SNA data will flow.
Parameter	Class
Valid Values	**1** Explicit Workstation **2** Implicit Workstation **3** Explicit Printer **4** Implicit Printer
Default Value	1
Description	This parameter specifies the LU class.
Parameter	Define an associated printer
Valid Values	Yes or No
Default Value	No
Description	This parameter specifies whether you want to define an associated printer.
Parameter	Associated printer name
Valid Values	A string of 1 to 8 characters: • First character: A to Z,@, $, and # • Second to eighth characters: A to Z, 0 to 9
Default Value	None
Description	This parameter specifies the name of the associated printer.
Parameter	Associated printer NAU address
Valid Values	2 - 254
Default Value	None
Description	This parameter specifies the NAU address for the associated printer LU definition.

Delete

Use the **delete** command to delete:

Syntax:

delete
- port *port-name*
- link *link-station-name*
- lu-name *lu-name*
- connection-network *connection-network-name*
- additional-port-to-connection-network *cn-port-name*
- mode *name*
- focal_point *focal-point-name*
- local-pu
- tn3270e *lu*
- tn3270e implicitpool

List

Use the **list** command to list:

Syntax:

list
- all
- node
- traces
- management
- hpr
- dlur
- port *port name*
- link station *link station name*
- lu name *lu name*
- mode name *mode name*
- connection network *connection network name*
- focal_point
- tn3270e *ipaddr*

Activate_new_config

Use the **activate_new_config** command to read the configuration into non-volatile memory.

Syntax:

ac**tivate_new_config**

Monitoring APPN

This section describes how to monitor APPN. It includes the following sections:

- "Accessing the APPN Monitoring Commands"
- "APPN monitoring Commands" on page 39-66

Accessing the APPN Monitoring Commands

Use the following procedure to access the APPN monitoring commands. This process gives you access to an APPN's *monitoring* process.

At the OPCON prompt, enter **talk 5**.

After you enter the **talk 5** command, the GWCON prompt (+) displays on the terminal. If the prompt does not appear when you first enter configuration, press **Return** again.

Enter **protocol APPN** For example:

```
* talk 5
+
+ protocol APPN
```

APPN monitoring Commands

This section describes the APPN monitoring commands for monitoring APPN interfaces. Enter the commands at the APPN> prompt.

Table 39-37. APPN monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvii.
Stop	Stops APPN
Restart	Restarts APPN
List	Lists: • CP-CP_sessions - displays information on CP-CP sessions. • ISR_sessions - displays information on active ISR transmission groups. • Session_information - If *Save RSCV information for intermediate nodes* is Yes, displays origin CP Name, primary LU Name, and secondary LU Name. • RTP_connections - displays information on RTP connections. • Port_information - displays information on all ports unless a particular interface is requested. • Link_information - displays information on all links unless a particular interface is requested. • Focal_point - displays currently active focal point. • TN3270E • Local-link
Memory	Obtains and displays APPN memory usage information.
Exit	Returns you to the previous command level. See “Exiting a Lower-Level Environment” on page xxviii.

Dump

Use the **Dump** command to create an APPN dump. You can use **Boot config**> on **talk 6** to determine where the dump will be saved. The dump name will be the same as the dump of the whole router with '_A.1' concatenated to the end. You can initiate multiple dumps. The concatenation will be incremented for each dump. When the dump name has reached '_A.5', it will be reset to '_A.1'.

Syntax:

d**ump**

You can check the size on the dump server to know when the dump finishes.

The router continues to execute while the dump occurs.

Stop

Use the **Stop** command to cause APPN to stop.

Syntax:

s**top**

Restart

Use the **Restart** command to restart APPN after it has been stopped.

Syntax:

restart

List

Use the **List** command to display information about the APPN configuration. The command lists:

Syntax:

list *name*

Command	Function
List cp	Displays a table of all cp sessions.
List isr	Displays a table of all defined active ISR transmission groups.
List session_info	Displays origin CP Name, primary LU Name and secondary LU Name if *Save RSCV information for intermediate sessions* is Yes.
List rtp	Displays a table of all RTP connections.
List port	Displays a summary table of all ports.
List port *port name*	Displays detailed information about the requested port.
List link	Displays a summary table of all links.
List link *station name*	Displays detailed information about the requested link station.
List focal	Displays currently active focal point, if there is one.
List tn3270e	Displays information about TN3270E.
List local_link_information	Displays information about local links.

Abbreviations

AAL ATM Adaptation Layer

AAL-5 ATM Adaptation Layer 5

AARP AppleTalk Address Resolution Protocol

ABR area border router

ack acknowledgment

AIX Advanced Interactive Executive

AMA arbitrary MAC addressing

AMP active monitor present

ANSI American National Standards Institute

AP2 AppleTalk Phase 2

APPN Advanced Peer-to-Peer Networking

ARE all-routes explorer

ARI ATM real interface

ARI/FCI address recognized indicator/frame copied indicator

ARP Address Resolution Protocol

AS autonomous system

ASBR autonomous system boundary router

ASCII American National Standard Code for Information Interchange

ASN.1 abstract syntax notation 1

ASRT adaptive source routing transparent

ASYNC asynchronous

ATCP AppleTalk Control Protocol

ATM Asynchronous Transfer Mode

ATMARP ARP in Classical IP

ATP AppleTalk Transaction Protocol

AUI attachment unit interface

AVI ATM virtual interface

ayt are you there

BAN Boundary Access Node

BBCM Bridging Broadcast Manager

BCM BroadCast Manager

BECN backward explicit congestion notification

BGP Border Gateway Protocol

BGP Border Growth Protocol

BNC bayonet Niell-Concelman

BNCP Bridging Network Control Protocol

BOOTP BOOT protocol

BPDU bridge protocol data unit

bps bits per second

bandwidth reservation

BSD Berkeley software distribution

BTP BOOTP relay agent

BTU basic transmission unit

BUS Broadcast and Unknown Server

CAM content-addressable memory

CCITT Consultative Committee on International Telegraph and Telephone

CD collision detection

CGWCON Gateway Console

CIDR Classless Inter-Domain Routing

CIP Classical IP

CIPC Classical IP Client

CIR committed information rate

CLNP Connectionless-Mode Network Protocol

CPU central processing unit

CRC cyclic redundancy check

CRS configuration report server

CTS clear to send

CUD call user data

DAF destination address filtering

DB database

DBsum database summary

DCD data channel received line signal detector

DCE data circuit-terminating equipment

DCS directly connected server

DDLC dual data-link controller

DDN Defense Data Network

DDP Datagram Delivery Protocol

DDT Dynamic Debugging Tool

DHCP Dynamic Host Configuration Protocol

dir directly connected

DL data link

DLC data link control

DLCI data link connection identifier

DLS data link switching

DLSw data link switching

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DMA direct memory access

DNA Digital Network Architecture

DNCP DECnet Protocol Control Protocol

DNIC Data Network Identifier Code

DoD Department of Defense

DOS Disk Operating System

DR designated router

DRAM Dynamic Random Access Memory

DSAP destination service access point

DSE data switching equipment

DSE data switching exchange

DSR data set ready

DSU data service unit

DTE data terminal equipment

DTR data terminal ready

Dtype destination type

DVMRP Distance Vector Multicast Routing Protocol

E1 2.048 Mbps transmission rate

EDEL end delimiter

EDI error detected indicator

EGP Exterior Gateway Protocol

EIA Electronics Industries Association

ELAN Emulated Local Area Network

ELAP EtherTalk Link Access Protocol

ELS Event Logging System

ESI End System Identifier

EST Eastern Standard Time

Eth Ethernet

fa-ga functional address-group address

FCS frame check sequence

FECN forward explicit congestion notification

FIFO first in, first out

FLT filter library

FR Frame Relay

FRL Frame Relay

FTP File Transfer Protocol

GMT Greenwich Mean Time

GOSIP Government Open Systems Interconnection Profile

GTE General Telephone Company

GWCON Gateway Console

HDLC high-level data link control

HEX hexadecimal

HST TCP/IP host services

HTF host table format

IBD Integrated Boot Device

ICMP Internet Control Message Protocol

ICP Internet Control Protocol

ID identification

IDP Initial Domain Part

IDP Internet Datagram Protocol

IEEE Institute of Electrical and Electronics Engineers

IETF Internet Engineering Task Force

Ifc# interface number

IGP interior gateway protocol

ILMI Interim Local Management Interface

InARP Inverse Address Resolution Protocol

IP Internet Protocol

IPCP IP Control Protocol

IPPN IP Protocol Network

IPX Internetwork Packet Exchange

IPXCP IPX Control Protocol

ISDN integrated services digital network

ISO International Organization for Standardization

Kbps kilobits per second

LAN local area network

LAPB link access protocol-balanced

LAT local area transport

LCP Link Control Protocol

LE LAN Emulation

LEC LAN Emulation Client

LED light-emitting diode

LECS LAN Emulation Configuration Server

LES LAN Emulation Server

LES-BUS LAN Emulation Server - Broadcast and Unknown Server

LF largest frame; line feed

LIS Logical IP subnet

LLC logical link control

LLC2 logical link control 2

LMI local management interface

LRM LAN reporting mechanism

LS link state

LSA link state advertisement

LSB least significant bit

LSI LANE Shortcuts Interface

LSreq link state request

LSrxl link state retransmission list

LU logical unit

MAC medium access control

Mb megabit

MB megabyte

Mbps megabits per second

MBps megabytes per second

MC multicast

MCF MAC filtering

MIB Management Information Base

MIB II Management Information Base II

MILNET military network

MOS Micro Operating System

MOSDDT Micro Operating System Dynamic Debugging Tool

MOSPF Open Shortest Path First with multicast extensions

MSB most significant bit

MSDU MAC service data unit

MSS Multiprotocol Switched Services

MTU maximum transmission unit

nak not acknowledged

NBMA Non-Broadcast Multiple Access

NBP Name Binding Protocol

NBR neighbor

NCP Network Control Protocol

NCP Network Core Protocol

NetBIOS Network Basic Input/Output System

NHRP Next Hop Resolution Protocol

NIST National Institute of Standards and Technology

NPDU Network Protocol Data Unit

NRZ non-return-to-zero

NRZI non-return-to-zero inverted

NSAP Network Service Access Point

NSF National Science Foundation

NSFNET National Science Foundation NETwork

NVCNFG nonvolatile configuration

OPCON Operator Console

OSI open systems interconnection

OSICP OSI Control Protocol

OSPF Open Shortest Path First

OUI organization unique identifier

PC personal computer

PCR peak cell rate

PDN public data network

PING Packet internet groper

PDU protocol data unit

PID process identification

P-P Point-to-Point

PPP Point-to-Point Protocol

PROM programmable read-only memory

PU physical unit

PVC permanent virtual circuit

QoS Quality of Service

RAM random access memory

RD route descriptor

REM ring error monitor

REV receive

RFC Request for Comments

RI ring indicator; routing information

RIF routing information field

RII routing information indicator

RIP Routing Information Protocol

RISC reduced instruction-set computer

RNR receive not ready

ROM read-only memory

ROpcon Remote Operator Console

RPS ring parameter server

RTMP Routing Table Maintenance Protocol

RTP RouTing update Protocol

RTS request to send

Rtype route type

rxmits retransmissions

rxmt retransmit

SAF source address filtering

SAP service access point

SAP Service Advertising Protocol

SCR sustained cell rate

SCSP Server Cache Synchronization Protocol

sdel start delimiter

SDLC SDLC relay, synchronous data link control

SDU Service Data Unit

SGID server group id

seqno sequence number

SGMP Simple Gateway Monitoring Protocol

SL serial line

SLIP Serial Line IP

SMP standby monitor present

SMTP Simple Mail Transfer Protocol

SNA Systems Network Architecture

SNAP Subnetwork Access Protocol
SubNetwork Attachment Point

SNMP Simple Network Management Protocol

SNPA subnetwork point of attachment

SPF OSPF intra-area route

SPE1 OSPF external route type 1

SPE2 OSPF external route type 2

SPIA OSPF inter-area route type

SPID service profile ID

SPX Sequenced Packet Exchange

SQE signal quality error

SRAM static random access memory

SRB source routing bridge

SRF specifically routed frame

SRLY SDLC relay

SRT source routing transparent

SR-TB source routing-transparent bridge

STA static

STB spanning tree bridge

STE spanning tree explorer

STP shielded twisted pair; spanning tree protocol

SVC switched virtual circuit

SVN Switched Virtual Networking

TB transparent bridge

TCN topology change notification

TCP Transmission Control Protocol

TCP/IP Transmission Control Protocol/Internet Protocol

TEI terminal point identifier

TFTP Trivial File Transfer Protocol

TKR token ring

TLV Type/Length/Value

TMO timeout

TOS type of service

TSF transparent spanning frames

TTL time to live

TTY teletypewriter

TX transmit

UA unnumbered acknowledgment

UDP User Datagram Protocol

UI unnumbered information

UNI User-Network Interface

UTP unshielded twisted pair

VCC Virtual Channel connection

VINES VIrtual NEtworking System

VIR variable information rate

VL virtual link

VNI Virtual Network Interface

VR virtual route

WAN wide area network

WRS WAN restoral

X.25 packet-switched networks

X.251 X.25 physical layer

X.252 X.25 frame layer

X.253 X.25 packet layer

XID exchange identification

XNS Xerox Network Systems

XSUM checksum

ZIP AppleTalk Zone Information Protocol

ZIP2 AppleTalk Zone Information Protocol 2

ZIT Zone Information Table

Glossary

This glossary includes terms and definitions from:

- The *American National Standard Dictionary for Information Systems*, ANSI X3.172-1990, copyright 1990 by the American National Standards Institute (ANSI). Copies may be purchased from the American National Standards Institute, 11 West 42nd Street, New York, New York 10036. Definitions are identified by the symbol (A) after the definition.
- The ANSI/EIA Standard—440-A, *Fiber Optic Terminology* Copies may be purchased from the Electronic Industries Association, 2001 Pennsylvania Avenue, N.W., Washington, DC 20006. Definitions are identified by the symbol (E) after the definition.
- The *Information Technology Vocabulary* developed by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions of published parts of this vocabulary are identified by the symbol (I) after the definition; definitions taken from draft international standards, committee drafts, and working papers being developed by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet been reached among the participating National Bodies of SC1.
- The *IBM Dictionary of Computing*, New York: McGraw-Hill, 1994.
- Internet Request for Comments: 1208, *Glossary of Networking Terms*
- Internet Request for Comments: 1392, *Internet Users' Glossary*
- The *Object-Oriented Interface Design: IBM Common User Access Guidelines*, Carmel, Indiana: Que, 1992.

The following cross-references are used in this glossary:

Contrast with: This refers to a term that has an opposed or substantively different meaning.

Synonym for: This indicates that the term has the same meaning as a preferred term, which is defined in its proper place in the glossary.

Synonymous with: This is a backward reference from a defined term to all other terms that have the same meaning.

See: This refers the reader to multiple-word terms that have the same last word.

See also: This refers the reader to terms that have a related, but not synonymous, meaning.

A

AAL. ATM Adaptation Layer, the layer that adapts user data to/from the ATM network by adding/removing headers and segmenting/reassembling the data into/from cells.

AAL-5. ATM Adaptation Layer 5, one of several standard AALs. AAL-5 was designed for data communications, and is used by LAN Emulation and Classical IP.

abstract syntax. A data specification that includes all distinctions that are needed in data transmissions, but that omits (abstracts) other details such as those that depend on specific computer architectures. See also *abstract syntax notation 1 (ASN.1)* and *basic encoding rules (BER)*.

abstract syntax notation 1 (ASN.1). The Open Systems Interconnection (OSI) method for abstract syntax specified in the following standards:

- ITU-T Recommendation X.208 (1988) | ISO/IEC 8824: 1990
- ITU-T Recommendation X.680 (1994) | ISO/IEC 8824-1: 1994

See also *basic encoding rules (BER)*.

ACCESS. In the Simple Network Management Protocol (SNMP), the clause in a Management Information Base (MIB) module that defines the minimum level of support that a managed node provides for an object.

acknowledgment. (1) The transmission, by a receiver, of acknowledge characters as an affirmative response to a sender. (T) (2) An indication that an item sent was received.

active monitor. In a token-ring network, a function performed at any one time by one ring station that initiates the transmission of tokens and provides token error recovery facilities. Any active adapter on the ring has the ability to provide the active monitor function if the current active monitor fails.

address. In data communication, the unique code assigned to each device, workstation, or user connected to a network.

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address mapping table (AMT). A table, maintained within the AppleTalk router, that provides a current mapping of node addresses to hardware addresses.

address mask. For internet subnetworking, a 32-bit mask used to identify the subnetwork address bits in the host portion of an IP address. Synonymous with *subnet mask* and *subnetwork mask*.

address resolution. (1) A method for mapping network-layer addresses to media-specific addresses. (2) See also *Address Resolution Protocol (ARP)* and *AppleTalk Address Resolution Protocol (AARP)*.

Address Resolution Protocol (ARP). (1) In the Internet suite of protocols, the protocol that dynamically maps an IP address to an address used by a supporting metropolitan or local area network such as Ethernet or token-ring. (2) See also *Reverse Address Resolution Protocol (RARP)*.

addressing. In data communication, the way in which a station selects the station to which it is to send data.

adjacent nodes. Two nodes connected together by at least one path that connects no other node. (T)

Administrative Domain. A collection of hosts and routers, and the interconnecting networks, managed by a single administrative authority.

Advanced Peer-to-Peer Networking (APPN). An extension to SNA featuring (a) greater distributed network control that avoids critical hierarchical dependencies, thereby isolating the effects of single points of failure; (b) dynamic exchange of network topology information to foster ease of connection, reconfiguration, and adaptive route selection; (c) dynamic definition of network resources; and (d) automated resource registration and directory lookup. APPN extends the LU 6.2 peer orientation for end-user services to network control and supports multiple LU types, including LU 2, LU 3, and LU 6.2.

Advanced Peer-to-Peer Networking (APPN) end node. A node that provides a broad range of end-user services and supports sessions between its local control point (CP) and the CP in an adjacent network node. It uses these sessions to dynamically register its resources with the adjacent CP (its network node server), to send and receive directory search requests, and to obtain management services. An APPN end node can also attach to a subarea network as a peripheral node or to other end nodes.

Advanced Peer-to-Peer Networking (APPN) network. A collection of interconnected network nodes and their client end nodes.

Advanced Peer-to-Peer Networking (APPN) network node. A node that offers a broad range of end-user services and that can provide the following:

- Distributed directory services, including registration of its domain resources to a central directory server
- Topology database exchanges with other APPN network nodes, enabling network nodes throughout the network to select optimal routes for LU-LU sessions based on requested classes of service
- Session services for its local LUs and client end nodes
- Intermediate routing services within an APPN network

Advanced Peer-to-Peer Networking (APPN) node. An APPN network node or an APPN end node.

alert. A message sent to a management services focal point in a network to identify a problem or an impending problem.

all-stations address. In communications, synonym for *broadcast address*.

American National Standards Institute (ANSI). An organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States. (A)

analog. (1) Pertaining to data consisting of continuously variable physical quantities. (A) (2) Contrast with *digital*.

AppleTalk. A network protocol developed by Apple Computer, Inc. This protocol is used to interconnect network devices, which can be a mixture of Apple and non-Apple products.

AppleTalk Address Resolution Protocol (AARP). In AppleTalk networks, a protocol that (a) translates AppleTalk node addresses into hardware addresses and (b) reconciles addressing discrepancies in networks that support more than one set of protocols.

AppleTalk Transaction Protocol (ATP). In AppleTalk networks, a protocol that provides client/server request and response functions for hosts accessing the Zone Information Protocol (ZIP) for zone information.

APPN network. See *Advanced Peer-to-Peer Networking (APPN) network*.

APPN network node. See *Advanced Peer-to-Peer Networking (APPN) network node*.

arbitrary MAC addressing (AMA). In DECnet architecture, an addressing scheme used by DECnet

Phase IV-Prime that supports universally administered addresses and locally administered addresses.

area. In Internet and DECnet routing protocols, a subset of a network or gateway grouped together by definition of the network administrator. Each area is self-contained; knowledge of an area's topology remains hidden from other areas.

asynchronous (ASYNC). Pertaining to two or more processes that do not depend upon the occurrence of specific events such as common timing signals. (T)

ATM. Asynchonous Transfer Mode, a connection-oriented, high-speed networking technology based on cell switching.

ATMARP. ARP in Classical IP.

attachment unit interface (AUI). In a local area network, the interface between the medium attachment unit and the data terminal equipment within a data station. (I) (A)

authentication failure. In the Simple Network Management Protocol (SNMP), a trap that may be generated by an authentication entity when a requesting client is not a member of the SNMP community.

autonomous system. In TCP/IP, a group of networks and routers under one administrative authority. These networks and routers cooperate closely to propagate network reachability (and routing) information among themselves using an interior gateway protocol of their choice.

autonomous system number. In TCP/IP, a number assigned to an autonomous system by the same central authority that also assigns IP addresses. The autonomous system number makes it possible for automated routing algorithms to distinguish autonomous systems.

B

BCM. BroadCast Manager, an IBM extension to LAN Emulation designed to limit the effects of broadcast frames.

backbone. (1) In a local area network multiple-bridge ring configuration, a high-speed link to which the rings are connected by means of bridges or routers. A backbone may be configured as a bus or as a ring. (2) In a wide area network, a high-speed link to which nodes or data switching exchanges (DSEs) are connected.

backbone network. A central network to which smaller networks, normally of lower speed, connect. The backbone network usually has a much higher capacity than the networks it helps interconnect or is a wide-area network (WAN) such as a public packet-switched datagram network.

backbone router. (1) A router used to transmit data between areas. (2) One in a series of routers that is used to interconnect networks into a larger internet.

Bandwidth. The bandwidth of an optical link designates the information-carrying capacity of the link and is related to the maximum bit rate that a fiber link can support.

basic transmission unit (BTU). In SNA, the unit of data and control information passed between path control components. A BTU can consist of one or more path information units (PIUs).

bootstrap. (1) A sequence of instructions whose execution causes additional instructions to be loaded and executed until the complete computer program is in storage. (T) (2) A technique or device designed to bring itself into a desired state by means of its own action, for example, a machine routine whose first few instructions are sufficient to bring the rest of itself into the computer from an input device. (A)

baud. In asynchronous transmission, the unit of modulation rate corresponding to one unit interval per second; that is, if the duration of the unit interval is 20 milliseconds, the modulation rate is 50 baud. (A)

Border Gateway Protocol (BGP). An Internet Protocol (IP) routing protocol used between domains and autonomous systems. Contrast with *Exterior Gateway Protocol (EGP)*.

border router. In Internet communications, a router, positioned at the edge of an autonomous system, that communicates with a router that is positioned at the edge of a different autonomous system.

bridge. A functional unit that interconnects multiple LANs (locally or remotely) that use the same logical link control protocol but that can use different medium access control protocols. A bridge forwards a frame to another bridge based on the medium access control (MAC) address.

bridge identifier. An 8-byte field, used in a spanning tree protocol, composed of the MAC address of the port with the lowest port identifier and a user-defined value.

bridging. In LANs, the forwarding of a frame from one LAN segment to another. The destination is specified by the medium access control (MAC) sublayer address encoded in the destination address field of the frame header.

broadcast. (1) Transmission of the same data to all destinations. (T) (2) Simultaneous transmission of data

to more than one destination. (3) Contrast with *multicast*.

broadcast address. In communications, a station address (eight 1's) reserved as an address common to all stations on a link. Synonymous with *all-stations address*.

BUS. Broadcast and Unknown Server, a LAN Emulation Service component responsible for the delivery of multicast and unknown unicast frames.

C

cache. (1) A special-purpose buffer storage, smaller and faster than main storage, used to hold a copy of instructions and data obtained from main storage and likely to be needed next by the processor. (T) (2) A buffer storage that contains frequently accessed instructions and data; it is used to reduce access time. (3) An optional part of the directory database in network nodes where frequently used directory information may be stored to speed directory searches. (4) To place, hide, or store in a cache.

call request packet. (1) A call supervision packet that a data terminal equipment (DTE) transmits to ask that a connection for a call be established throughout the network. (2) In X.25 communications, a call supervision packet transmitted by a DTE to ask for a call establishment through the network.

canonical address. In LANs, the IEEE 802.1 format for the transmission of medium access control (MAC) addresses for token-ring and Ethernet adapters. In canonical format, the least significant (rightmost) bit of each address byte is transmitted first. Contrast with *noncanonical address*.

carrier. An electric or electromagnetic wave or pulse train that may be varied by a signal bearing information to be transmitted over a communication system. (T)

carrier detect. Synonym for *received line signal detector (RLSD)*.

carrier sense. In a local area network, an ongoing activity of a data station to detect whether another station is transmitting. (T)

carrier sense multiple access with collision detection (CSMA/CD). A protocol that requires carrier sense and in which a transmitting data station that detects another signal while transmitting, stops sending, sends a jam signal, and then waits for a variable time before trying again. (T) (A)

channel. (1) A path along which signals can be sent, for example, data channel, output channel. (A) (2) A functional unit, controlled by the processor, that handles the transfer of data between processor storage and local peripheral equipment.

channel service unit (CSU). A unit that provides the interface to a digital network. The CSU provides line conditioning (or equalization) functions, which keep the signal's performance consistent across the channel bandwidth; signal reshaping, which constitutes the binary pulse stream; and loopback testing, which includes the transmission of test signals between the CSU and the network carrier's office channel unit. See also *data service unit (DSU)*.

checksum. (1) The sum of a group of data associated with the group and used for checking purposes. (T) (2) In error detection, a function of all bits in a block. If the written and calculated sums do not agree, an error is indicated. (3) On a diskette, data written in a sector for error detection purposes; a calculated checksum that does not match the checksum of data written in the sector indicates a bad sector. The data are either numeric or other character strings regarded as numeric for the purpose of calculating the checksum.

CIP. Classical IP.

CIPC. Classical IP Client.

Classical IP. An IETF standard for ATM-attached hosts to communicate using IP over ATM.

Classical IP Client. A Classical IP component that represents users of the Logical IP Subnet.

circuit switching. (1) A process that, on demand, connects two or more data terminal equipment (DTEs) and permits the exclusive use of a data circuit between them until the connection is released. (I) (A) (2) Synonymous with *line switching*.

class A network. In Internet communications, a network in which the high-order (most significant) bit of the IP address is set to 0 and the host ID occupies the three low-order octets.

class B network. In Internet communications, a network in which the two high-order (most significant and next-to-most significant) bits of the IP address are set to 1 and 0, respectively, and the host ID occupies the two low-order octets.

class of service (COS). A set of characteristics (such as route security, transmission priority, and bandwidth) used to construct a route between session partners. The class of service is derived from a mode name specified by the initiator of a session.

client. (1) A functional unit that receives shared services from a server. (T) (2) A user.

client/server. In communications, the model of interaction in distributed data processing in which a program at one site sends a request to a program at another site and awaits a response. The requesting program is called a client; the answering program is called a server.

clocking. (1) In binary synchronous communication, the use of clock pulses to control synchronization of data and control characters. (2) A method of controlling the number of data bits sent on a telecommunication line in a given time.

collision. An unwanted condition that results from concurrent transmissions on a channel. (T)

collision detection. In carrier sense multiple access with collision detection (CSMA/CD), a signal indicating that two or more stations are transmitting simultaneously.

Committed information rate. The maximum amount of data in bits that the network agrees to deliver.

community. In the Simple Network Management Protocol (SNMP), an administrative relationship between entities.

community name. In the Simple Network Management Protocol (SNMP), a string of octets identifying a community.

compression. (1) The process of eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks. (2) Any encoding to reduce the number of bits used to represent a given message or record.

configuration. (1) The manner in which the hardware and software of an information processing system are organized and interconnected. (T) (2) The devices and programs that make up a system, subsystem, or network.

configuration file. A file that specifies the characteristics of a system device or network.

configuration parameter. A variable in a configuration definition, the values of which can characterize the relationship of a product to other products in the same network or can define characteristics of the product itself.

configuration report server (CRS). In the IBM Token-Ring Network Bridge Program, the server that accepts commands from the LAN Network Manager (LNM) to get station information, set station parameters, and remove stations on its ring. This server also collects and forwards configuration reports generated by stations on its ring. The configuration reports include the new active monitor reports and the nearest active upstream neighbor (NAUN) reports.

congestion. See *network congestion*.

control point (CP). (1) A component of an APPN or LEN node that manages the resources of that node. In an APPN node, the CP is capable of engaging in CP-CP sessions with other APPN nodes. In an APPN network node, the CP also provides services to adjacent end nodes in the APPN network. (2) A component of a node that manages resources of that node and optionally provides services to other nodes in the network. Examples are a system services control point (SSCP) in a type 5 subarea node, a network node control point (NNCP) in an APPN network node, and an end node control point (ENCP) in an APPN or LEN end node. An SSCP and an NNCP can provide services to other nodes.

control point management services (CPMS). A component of a control point, consisting of management services function sets, that provides facilities to assist in performing problem management, performance and accounting management, change management, and configuration management. Capabilities provided by the CPMS include sending requests to physical unit management services (PUMS) to test system resources, collecting statistical information (for example, error and performance data) from PUMS about the system resources, and analyzing and presenting test results and statistical information collected about the system resources. Analysis and presentation responsibilities for problem determination and performance monitoring can be distributed among multiple CPMSs.

control point management services unit (CP-MSU). The message unit that contains management services data and flows between management services function sets. This message unit is in general data stream (GDS) format. See also *management services unit (MSU)* and *network management vector transport (NMVT)*.

D

D-bit. Delivery-confirmation bit. In X.25 communications, the bit in a data packet or call-request packet that is set to 1 if end-to-end acknowledgment (delivery confirmation) is required from the recipient.

daemon. A program that runs unattended to perform a standard service. Some daemons are triggered automatically to perform their task; others operate periodically.

data carrier detect (DCD). Synonym for *received line signal detector (RLSD)*.

data circuit. (1) A pair of associated transmit and receive channels that provide a means of two-way data communication. (I) (2) In SNA, synonym for *link connection*. (3) See also *physical circuit* and *virtual circuit*.

Notes:

1. Between data switching exchanges, the data circuit may include data circuit-terminating equipment (DCE), depending on the type of interface used at the data switching exchange.
2. Between a data station and a data switching exchange or data concentrator, the data circuit includes the data circuit-terminating equipment at the data station end, and may include equipment similar to a DCE at the data switching exchange or data concentrator location.

data circuit-terminating equipment (DCE). In a data station, the equipment that provides the signal conversion and coding between the data terminal equipment (DTE) and the line. (I)

Notes:

1. The DCE may be separate equipment or an integral part of the DTE or of the intermediate equipment.
2. A DCE may perform other functions that are usually performed at the network end of the line.

data link connection identifier (DLCI). The numeric identifier of a frame-relay subport or PVC segment in a frame-relay network. Each subport in a single frame-relay port has a unique DLCI. The following table, excerpted from the American National Standards Institute (ANSI) Standard T1.618 and the International Telegraph and Telephone Consultative Committee (ITU-T/CCITT) Standard Q.922, indicates the functions associated with certain DLCI values:

DLCI Values	Function
0	in-channel signaling
1–15	reserved
16–991	assigned using frame-relay connection procedures
992–1007	layer 2 management of frame-relay bearer service
1008–1022	reserved
1023	in-channel layer management

data link control (DLC). A set of rules used by nodes on a data link (such as an SDLC link or a token ring) to accomplish an orderly exchange of information.

data link control (DLC) layer. In SNA, the layer that consists of the link stations that schedule data transfer over a link between two nodes and perform error control for the link. Examples of data link control are SDLC for serial-by-bit link connection and data link control for the System/370 channel.

Note: The DLC layer is usually independent of the physical transport mechanism and ensures the integrity of data that reaches the higher layers.

data link layer. In the Open Systems Interconnection reference model, the layer that provides services to transfer data between entities in the network layer over a communication link. The data link layer detects and possibly corrects errors that may occur in the physical layer. (T)

data link level. (1) In the hierarchical structure of a data station, the conceptual level of control or processing logic between high level logic and the data link that maintains control of the data link. The data link level performs such functions as inserting transmit bits and deleting receive bits; interpreting address and control fields; generating, transmitting, and interpreting commands and responses; and computing and interpreting frame check sequences. See also *packet level* and *physical level*. (2) In X.25 communications, synonym for *frame level*.

data link switching (DLSw). A method of transporting network protocols that use IEEE 802.2 logical link control (LLC) type 2. SNA and NetBIOS are examples of protocols that use LLC type 2. See also *encapsulation* and *spoofing*.

data packet. In X.25 communications, a packet used for the transmission of user data on a virtual circuit at the DTE/DCE interface.

data service unit (DSU). A device that provides a digital data service interface directly to the data terminal equipment. The DSU provides loop equalization, remote and local testing capabilities, and a standard EIA/CCITT interface.

data set ready (DSR). Synonym for *DCE ready*.

data switching exchange (DSE). The equipment installed at a single location to provide switching functions, such as circuit switching, message switching, and packet switching. (I)

data terminal equipment (DTE). That part of a data station that serves as a data source, data sink, or both. (I) (A)

data terminal ready (DTR). A signal to the modem used with the EIA 232 protocol.

data transfer rate. The average number of bits, characters, or blocks per unit time passing between corresponding equipment in a data transmission system. (I)

Notes:

1. The rate is expressed in bits, characters, or blocks per second, minute, or hour.
2. Corresponding equipment should be indicated; for example, modems, intermediate equipment, or source and sink.

datagram. (1) In packet switching, a self-contained packet, independent of other packets, that carries information sufficient for routing from the originating data terminal equipment (DTE) to the destination DTE without relying on earlier exchanges between the DTEs and the network. (I) (2) In TCP/IP, the basic unit of information passed across the Internet environment. A datagram contains a source and destination address along with the data. An Internet Protocol (IP) datagram consists of an IP header followed by the transport layer data. (3) See also *packet* and *segment*.

Datagram Delivery Protocol (DDP). In AppleTalk networks, a protocol that provides network connectivity by means of connectionless socket-to-socket delivery service on the internet layer.

DCE ready. In the EIA 232 standard, a signal that indicates to the data terminal equipment (DTE) that the local data circuit-terminating equipment (DCE) is connected to the communication channel and is ready to send data. Synonymous with *data set ready (DSR)*.

DECnet. A network architecture that defines the operation of a family of software modules, databases, and hardware components typically used to tie Digital Equipment Corporation systems together for resource sharing, distributed computation, or remote system configuration. DECnet network implementations follow the Digital Network Architecture (DNA) model.

default. Pertaining to an attribute, condition, value, or option that is assumed when none is explicitly specified. (I)

designated router. A router that informs end nodes of the existence and identity of other routers. The selection of the designated router is based upon the router with the highest priority. When several routers share the highest priority, the router with the highest station address is selected.

destination node. The node to which a request or data is sent.

destination port. The 8-port asynchronous adapter that serves as a connection point with a serial service.

destination service access point (DSAP). In SNA and TCP/IP, a logical address that allows a system to route data from a remote device to the appropriate communications support. Contrast with *source service access point (SSAP)*.

device. A mechanical, electrical, or electronic contrivance with a specific purpose.

digital. (1) Pertaining to data that consist of digits. (T) (2) Pertaining to data in the form of digits. (A) (3) Contrast with *analog*.

Digital Network Architecture (DNA). The model for all DECnet hardware and software implementations.

direct memory access (DMA). The system facility that allows a device on the Micro Channel bus to get direct access to the system or bus memory without the intervention of the system processor.

directory. A table of identifiers and references to the corresponding items of data. (I) (A)

directory service (DS). An application service element that translates the symbolic names used by application processes into the complete network addresses used in an OSI environment. (T)

directory services (DS). A control point component of an APPN node that maintains knowledge of the location of network resources.

disable. To make nonfunctional.

disabled. (1) Pertaining to a state of a processing unit that prevents the occurrence of certain types of interruptions. (2) Pertaining to the state in which a transmission control unit or audio response unit cannot accept incoming calls on a line.

domain. (1) That part of a computer network in which the data processing resources are under common control. (T) (2) In Open Systems Interconnection (OSI), a part of a distributed system or a set of managed objects to which a common policy applies. (3) See *Administrative Domain* and *domain name*.

domain name. In the Internet suite of protocols, a name of a host system. A domain name consists of a sequence of subnames separated by a delimiter character. For example, if the fully qualified domain name (FQDN) of a host system is `ralvm7.vnet.ibm.com`, each of the following is a domain name:

- `ralvm7.vnet.ibm.com`
- `vnet.ibm.com`
- `ibm.com`

domain name server. In the Internet suite of protocols, a server program that supplies name-to-address translation by mapping domain names to IP addresses. Synonymous with *name server*.

Domain Name System (DNS). In the Internet suite of protocols, the distributed database system used to map domain names to IP addresses.

dotted decimal notation. The syntactical representation for a 32-bit integer that consists of four 8-bit numbers written in base 10 with periods (dots) separating them. It is used to represent IP addresses.

dump. (1) Data that has been dumped. (T) (2) To copy the contents of all or part of virtual storage for the purpose of collecting error information.

dynamic reconfiguration (DR). The process of changing the network configuration (peripheral PUs and LUs) without regenerating complete configuration tables or deactivating the affected major node.

Dynamic Routing. Routing using learned routes rather than routes statically configured at initialization.

E

echo. In data communication, a reflected signal on a communications channel. For example, on a communications terminal, each signal is displayed twice, once when entered at the local terminal and again when returned over the communications link. This allows the signals to be checked for accuracy.

EIA 232. In data communication, a specification of the Electronic Industries Association (EIA) that defines the interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE), using serial binary data interchange.

ELAN. Emulated Local Area Network, a LAN segment implemented with ATM technology.

Electronic Industries Association (EIA). An organization of electronics manufacturers that advances the technological growth of the industry, represents the views of its members, and develops industry standards.

encapsulation. (1) In communications, a technique used by layered protocols by which a layer adds control information to the protocol data unit (PDU) from the layer it supports. In this respect, the layer encapsulates the data from the supported layer. In the Internet suite of protocols, for example, a packet would contain control information from the physical layer, followed by control information from the network layer, followed by the application protocol data. (2) See also *data link switching*.

encode. To convert data by the use of a code in such a manner that reconversion to the original form is possible. (T)

end node (EN). (1) See *Advanced Peer-to-Peer Networking (APPN) end node* and *low-entry networking (LEN) end node*. (2) In communications, a node that is frequently attached to a single data link and cannot perform intermediate routing functions.

entry point (EP). In SNA, a type 2.0, type 2.1, type 4, or type 5 node that provides distributed network management support. It sends network management data about itself and the resources it controls to a focal point for centralized processing, and it receives and executes focal-point initiated commands to manage and control its resources.

ESI. End System Identifier, a 6-byte component of an ATM address.

Ethernet. A 10-Mbps baseband local area network that allows multiple stations to access the transmission medium at will without prior coordination, avoids contention by using carrier sense and deference, and resolves contention by using collision detection and delayed retransmission. Ethernet uses carrier sense multiple access with collision detection (CSMA/CD).

exception. An abnormal condition such as an I/O error encountered in processing a data set or a file.

exception response (ER). In SNA, a protocol requested in the form-of-response-requested field of a request header that directs the receiver to return a response only if the request is unacceptable as received or cannot be processed; that is, a negative response, but not a positive response, can be returned. Contrast with *definite response* and *no response*.

exchange identification (XID). A specific type of basic link unit that is used to convey node and link characteristics between adjacent nodes. XIDs are exchanged between link stations before and during link activation to establish and negotiate link and node characteristics, and after link activation to communicate changes in these characteristics.

explicit route (ER). In SNA, a series of one or more transmission groups that connect two subarea nodes. An explicit route is identified by an origin subarea address, a destination subarea address, an explicit route number, and a reverse explicit route number. Contrast with *virtual route (VR)*.

explorer frame. See *explorer packet*.

explorer packet. In LANs, a packet that is generated by the source host and that traverses the entire source routing part of a LAN, gathering information on the possible paths available to the host.

exterior gateway. In Internet communications, a gateway on one autonomous system that communicates

with another autonomous system. Contrast with *interior gateway*.

Exterior Gateway Protocol (EGP). In the Internet suite of protocols, a protocol, used between domains and autonomous systems, that enables network reachability information to be advertised and exchanged. IP network addresses in one autonomous system are advertised to another autonomous system by means of EGP-participating routers. Contrast with *Border Gateway Protocol (BGP)*.

F

File Transfer Protocol (FTP). In the Internet suite of protocols, an application layer protocol that uses TCP and Telnet services to transfer bulk-data files between machines or hosts.

flow control. (1) In SNA, the process of managing the rate at which data traffic passes between components of the network. The purpose of flow control is to optimize the rate of flow of message units with minimum congestion in the network; that is, to neither overflow the buffers at the receiver or at intermediate routing nodes, nor leave the receiver waiting for more message units. (2) See also *pacing*.

fragment. See *fragmentation*.

fragmentation. (1) The process of dividing a datagram into smaller parts, or fragments, to match the capabilities of the physical medium over which it is to be transmitted. (2) See also *segmenting*.

frame. (1) In Open Systems Interconnection architecture, a data structure pertaining to a particular area of knowledge and consisting of slots that can accept the values of specific attributes and from which inferences can be drawn by appropriate procedural attachments. (T) (2) The unit of transmission in some local area networks, including the IBM Token-Ring Network. It includes delimiters, control characters, information, and checking characters. (3) In SDLC, the vehicle for every command, every response, and all information that is transmitted using SDLC procedures.

frame level. Synonymous with *data link level*. See *link level*.

frame relay. (1) An interface standard describing the boundary between a user's equipment and a fast-packet network. In frame-relay systems, flawed frames are discarded; recovery comes end-to-end rather than hop-by-hop. (2) A technique derived from the integrated services digital network (ISDN) D channel standard. It assumes that connections are reliable and dispenses with the overhead of error detection and control within the network.

G

gateway. (1) A functional unit that interconnects two computer networks with different network architectures. A gateway connects networks or systems of different architectures. A bridge interconnects networks or systems with the same or similar architectures. (T) (2) In the IBM Token-Ring Network, a device and its associated software that connect a local area network to another local area network or a host that uses different logical link protocols. (3) In TCP/IP, synonym for *router*.

general data stream (GDS). The data stream used for conversations in LU 6.2 sessions.

general data stream (GDS) variable. A type of RU substructure that is preceded by an identifier and a length field and includes either application data, user control data, or SNA-defined control data.

H

header. (1) System-defined control information that precedes user data. (2) The portion of a message that contains control information for the message such as one or more destination fields, name of the originating station, input sequence number, character string indicating the type of message, and priority level for the message.

heap memory. The amount of RAM used to dynamically allocate data structures.

Hello. A protocol used by a group of cooperating, trusting routers to allow them to discover minimal delay routes.

hello message. (1) A message sent periodically to establish and test reachability between routers or between routers and hosts. (2) In the Internet suite of protocols, a message defined by the Hello protocol as an Interior Gateway Protocol (IGP).

heuristic. Pertaining to exploratory methods of problem solving in which solutions are discovered by evaluation of the progress made toward the final result.

high-level data link control (HDLC). In data communication, the use of a specified series of bits to control data links in accordance with the International Standards for HDLC: ISO 3309 Frame Structure and ISO 4335 Elements of Procedures.

hop. (1) In APPN, a portion of a route that has no intermediate nodes. It consists of only a single transmission group connecting adjacent nodes. (2) To the routing layer, the logical distance between two nodes in a network.

hop count. (1) A metric or measure of distance between two points. (2) In Internet communications, the number of routers that a datagram passes through on its way to its destination. (3) In SNA, a measure of the number of links to be traversed in a path to a destination.

host. In the Internet suite of protocols, an end system. The end system can be any workstation; it does not have to be a mainframe.

hysteresis. The amount the temperature must change past the set alert threshold before the alert condition is cleared.

I

I frame. Information frame.

IETF. Internet Engineering Task Force, an organization that produces Internet specifications.

ILMI. Interim Local Management Interface, SNMP-based procedures for managing the User-Network Interface (UNI).

information (I) frame. A frame in I format used for numbered information transfer.

input/output channel. In a data processing system, a functional unit that handles transfer of data between internal and peripheral equipment. (I) (A)

integrated services digital network (ISDN). A digital end-to-end telecommunication network that supports multiple services including, but not limited to, voice and data.

Note: ISDNs are used in public and private network architectures.

interface. (1) A shared boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics, as appropriate. The concept includes the specification of the connection of two devices having different functions. (T) (2) Hardware, software, or both, that links systems, programs, or devices.

interior gateway. In Internet communications, a gateway that communicates only with its own autonomous system. Contrast with *exterior gateway*.

Interior Gateway Protocol (IGP). In the Internet suite of protocols, a protocol used to propagate network reachability and routing information within an autonomous system. Examples of IGPs are Routing Information Protocol (RIP) and Open Shortest Path First (OSPF).

intermediate node. A node that is at the end of more than one branch. (T)

intermediate session routing (ISR). A type of routing function within an APPN network node that provides session-level flow control and outage reporting for all sessions that pass through the node but whose end points are elsewhere.

International Organization for Standardization (ISO). An organization of national standards bodies from various countries established to promote development of standards to facilitate international exchange of goods and services, and develop cooperation in intellectual, scientific, technological, and economic activity.

International Telecommunication Union (ITU). The specialized telecommunication agency of the United Nations, established to provide standardized communication procedures and practices, including frequency allocation and radio regulations worldwide.

internet. A collection of networks interconnected by a set of routers that allow them to function as a single, large network. See also *Internet*.

Internet. The internet administered by the Internet Architecture Board (IAB), consisting of large national backbone networks and many regional and campus networks all over the world. The Internet uses the Internet suite of protocols.

Internet address. See *IP address*.

Internet Architecture Board (IAB). The technical body that oversees the development of the Internet suite of protocols that are known as TCP/IP.

Internet Control Message Protocol (ICMP). The protocol used to handle errors and control messages in the Internet Protocol (IP) layer. Reports of problems and incorrect datagram destinations are returned to the original datagram source. ICMP is part of the Internet Protocol.

Internet Control Protocol (ICP). The VIrtual NEtworking System (VINES) protocol that provides exception notifications, metric notifications, and PING support. See also *RouTing update Protocol (RTP)*.

Internet Engineering Task Force (IETF). The task force of the Internet Architecture Board (IAB) that is responsible for solving the short-term engineering needs of the Internet.

Internet Protocol (IP). A connectionless protocol that routes data through a network or interconnected networks. IP acts as an intermediary between the higher protocol layers and the physical network. However, this protocol does not provide error recovery

and flow control and does not guarantee the reliability of the physical network.

Internetwork Packet Exchange (IPX). (1) The network protocol used to connect Novell's servers, or any workstation or router that implements IPX, with other workstations. Although similar to the Internet Protocol (IP), IPX uses different packet formats and terminology. (2) See also *Xerox Network Systems (XNS)*.

interoperability. The capability to communicate, execute programs, or transfer data among various functional units in a way that requires the user to have little or no knowledge of the unique characteristics of those units. (T)

intra-area routing. In Internet communications, the routing of data within an area.

Inverse Address Resolution Protocol (InARP). In the Internet suite of protocols, the protocol used for locating a protocol address through the known hardware address. In a frame-relay context, the data link connection identifier (DLCI) is synonymous with the known hardware address.

IP address. The 32-bit address defined by the Internet Protocol, standard 5, Request for Comments (RFC) 791. It is usually represented in dotted decimal notation.

IP datagram. In the Internet suite of protocols, the fundamental unit of information transmitted through an internet. It contains source and destination addresses, user data, and control information such as the length of the datagram, the header checksum, and flags indicating whether the datagram can be or has been fragmented.

IP router. A device in an IP internet that is responsible for making decisions about the paths over which network traffic will flow. Routing protocols are used to gain information about the network and to determine the best route over which the datagram should be forwarded toward the final destination. The datagrams are routed based on IP destination addresses.

IPXWAN. A Novell protocol that is used to exchange router-to-router information before exchanging standard Internetwork Packet Exchange (IPX) routing information and traffic over wide area networks (WANs).

L

LAN bridge server (LBS). In the IBM Token-Ring Network Bridge Program, the server that keeps statistical information about frames forwarded between two or more rings (through a bridge). The LBS sends these statistics to the appropriate LAN managers through the LAN reporting mechanism (LRM).

LAN Emulation (LE). An ATM Forum standard that supports legacy LAN applications over ATM networks.

LAN Emulation Client (LEC). A LAN Emulation component that represents users of the Emulated LAN.

LAN Emulation Configuration Server (LECS). A LAN Emulation Service component that centralizes and disseminates configuration data.

LAN Emulation Server (LES). A LAN Emulation Service component that resolves LAN Destinations to ATM Addresses.

LAN Network Manager (LNM). An IBM licensed program that enables a user to manage and monitor LAN resources from a central workstation.

LAN segment. (1) Any portion of a LAN (for example, a bus or ring) that can operate independently, but that is connected to other parts of the network by means of bridges. (2) A ring or bus network without bridges.

layer. (1) In network architecture, a group of services that is complete from a conceptual point of view, that is one out of a set of hierarchically arranged groups, and that extends across all systems that conform to the network architecture. (T) (2) In the Open Systems Interconnection reference model, one of seven conceptually complete, hierarchically arranged groups of services, functions, and protocols, that extend across all open systems. (T) (3) In SNA, a grouping of related functions that are logically separate from the functions in other groups. Implementation of the functions in one layer can be changed without affecting functions in other layers.

LE. LAN Emulation.

LEC. LAN Emulation Client.

LECS. LAN Emulation Configuration Server.

LES. LAN Emulation Server.

line switching. Synonym for *circuit switching*.

link. The combination of the link connection (the transmission medium) and two link stations, one at each end of the link connection. A link connection can be shared among multiple links in a multipoint or token-ring configuration.

link access protocol balanced (LAPB). A protocol used for accessing an X.25 network at the link level. LAPB is a duplex, asynchronous, symmetric protocol, used in point-to-point communication.

link-attached. (1) Pertaining to devices that are connected to a controlling unit by a data link.

(2) Contrast with *channel-attached*. (3) Synonymous with *remote*.

link connection. (1) The physical equipment providing two-way communication between one link station and one or more other link stations; for example, a telecommunication line and data circuit-terminating equipment (DCE). (2) In SNA, synonymous with *data circuit*.

link level. (1) A part of Recommendation X.25 that defines the link protocol used to get data into and out of the network across the full-duplex link connecting the subscriber's machine to the network node. LAP and LAPB are the link access protocols recommended by the CCITT. (2) See *data link level*.

link-state. In routing protocols, the advertised information about the usable interfaces and reachable neighbors of a router or network. The protocol's topological database is formed from the collected link-state advertisements.

link station. (1) The hardware and software components within a node representing a connection to an adjacent node over a specific link. For example, if node A is the primary end of a multipoint line that connects to three adjacent nodes, node A will have three link stations representing the connections to the adjacent nodes. (2) See also *adjacent link station (ALS)*.

LIS. Logical IP Subnet, an IP subnet implemented with ATM technology Virtual Networking (SVN) framework.

local. (1) Pertaining to a device accessed directly without use of a telecommunication line. (2) Contrast with *remote*. (3) Synonym for *channel-attached*.

local area network (LAN). (1) A computer network located on a user's premises within a limited geographical area. Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary may be subject to some form of regulation. (T) (2) A network in which a set of devices are connected to one another for communication and that can be connected to a larger network. (3) See also *Ethernet* and *token ring*. (4) Contrast with *metropolitan area network (MAN)* and *wide area network (WAN)*.

local bridging. A function of a bridge program that allows a single bridge to connect multiple LAN segments without using a telecommunication link. Contrast with *remote bridging*.

local management interface (LMI). See *local management interface (LMI) protocol*.

local management interface (LMI) protocol. In NCP, a set of frame-relay network management procedures and messages used by adjacent frame-relay nodes to exchange line status information over DLCI X'00'. NCP supports both the American National Standards Institute (ANSI) and International Telegraph and Telephone Consultative Committee (ITU-T/CCITT) versions of LMI protocol. These standards refer to LMI protocol as *link integrity verification tests (LIVT)*.

locally administered address. In a local area network, an adapter address that the user can assign to override the universally administered address. Contrast with *universally administered address*.

logical channel. In packet mode operation, a sending channel and a receiving channel that together are used to send and receive data over a data link at the same time. Several logical channels can be established on the same data link by interleaving the transmission of packets.

logical link. A pair of link stations, one in each of two adjacent nodes, and their underlying link connection, providing a single link-layer connection between the two nodes. Multiple logical links can be distinguished while they share the use of the same physical media connecting two nodes. Examples are 802.2 logical links used on local area network (LAN) facilities and LAP E logical links on the same point-to-point physical link between two nodes. The term logical link also includes the multiple X.25 logical channels that share the use of the access link from a DTE to an X.25 network.

logical link control (LLC). The data link control (DLC) LAN sublayer that provides two types of DLC operation for the orderly exchange of information. The first type is connectionless service, which allows information to be sent and received without establishing a link. The LLC sublayer does not perform error recovery or flow control for connectionless service. The second type is connection-oriented service, which requires establishing a link prior to the exchange of information. Connection-oriented service provides sequenced information transfer, flow control, and error recovery.

logical link control (LLC) protocol. In a local area network, the protocol that governs the exchange of transmission frames between data stations independently of how the transmission medium is shared. (T) The LLC protocol was developed by the IEEE 802 committee and is common to all LAN standards.

logical link control (LLC) protocol data unit. A unit of information exchanged between link stations in different nodes. The LLC protocol data unit contains a destination service access point (DSAP), a source service access point (SSAP), a control field, and user data.

logical unit (LU). A type of network accessible unit that enables users to gain access to network resources and communicate with each other.

loopback test. A test in which signals from a tester are looped at a modem or other network element back to the tester for measurements that determine or verify the quality of the communications path.

low-entry networking (LEN). A capability of nodes to attach directly to one another using basic peer-to-peer protocols to support multiple and parallel sessions between logical units.

low-entry networking (LEN) end node. A LEN node receiving network services from an adjacent APPN network node.

low-entry networking (LEN) node. A node that provides a range of end-user services, attaches directly to other nodes using peer protocols, and derives network services implicitly from an adjacent APPN network node, that is, without the direct use of CP-CP sessions.

M

Management Information Base (MIB). (1) A collection of objects that can be accessed by means of a network management protocol. (2) A definition for management information that specifies the information available from a host or gateway and the operations allowed. (3) In OSI, the conceptual repository of management information within an open system.

management station. In Internet communications, the system responsible for managing all, or a portion of, a network. The management station communicates with network management agents that reside in the managed node by means of a network management protocol, such as the Simple Network Management Protocol (SNMP).

mapping. The process of converting data that is transmitted in one format by the sender into the data format that can be accepted by the receiver.

mask. (1) A pattern of characters used to control retention or elimination of portions of another pattern of characters. (I) (A) (2) To use a pattern of characters to control retention or elimination of portions of another pattern of characters. (I) (A)

maximum transmission unit (MTU). In LANs, the largest possible unit of data that can be sent on a given physical medium in a single frame. For example, the MTU for Ethernet is 1500 bytes.

medium access control (MAC). In LANs, the sublayer of the data link control layer that supports medium-dependent functions and uses the services of the physical layer to provide services to the logical link control (LLC) sublayer. The MAC sublayer includes the method of determining when a device has access to the transmission medium.

medium access control (MAC) protocol. In a local area network, the protocol that governs access to the transmission medium, taking into account the topological aspects of the network, in order to enable the exchange of data between data stations. (T)

medium access control (MAC) sublayer. In a local area network, the part of the data link layer that applies a medium access method. The MAC sublayer supports topology-dependent functions and uses the services of the physical layer to provide services to the logical link control sublayer. (T)

metric. In Internet communications, a value, associated with a route, which is used to discriminate between multiple exit or entry points to the same autonomous system. The route with the lowest metric is preferred.

metropolitan area network (MAN). A network formed by the interconnection of two or more networks which may operate at higher speed than those networks, may cross administrative boundaries, and may use multiple access methods. (T) Contrast with *local area network (LAN)* and *wide area network (WAN)*.

MIB object. Synonym for *MIB variable*.

MIB variable. In the Simple Network Management Protocol (SNMP), a specific instance of data defined in a MIB module. Synonymous with *MIB object*.

MIB view. In the Simple Network Management Protocol (SNMP), the collection of managed objects, known to the agent, that is visible to a particular community.

MILNET. The military network that was originally part of ARPANET. It was partitioned from ARPANET in 1984. MILNET provides a reliable network service for military installations.

modem (modulator/demodulator). (1) A functional unit that modulates and demodulates signals. One of the functions of a modem is to enable digital data to be transmitted over analog transmission facilities. (T) (A) (2) A device that converts digital data from a computer to an analog signal that can be transmitted on a telecommunication line, and converts the analog signal received to data for the computer.

modulo. (1) Pertaining to a modulus; for example, 9 is equivalent to 4 modulo 5. (2) See also *modulus*.

modulus. A number, such as a positive integer, in a relationship that divides the difference between two related numbers without leaving a remainder; for example, 9 and 4 have a modulus of 5 (9 - 4 = 5; 4 - 9 = -5; and 5 divides both 5 and -5 without leaving a remainder).

monitor. (1) A device that observes and records selected activities within a data processing system for analysis. Possible uses are to indicate significant departure from the norm, or to determine levels of utilization of particular functional units. (T)
(2) Software or hardware that observes, supervises, controls, or verifies operations of a system. (A)
(3) The function required to initiate the transmission of a token on the ring and to provide soft-error recovery in case of lost tokens, circulating frames, or other difficulties. The capability is present in all ring stations.

MSS. Multiprotocol Switched Services, a component of IBM's Switched Virtual Networking (SVN) framework.

multicast. (1) Transmission of the same data to a selected group of destinations. (T) (2) A special form of broadcast in which copies of a packet are delivered to only a subset of all possible destinations.

multiple-domain support (MDS). A technique for transporting management services data between management services function sets over LU-LU and CP-CP sessions. See also *multiple-domain support message unit (MDS-MU)*.

multiple-domain support message unit (MDS-MU). The message unit that contains management services data and flows between management services function sets over the LU-LU and CP-CP sessions used by multiple-domain support. This message unit, as well as the actual management services data that it contains, is in general data stream (GDS) format. See also *control point management services unit (CP-MSU)*, *management services unit (MSU)*, and *network management vector transport (NMVT)*.

N

Name Binding Protocol (NBP). In AppleTalk networks, a protocol that provides name translation function from the AppleTalk entity (resource) name (character string) into an AppleTalk IP address (16-bit number) on the transport layer.

name resolution. In Internet communications, the process of mapping a machine name to the corresponding Internet Protocol (IP) address. See also *Domain Name System (DNS)*.

name server. In the Internet suite of protocols, synonym for *domain name server*.

nearest active upstream neighbor (NAUN). In the IBM Token-Ring Network, the station sending data directly to a given station on the ring.

neighbor. A router on a common subnetwork that has been designated by a network administrator to receive routing information.

NetBIOS. Network Basic Input/Output System. A standard interface to networks, IBM personal computers (PCs), and compatible PCs, that is used on LANs to provide message, print-server, and file-server functions. Application programs that use NetBIOS do not need to handle the details of LAN data link control (DLC) protocols.

network. (1) A configuration of data processing devices and software connected for information interchange. (2) A group of nodes and the links interconnecting them.

network accessible unit (NAU). A logical unit (LU), physical unit (PU), control point (CP), or system services control point (SSCP). It is the origin or the destination of information transmitted by the path control network. Synonymous with *network addressable unit*.

network address. According to ISO 7498-3, a name, unambiguous within the OSI environment, that identifies a set of network service access points.

network addressable unit (NAU). Synonym for *network accessible unit*.

network architecture. The logical structure and operating principles of a computer network. (T)

Note: The operating principles of a network include those of services, functions, and protocols.

network congestion. An undesirable overload condition caused by traffic in excess of what a network can handle.

network identifier. (1) In TCP/IP, that part of the IP address that defines a network. The length of the network ID depends on the type of network class (A, B, or C). (2) A 1- to 8-byte customer-selected name or an 8-byte IBM-registered name that uniquely identifies a specific subnetwork.

Network Information Center (NIC). In Internet communications, local, regional, and national groups throughout the world who provide assistance, documentation, training, and other services to users.

network layer. In Open Systems Interconnection (OSI) architecture, the layer that is responsible for routing, switching, and link-layer access across the OSI environment.

network management. The process of planning, organizing, and controlling a communication-oriented data processing or information system.

network management station. In the Simple Network Management Protocol (SNMP), a station that executes management application programs that monitor and control network elements.

network management vector transport (NMVT). A management services request/response unit (RU) that flows over an active session between physical unit management services and control point management services (SSCP-PU session).

network manager. A program or group of programs that is used to monitor, manage, and diagnose the problems of a network.

network node (NN). See *Advanced Peer-to-Peer Networking (APPN) network node*.

Next Hop Resolution Protocol (NHRP). A routing protocol, specified in Internet Draft Version 10 which has been submitted for RFC status. The Next Hop Resolution Protocol defines a method for a source station to determine the Non-Broadcast Multi-Access (NBMA) address of the "NBMA next hop" towards a destination. The NBMA next hop may be the destination itself or the router in the NBMA network that is "nearest" to the destination. The source station can then establish an NBMA virtual circuit directly with the destination or the router and reduce the number of routing hops through the NBMA network.

network user address (NUA). In X.25 communications, the X.121 address containing up to 15 binary code digits.

NHRP. Next Hop Resolution Protocol

node. (1) In a network, a point at which one or more functional units connect channels or data circuits. (I) (2) Any device, attached to a network, that transmits and receives data.

noncanonical address. In LANs, a format for the transmission of medium access control (MAC) addresses for token-ring adapters. In noncanonical format, the most significant (leftmost) bit of each address byte is transmitted first. Contrast with *canonical address*.

nonseed router. In AppleTalk networks, a router that acquires network number range and zone list information from a seed router attached to the same network.

O

Open Shortest Path First (OSPF). In the Internet suite of protocols, a function that provides intradomain information transfer. An alternative to the Routing Information Protocol (RIP), OSPF allows the lowest-cost routing and handles routing in large regional or corporate networks.

Open Systems Interconnection (OSI). (1) The interconnection of open systems in accordance with standards of the International Organization for Standardization (ISO) for the exchange of information. (T) (A) (2) The use of standardized procedures to enable the interconnection of data processing systems.

Note: OSI architecture establishes a framework for coordinating the development of current and future standards for the interconnection of computer systems. Network functions are divided into seven layers. Each layer represents a group of related data processing and communication functions that can be carried out in a standard way to support different applications.

Open Systems Interconnection (OSI) architecture. Network architecture that adheres to that particular set of ISO standards that relates to Open Systems Interconnection. (T)

Open Systems Interconnection (OSI) reference model. A model that describes the general principles of the Open Systems Interconnection, as well as the purpose and the hierarchical arrangement of its seven layers. (T)

origin. An external logical unit (LU) or application program from which a message or other data originates. See also *destination*.

orphan circuit. A non-configured circuit whose availability is learned dynamically.

P

pacing. (1) A technique by which a receiving component controls the rate of transmission of a sending component to prevent overrun or congestion. (2) See also *flow control*, *receive pacing*, *send pacing*, *session-level pacing*, and *virtual route (VR) pacing*.

packet. In data communication, a sequence of binary digits, including data and control signals, that is transmitted and switched as a composite whole. The data, control signals, and, possibly, error control information are arranged in a specific format. (I)

packet internet groper (PING). (1) In Internet communications, a program used in TCP/IP networks to test the ability to reach destinations by sending the destinations an Internet Control Message Protocol (ICMP) echo request and waiting for a reply. (2) In communications, a test of reachability.

packet mode operation. Synonym for *packet switching*.

packet switching. (1) The process of routing and transferring data by means of addressed packets so that a channel is occupied only during transmission of a packet. On completion of the transmission, the channel is made available for transfer of other packets. (I) (2) Synonymous with *packet mode operation*. See also *circuit switching*.

parallel bridges. A pair of bridges connected to the same LAN segment, creating redundant paths to the segment.

parallel transmission groups. Multiple transmission groups between adjacent nodes, with each group having a distinct transmission group number.

path. (1) In a network, any route between any two nodes. A path may include more than one branch. (T) (2) The series of transport network components (path control and data link control) that are traversed by the information exchanged between two network accessible units. See also *explicit route (ER)*, *route extension*, and *virtual route (VR)*.

path control (PC). The function that routes message units between network accessible units in the network and provides the paths between them. It converts the basic information units (BIUs) from transmission control (possibly segmenting them) into path information units (PIUs) and exchanges basic transmission units containing one or more PIUs with data link control. Path control differs by node type: some nodes (APPN nodes, for example) use locally generated session identifiers for routing, and others (subarea nodes) use network addresses for routing.

path cost. In link-state routing protocols, the sum of the link costs along the path between two nodes or networks.

path information unit (PIU). A message unit consisting of a transmission header (TH) alone, or a TH followed by a basic information unit (BIU) or a BIU segment.

pattern-matching character. A special character such as an asterisk (*) or a question mark (?) that can be used to represent one or more characters. Any character or set of characters can replace a pattern-matching character. Synonymous with *global character* and *wildcard character*.

permanent virtual circuit (PVC). In X.25 and frame-relay communications, a virtual circuit that has a logical channel permanently assigned to it at each data terminal equipment (DTE). Call-establishment protocols are not required. Contrast with *switched virtual circuit (SVC)*.

physical circuit. A circuit established without multiplexing. See also *data circuit*. Contrast with *virtual circuit*.

physical layer. In the Open Systems Interconnection reference model, the layer that provides the mechanical, electrical, functional, and procedural means to establish, maintain, and release physical connections over the transmission medium. (T)

physical unit (PU). (1) The component that manages and monitors the resources (such as attached links and adjacent link stations) associated with a node, as requested by an SSCP via an SSCP-PU session. An SSCP activates a session with the physical unit in order to indirectly manage, through the PU, resources of the node such as attached links. This term applies to type 2.0, type 4, and type 5 nodes only. (2) See also *peripheral PU* and *subarea PU*.

ping command. The command that sends an Internet Control Message Protocol (ICMP) echo-request packet to a gateway, router, or host with the expectation of receiving a reply.

Point-to-Point Protocol (PPP). A protocol that provides a method for encapsulating and transmitting packets over serial point-to-point links.

polling. (1) On a multipoint connection or a point-to-point connection, the process whereby data stations are invited, one at a time, to transmit. (I) (2) Interrogation of devices for such purposes as to avoid contention, to determine operational status, or to determine readiness to send or receive data. (A)

port. (1) An access point for data entry or exit. (2) A connector on a device to which cables for other devices such as display stations and printers are attached. (3) The representation of a physical connection to the link hardware. A port is sometimes referred to as an adapter; however, there can be more than one port on an adapter. There may be one or more ports controlled by a single DLC process. (4) In the Internet suite of protocols, a 16-bit number used to communicate between TCP or the User Datagram Protocol (UDP) and a higher-level protocol or application. Some protocols, such as File Transfer Protocol (FTP) and Simple Mail Transfer Protocol (SMTP), use the same well-known port number in all TCP/IP implementations. (5) An abstraction used by transport protocols to

distinguish among multiple destinations within a host machine. (6) Synonymous with *socket*.

port number. In Internet communications, the identification of an application entity to the transport service.

problem determination. The process of determining the source of a problem; for example, a program component, machine failure, telecommunication facilities, user or contractor-installed programs or equipment, environmental failure such as a power loss, or user error.

program temporary fix (PTF). A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of the program.

protocol. (1) A set of semantic and syntactic rules that determine the behavior of functional units in achieving communication. (I) (2) In Open Systems Interconnection architecture, a set of semantic and syntactic rules that determine the behavior of entities in the same layer in performing communication functions. (T) (3) In SNA, the meanings of, and the sequencing rules for, requests and responses used for managing the network, transferring data, and synchronizing the states of network components. Synonymous with *line control discipline* and *line discipline*. See *bracket protocol* and *link protocol*.

protocol data unit (PDU). A unit of data specified in a protocol of a given layer and consisting of protocol control information of this layer, and possibly user data of this layer. (T)

Q

Quality of Service (QoS). The user-oriented performance of an end-to-end service which is accessed using performance parameters. In ATM networks, the following performance parameters determine the QoS of an end-to-end ATM connection: cell loss ratio, cell transfer delay, and cell delay variation.

R

Rapid Transport Protocol (RTP) connection. In high-performance routing (HPR), the connection established between the endpoints of the route to transport session traffic.

reachability. The ability of a node or a resource to communicate with another node or resource.

read-only memory (ROM). Memory in which stored data cannot be modified by the user except under special conditions.

reassembly. In communications, the process of putting segmented packets back together after they have been received.

receive not ready (RNR). In communications, a data link command or response that indicates a temporary condition of being unable to accept incoming frames.

receive not ready (RNR) packet. See *RNR packet*.

received line signal detector (RLSD). In the EIA 232 standard, a signal that indicates to the data terminal equipment (DTE) that it is receiving a signal from the remote data circuit-terminating equipment (DCE). Synonymous with *carrier detect* and *data carrier detect (DCD)*.

Recognized Private Operating Agency (RPOA). Any individual, company, or corporation, other than a government department or service, that operates a telecommunication service and is subject to the obligations undertaken in the Convention of the International Telecommunication Union and in the Regulations; for example, a communication common carrier.

reduced instruction-set computer (RISC). A computer that uses a small, simplified set of frequently used instructions for rapid execution.

remote. (1) Pertaining to a system, program, or device that is accessed through a telecommunication line. (2) Synonym for *link-attached*. (3) Contrast with *local*.

remote bridging. The function of a bridge that allows two bridges to connect multiple LANs using a telecommunication link. Contrast with *local bridging*.

Remote Execution Protocol (REXEC). A protocol that allows the execution of a command or program on any host in the network. The local host receives the results of the command execution.

Request for Comments (RFC). In Internet communications, the document series that describes a part of the Internet suite of protocols and related experiments. All Internet standards are documented as RFCs.

reset. On a virtual circuit, reinitialization of data flow control. At reset, all data in transit are eliminated.

reset request packet. In X.25 communications, a packet transmitted by the data terminal equipment (DTE) to the data circuit-terminating equipment (DCE) to request that a virtual call or a permanent virtual circuit be reset. The reason for the request can also be specified in the packet.

ring. See *ring network*.

ring network. (1) A network in which every node has exactly two branches connected to it and in which there are exactly two paths between any two nodes. (T) (2) A network configuration in which devices are connected by unidirectional transmission links to form a closed path.

ring segment. A section of a ring that can be isolated (by unplugging connectors) from the rest of the ring. See *LAN segment*.

rlogin (remote login). A service, offered by Berkeley UNIX-based systems, that allows authorized users of one machine to connect to other UNIX systems across an internet and interact as if their terminals were connected directly. The rlogin software passes information about the user's environment (for example, terminal type) to the remote machine.

RNR packet. A packet used by a data terminal equipment (DTE) or by a data circuit-terminating equipment (DCE) to indicate a temporary inability to accept additional packets for a virtual call or permanent virtual circuit.

root bridge. The bridge that is the root of a spanning tree formed between other active bridges in the bridging network. The root bridge originates and transmits bridge protocol data units (BPDUs) to other active bridges to maintain the spanning tree topology. It is the bridge with the highest priority in the network.

route. (1) An ordered sequence of nodes and transmission groups (TGs) that represent a path from an origin node to a destination node traversed by the traffic exchanged between them. (2) The path that network traffic uses to get from source to destination.

route bridge. A function of an IBM bridge program that allows two bridge computers to use a telecommunication link to connect two LANs. Each bridge computer is connected directly to one of the LANs, and the telecommunication link connects the two bridge computers.

route extension (REX). In SNA, the path control network components, including a peripheral link, that make up the portion of a path between a subarea node and a network addressable unit (NAU) in an adjacent peripheral node. See also *explicit route (ER)*, *path*, and *virtual route (VR)*.

Route Selection control vector (RSCV). A control vector that describes a route within an APPN network. The RSCV consists of an ordered sequence of control vectors that identify the TGs and nodes that make up the path from an origin node to a destination node.

router. (1) A computer that determines the path of network traffic flow. The path selection is made from several paths based on information obtained from specific protocols, algorithms that attempt to identify the shortest or best path, and other criteria such as metrics or protocol-specific destination addresses. (2) An attaching device that connects two LAN segments, which use similar or different architectures, at the reference model network layer. (3) In OSI terminology, a function that determines a path by which an entity can be reached. (4) In TCP/IP, synonymous with *gateway*. (5) Contrast with *bridge*.

routing. (1) The assignment of the path by which a message is to reach its destination. (2) In SNA, the forwarding of a message unit along a particular path through a network, as determined by parameters carried in the message unit, such as the destination network address in a transmission header.

routing domain. In Internet communications, a group of intermediate systems that use a routing protocol so that the representation of the overall network is the same within each intermediate system. Routing domains are connected to each other by exterior links.

Routing Information Protocol (RIP). In the Internet suite of protocols, an interior gateway protocol used to exchange intradomain routing information and to determine optimum routes between internet hosts. RIP determines optimum routes on the basis of route metrics, not link transmission speed.

routing loop. A situation that occurs when routers circulate information among themselves until convergence occurs or until the networks involved are considered unreachable.

routing protocol. A technique used by a router to find other routers and to remain up to date about the best way to get to reachable networks.

routing table. A collection of routes used to direct datagram forwarding or to establish a connection. The information is passed among routers to identify network topology and destination feasibility.

Routing Table Maintenance Protocol (RTMP). In AppleTalk networks, a protocol that provides routing information generation and maintenance on the transport layer by means of the AppleTalk routing table. The AppleTalk routing table directs packet transmission through the internet from source socket to destination socket.

RouTing update Protocol (RTP). The VIrtual NEtworking System (VINES) protocol that maintains the routing database and allows the exchange of routing information between VINES nodes. See also *Internet Control Protocol (ICP)*.

rsh. A variant of the rlogin command that invokes a command interpreter on a remote UNIX machine and

passes the command-line arguments to the command interpreter, skipping the login step completely.

S

SDU. Service Data Unit, data as it appears at the interface between a layer and the layer immediately above.

seed router. In AppleTalk networks, a router that maintains configuration data (network range numbers and zone lists, for example) for the network. Each network must have at least one seed router. The seed router must be initially set up using the configurator tool. Contrast with *nonseed router*.

segment. (1) A section of cable between components or devices. A segment may consist of a single patch cable, several patch cables that are connected, or a combination of building cable and patch cables that are connected. (2) In Internet communications, the unit of transfer between TCP functions in different machines. Each segment contains control and data fields; the current byte-stream position and actual data bytes are identified along with a checksum to validate received data.

segmenting. In OSI, a function performed by a layer to map one protocol data unit (PDU) from the layer it supports into multiple PDUs.

sequence number. In communications, a number assigned to a particular frame or packet to control the transmission flow and receipt of data.

server. A functional unit that provides shared services to workstations over a network; for example, a file server, a print server, a mail server. (T)

service access point (SAP). (1) In Open Systems Interconnection (OSI) architecture, the point at which the services of a layer are provided by an entity of that layer to an entity of the next higher layer. (T) (2) A logical point made available by an adapter where information can be received and transmitted. A single service access point can have many links terminating in it.

Service Advertising Protocol (SAP). In Internetwork Packet Exchange (IPX), a protocol that provides the following:

- A mechanism that allows IPX servers on an internet to advertise their services by name and type. Servers using this protocol have their name, service type, and IP address recorded in all file servers running NetWare.
- A mechanism that allows a workstation to broadcast a query to discover the identities of all servers of all types, all servers of a specific type, or the nearest server of a specific type.
- A mechanism that allows a workstation to query any file server running NetWare to discover the names and addresses of all servers of a specific type.

session. (1) In network architecture, for the purpose of data communication between functional units, all the activities which take place during the establishment, maintenance, and release of the connection. (T) (2) A logical connection between two network accessible units (NAUs) that can be activated, tailored to provide various protocols, and deactivated, as requested. Each session is uniquely identified in a transmission header (TH) accompanying any transmissions exchanged during the session.

Simple Network Management Protocol (SNMP). In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices managed is defined and stored in the application's Management Information Base (MIB).

SLIP. Serial Line IP, an IETF standard for running IP over serial communication links.

SNA management services (SNA/MS). The services provided to assist in management of SNA networks.

SNAP. (1) SubNetwork Access Protocol. (2) SubNetwork Attachment Point.

socket. An endpoint for communication between processes or application programs.

source route bridging. In LANs, a bridging method that uses the routing information field in the IEEE 802.5 medium access control (MAC) header of a frame to determine which rings or token-ring segments the frame must transit. The routing information field is inserted into the MAC header by the source node. The information in the routing information field is derived from explorer packets generated by the source host.

source routing. In LANs, a method by which the sending station determines the route the frame will follow and includes the routing information with the frame. Bridges then read the routing information to determine whether they should forward the frame.

source service access point (SSAP). In SNA and TCP/IP, a logical address that allows a system to send data to a remote device from the appropriate communications support. Contrast with *destination service access point (DSAP)*.

spanning tree. In LAN contexts, the method by which bridges automatically develop a routing table and

update that table in response to changing topology to ensure that there is only one route between any two LANs in the bridged network. This method prevents packet looping, where a packet returns in a circuitous route back to the sending router.

sphere of control (SOC). The set of control point domains served by a single management services focal point.

sphere of control (SOC) node. A node directly in the sphere of control of a focal point. A SOC node has exchanged management services capabilities with its focal point. An APPN end node can be a SOC node if it supports the function to exchange management services capabilities.

split horizon. A technique for minimizing the time to achieve network convergence. A router records the interface over which it received a particular route and does not propagate its information about the route back over the same interface.

spoofing. For data links, a technique in which a protocol initiated from an end station is acknowledged and processed by an intermediate node on behalf of the final destination. In IBM 6611 data link switching, for example, SNA frames are encapsulated into TCP/IP packets for transport across a non-SNA wide area network, unpacked by another IBM 6611, and passed to the final destination. A benefit of spoofing is the prevention of end-to-end session timeouts.

standard MIB. In the Simple Network Management Protocol (SNMP), a MIB module that is located under the management branch of the Structure of Management Information (SMI) and that is considered a standard by the Internet Engineering Task Force (IETF).

static route. The route between hosts, networks, or both that is manually entered into a routing table.

station. An input or output point of a system that uses telecommunication facilities; for example, one or more systems, computers, terminals, devices, and associated programs at a particular location that can send or receive data over a telecommunication line.

StreetTalk. In the VIrtual NEtworking System (VINES), a unique network-wide naming and addressing system that allows users to locate and access any resource on the network without knowing the network topology. See also *Internet Control Protocol (ICP)* and *RouTing update Protocol (RTP)*.

Structure of Management Information (SMI). (1) In the Simple Network Management Protocol (SNMP), the rules used to define the objects that can be accessed by means of a network management protocol. (2) In OSI, the set of standards relating to management information. The set includes the *Management Information Model* and the *Guidelines for the Definition of Managed Objects*

subarea. A portion of the SNA network consisting of a subarea node, attached peripheral nodes, and associated resources. Within a subarea node, all network accessible units (NAUs), links, and adjacent link stations (in attached peripheral or subarea nodes) that are addressable within the subarea share a common subarea address and have distinct element addresses.

subnet. (1) In TCP/IP, a part of a network that is identified by a portion of the IP address. (2) Synonym for *subnetwork*.

subnet address. In Internet communications, an extension to the basic IP addressing scheme where a portion of the host address is interpreted as the local network address.

subnet mask. Synonym for *address mask*.

subnetwork. (1) Any group of nodes that have a set of common characteristics, such as the same network ID. (2) Synonymous with *subnet*.

Subnetwork Access Protocol (SNAP). In LANs, a 5-byte protocol discriminator that identifies the non-IEEE standard protocol family to which a packet belongs. The SNAP value is used to differentiate between protocols that use $AA as their service access point (SAP) value.

SubNetwork Attachment Point (SNAP). An LLC header extension that identifies the protocol type of a frame.

subnetwork mask. Synonym for *address mask*.

subsystem. A secondary or subordinate system, usually capable of operating independently of, or asynchronously with, a controlling system. (T)

SVN. Switched Virtual Networking, the name of IBM's framework for building and managing switch-based networks.

switched virtual circuit (SVC). An X.25 circuit that is dynamically established when needed. The X.25 equivalent of a switched line. Contrast with *permanent virtual circuit (PVC)*.

synchronous. (1) Pertaining to two or more processes that depend upon the occurrence of specific events such as common timing signals. (T) (2) Occurring with a regular or predictable time relationship.

Synchronous Data Link Control (SDLC). (1) A discipline conforming to subsets of the Advanced Data Communication Control Procedures (ADCCP) of the

American National Standards Institute (ANSI) and High-level Data Link Control (HDLC) of the International Organization for Standardization, for managing synchronous, code-transparent, serial-by-bit information transfer over a link connection. Transmission exchanges may be duplex or half-duplex over switched or nonswitched links. The configuration of the link connection may be point-to-point, multipoint, or loop. (I) (2) Contrast with *binary synchronous communication (BSC).*

SYNTAX. In the Simple Network Management Protocol (SNMP), a clause in the MIB module that defines the abstract data structure that corresponds to a managed object.

system configuration. A process that specifies the devices and programs that form a particular data processing system.

system services control point (SSCP). A component within a subarea network for managing the configuration, coordinating network operator and problem determination requests, and providing directory services and other session services for users of the network. Multiple SSCPs, cooperating as peers with one another, can divide the network into domains of control, with each SSCP having a hierarchical control relationship to the physical units and logical units within its own domain.

Systems Network Architecture (SNA). The description of the logical structure, formats, protocols, and operational sequences for transmitting information units through, and controlling the configuration and operation of, networks. The layered structure of SNA allows the ultimate origins and destinations of information, that is, the users, to be independent of and unaffected by the specific SNA network services and facilities used for information exchange.

T

Telnet. In the Internet suite of protocols, a protocol that provides remote terminal connection service. It allows users of one host to log on to a remote host and interact as directly attached terminal users of that host.

threshold. (1) In IBM bridge programs, a value set for the maximum number of frames that are not forwarded across a bridge due to errors, before a “threshold exceeded” occurrence is counted and indicated to network management programs. (2) An initial value from which a counter is decremented to 0, or a value to which a counter is incremented or decremented from an initial value.

throughput class. In packet switching, the speed at which data terminal equipment (DTE) packets travel through the packet switching network.

time to live (TTL). A technique used by best-effort delivery protocols to inhibit endlessly looping packets. The packet is discarded if the TTL counter reaches 0.

timeout. (1) An event that occurs at the end of a predetermined period of time that began at the occurrence of another specified event. (I) (2) A time interval allotted for certain operations to occur; for example, response to polling or addressing before system operation is interrupted and must be restarted.

TLV. Type/Length/Value, a generalized information element in a LAN Emulation packet.

token. (1) In a local area network, the symbol of authority passed successively from one data station to another to indicate the station temporarily in control of the transmission medium. Each data station has an opportunity to acquire and use the token to control the medium. A token is a particular message or bit pattern that signifies permission to transmit. (T) (2) In LANs, a sequence of bits passed from one device to another along the transmission medium. When the token has data appended to it, it becomes a frame.

token ring. (1) According to IEEE 802.5, network technology that controls media access by passing a token (special packet or frame) between media-attached stations. (2) A FDDI or IEEE 802.5 network with a ring topology that passes tokens from one attaching ring station (node) to another. (3) See also *local area network (LAN).*

token-ring network. (1) A ring network that allows unidirectional data transmission between data stations, by a token passing procedure, such that the transmitted data return to the transmitting station. (T) (2) A network that uses a ring topology, in which tokens are passed in a circuit from node to node. A node that is ready to send can capture the token and insert data for transmission.

topology. In communications, the physical or logical arrangement of nodes in a network, especially the relationships among nodes and the links between them.

topology database update (TDU). A message about a new or changed link or node that is broadcast among APPN network nodes to maintain the network topology database, which is fully replicated in each network node. A TDU contains information that identifies the following:

- The sending node
- The node and link characteristics of various resources in the network
- The sequence number of the most recent update for each of the resources described.

trace. (1) A record of the execution of a computer program. It exhibits the sequences in which the instructions were executed. (A) (2) For data links, a record of the frames and bytes transmitted or received.

transceiver (transmitter-receiver). In LANs, a physical device that connects a host interface to a local area network, such as Ethernet. Ethernet transceivers contain electronics that apply signals to the cable and that sense collisions.

Transmission Control Protocol (TCP). A communications protocol used in the Internet and in any network that follows the U.S. Department of Defense standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in packet-switched communications networks and in interconnected systems of such networks. It uses the Internet Protocol (IP) as the underlying protocol.

Transmission Control Protocol/Internet Protocol (TCP/IP). A set of communications protocols that support peer-to-peer connectivity functions for both local and wide area networks.

transmission group (TG). (1) A connection between adjacent nodes that is identified by a transmission group number. (2) In a subarea network, a single link or a group of links between adjacent nodes. When a transmission group consists of a group of links, the links are viewed as a single logical link, and the transmission group is called a *multilink transmission group (MLTG)*. A *mixed-media multilink transmission group (MMMLTG)* is one that contains links of different medium types (for example, token-ring, switched SDLC, nonswitched SDLC, and frame-relay links). (3) In an APPN network, a single link between adjacent nodes. (4) See also *parallel transmission groups*.

transmission header (TH). Control information, optionally followed by a basic information unit (BIU) or a BIU segment, that is created and used by path control to route message units and to control their flow within the network. See also *path information unit*.

transparent bridging. In LANs, a method for tying individual local area networks together through the medium access control (MAC) level. A transparent bridge stores the tables that contain MAC addresses so that frames seen by the bridge can be forwarded to another LAN if the tables indicate to do so.

transport layer. In the Open Systems Interconnection reference model, the layer that provides a reliable end-to-end data transfer service. There may be relay open systems in the path. (T) See also *Open Systems Interconnection reference model*.

trap. In the Simple Network Management Protocol (SNMP), a message sent by a managed node (agent function) to a management station to report an exception condition.

tunneling. To treat a transport network as though it were a single communication link or LAN. See also *encapsulation*.

T1. In the United States, a 1.544-Mbps public access line. It is available in twenty-four 64-Kbps channels. The European version (E1) transmits 2.048 Mbps. The Japanese version (J1) transmits 1.544 Mbps.

U

UNI. User-Network Interface, the interface between user equipment and an ATM switch network.

universally administered address. In a local area network, the address permanently encoded in an adapter at the time of manufacture. All universally administered addresses are unique. Contrast with *locally administered address*.

User Datagram Protocol (UDP). In the Internet suite of protocols, a protocol that provides unreliable, connectionless datagram service. It enables an application program on one machine or process to send a datagram to an application program on another machine or process. UDP uses the Internet Protocol (IP) to deliver datagrams.

V

V.24. In data communication, a specification of the CCITT that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE).

V.25. In data communication, a specification of the CCITT that defines the automatic answering equipment and parallel automatic calling equipment on the General Switched Telephone Network, including procedures for disabling of echo controlled devices for both manually and automatically established calls.

V.35. In data communication, a specification of the CCITT that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) at various data rates.

V.36. In data communication, a specification of the CCITT that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) at rates of 48, 56, 64, or 72 kilobits per second.

VCC. Virtual Channel Connection, a connection between parties.

VINES. VIrtual NEtworking System.

virtual circuit. (1) In packet switching, the facilities provided by a network that give the appearance to the user of an actual connection. (T) See also *data circuit*. Contrast with *physical circuit*. (2) A logical connection established between two DTEs.

virtual link. In Open Shortest Path First (OSPF), a point-to-point interface that connects border routers that are separated by a non-backbone transit area. Because area routers are part of the OSPF backbone, the virtual link connects the backbone. The virtual links ensure that the OSPF backbone does not become discontinuous.

Virtual Local Area Network (VLAN). A logical grouping of one or more LANs based on protocol and subnet and used to isolate network traffic within these groups.

VIrtual NEtworking System (VINES). The network operating system and network software from Banyan Systems, Inc. In a VINES network, virtual linking allows all devices and services to appear to be directly connected to each other, when they may actually be thousands of miles apart. See also *StreetTalk*.

virtual route (VR). (1) In SNA, either (a) a logical connection between two subarea nodes that is physically realized as a particular explicit route or (b) a logical connection that is contained wholly within a subarea node for intranode sessions. A virtual route between distinct subarea nodes imposes a transmission priority on the underlying explicit route, provides flow control through virtual route pacing, and provides data integrity through sequence numbering of path information units (PIUs). (2) Contrast with *explicit route (ER)*. See also *path* and *route extension (REX)*.

W

wide area network (WAN). (1) A network that provides communication services to a geographic area larger than that served by a local area network or a metropolitan area network, and that may use or provide public communication facilities. (T) (2) A data communication network designed to serve an area of hundreds or thousands of miles; for example, public and private packet-switching networks, and national telephone networks. (3) Contrast with *local area network (LAN)* and *metropolitan area network (MAN)*.

wildcard character. Synonym for *pattern-matching character*.

X

X.21. An International Telegraph and Telephone Consultative Committee (CCITT) recommendation for a general-purpose interface between data terminal equipment and data circuit-terminating equipment for synchronous operations on a public data network.

X.25. (1) An International Telegraph and Telephone Consultative Committee (CCITT) recommendation for the interface between data terminal equipment and packet-switched data networks. (2) See also *packet switching*.

Xerox Network Systems (XNS). The suite of internet protocols developed by the Xerox Corporation. Although similar to TCP/IP protocols, XNS uses different packet formats and terminology. See also *Internetwork Packet Exchange (IPX)*.

Z

zone. In AppleTalk networks, a subset of nodes within an internet.

Zone Information Protocol (ZIP). In AppleTalk networks, a protocol that provides zone management service by maintaining a mapping of the zone names and network numbers across the internet on the session layer.

zone information table (ZIT). A listing of network numbers and their associated zone name mappings in the internet. This listing is maintained by each internet router in an AppleTalk internet.

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