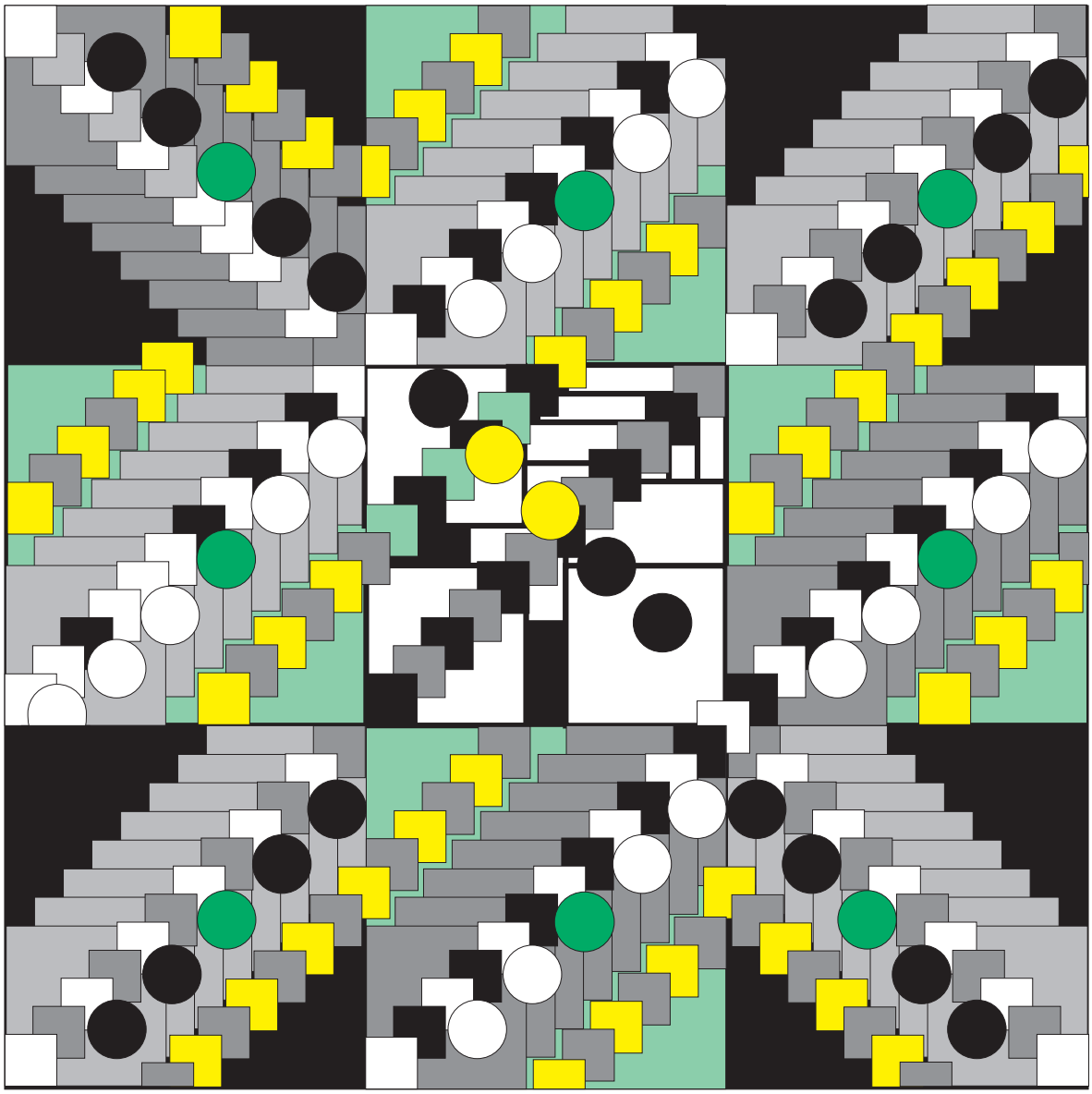
2220 Nways BroadBand Switch
Models 300, 500, and 501

IBM

At a Glance, an Overview



GA33-0292-06

2220 Nways BroadBand Switch
Models 300, 500, and 501

At a Glance, an Overview

GA33-0292-06

Note

Before using this information and the product it supports, be sure to read the general information under “Appendix. Notices” on page 113.

Seventh Edition (April 1998)

This edition applies to the following IBM licensed programs:

- Nways Switch Control Program Version 2 Release 2 (V2R2)
- Nways 2220 Switch Manager for AIX Version 1 replaces Nways Enterprise Manager Release 3.

The information contained in this manual is subject to change from time to time. Any such changes will be reported in subsequent revisions.

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About This Manual

This manual describes the *IBM* 2220 Nways* BroadBand Switch Models 300, 500, and 501* and associated programs. It is an introductory manual intended to help you learn about and evaluate the 2220 Nways BroadBand Switch (also called the *Nways Switch)* family of products. 2220 Nways Switches implement the Networking BroadBand Services (NBBS) architecture and, therefore, provide a unique solution to:

- Optimize the wide area network (WAN) interconnection of multiple protocol networking products
- Consolidate all traffic types on the same backbone.

In this manual, the following terms are used to describe the threeNways Switch products:

Nways Switch
IBM 2220 Nways BroadBand Switch

Nways Switch Control Program
IBM Nways BroadBand Switch Control Program

Nways 2220 Switch Manager
IBM Nways 2220 Switch Manager for AIX (2220 Switch Manager)

Intended Audience

This manual is intended for:

- Network planners
- Network administrators
- System programmers.

The reader is assumed to be familiar with LANs, WANs, and telecommunications in general.

How this Book Is Organized

This manual consists of the following sections:

"Part 1. Evolution of Communications Technology" on page 1 shows how communications technology is evolving.

- Chapter 1. Challenges Facing Present Infrastructures, is a brief discussion of the evolution of communications technology toward broadband fast-packet-switching networking.
- Chapter 2. IBM's Solution for High-Speed Broadband Networking, explains the benefits of using the IBM Networking BroadBand Services (NBBS) architecture and the 2220 Nways BroadBand Switch family for your broadband networking needs.

"Part 2. IBM Nways BroadBand Network" on page 27 describes features and operations of the IBM Nways Switch family:

- Chapter 3. How the Nways Switch Implements NBBS, explains which NBBS functions are implemented in the Nways Switch, introduces the Nways Switch hardware components, and briefly discusses network clocking.

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- Chapter 4. Protocols, explains the protocols offered by the IBM Nways Switch.
- Chapter 5. Resource Management, introduces the IBM licensed programs:
  - IBM Nways 2220 Switch Manager for AIX for the 2220 network management
  - IBM Nways BroadBand Switch Control Program for local node management.
- Chapter 6. Overview of Planning Tasks, provides information about the tasks covered in the *2220 Nways BroadBand Switch Planning Guide*, GA33-0293, and the service and education facilities that are offered by IBM for the Nways Switch.

"Part 3. Technical Specifications" on page 75 describes the hardware of the IBM Nways Switch family:

- Chapter 7. Nways Switch Hardware, provides information about the basic machine configuration for the Nways Switch models and lists the features available for these models.
- Chapter 8. Physical Line Attachment (Layer 1) Specifications, provides information about the line interface standards of the Nways Switch models.

The following information is included at the back of this manual:

- Appendix. Notices, includes the product warranty notices and trademark information.
- Glossary.
- Bibliography on page 131. Refer to the listed documentation to find more information about the IBM 2220 Nways BroadBand Switch.
- Index.

What's New in This Book

The following functions are new or have changed since the last edition of this book.

Nways 2220 Switch Manager for AIX

The IBM Nways 2220 Switch Manager (2220 Switch Manager) Version 1 is available and replaces IBM Nways Enterprise Manager (NEM). Router and Bridge Manager (RABM) that was a part of NEM is now a part of Nways Manager LAN.

This release of 2220 Switch Manager provides new functions that allow you to:

- Use Nways Switch Control Program V2R2, V2R1, and V1R5
- Import and export of Nways Switch configuration files from 2220 Switch Manager using NetView and the AIX command line
- Manage how the status of 2220 nodes and failing resources in a node are graphically displayed
- View progress messages during network discovery
- Use 2220 Switch Manager to manage two levels of Nways Switch Control Program code from a network management station.
- Translate alarms into SNMP traps
- Reset adapters using AIX command scripts
- Activate trunk lines using AIX command scripts
- List all trunks for a given 2220 node using AIX command scripts.

Nways Switch Control Program

The Nways Switch Control Program Version 2 Release 2 (V2R2) provides the following new functions:

- Frame Relay over ISDN allows Frame Relay Data Terminating Equipment (DTE) to access 2220 Frame Relay ports through an ISDN dial-up connection
- ISDN Trunk Backup allows you to define backup trunk lines over a Euro-ISDN network and set up temporary trunk lines that can be activated when more bandwidth is required in your 2220 network.
- ATM Bearer Service provides a cost-effective way to interconnect Nways Switches by spliting a physical ATM line interface into several NBBS trunks and mapping the trunks over ATM Virtual Paths (VPs) of an ATM service provider.
- The treatment of non-reserved Frame Relay and ATM traffic has been enhanced so that destination devices are notified of congestion conditions in the network. A warning is usually sent to the source device so that it can reduce its data transmission.

  For non-reserved ATM traffic, ATM Available Bit Rate (ABR) Explicit Forward Congestion Indication (EFCI) is supported. Early Packet Discard (EPD) is supported on Virtual Circuit (VC) connections. EPD-like support is provided on Virtual Path (VP) connections.
- Non-disruptive path switching (NDPS) is enhanced with parallel NBBS trunks that ensure continued network availability in case of trunk failure.

2220 Hardware Features

- In order to use the Euro-ISDN trunk backup function, the line interface coupler type 563 (LIC563) is required.

Part 1. Evolution of Communications Technology

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New and powerful applications pose challenges for our communications infrastructures. In Part 1, we look at the challenges, and what solutions we may find in the continuing evolution of communications technology.

Chapter 1. Challenges Facing Present Infrastructures

This chapter discusses:

- The challenges of coping with increasing volumes of communication traffic
- The evolution of both traffic requirements and networking technology
- The differing requirements of each type of traffic
- A solution that offers an answer to both challenges and the evolution of communications.

High-Speed Networking Challenges

The emergence of new technologies and new data traffic patterns means that the solutions that have served us so well in the last 20 years will no longer be able to do the complete job in the future.

We have in place infrastructures for our investment in *traditional* communication networks like:

- Voice and fax
- Computer data, such as SNA, OSI, and TCP/IP
- Isochronous communication networks using time division multiplexing (TDM) techniques.

These are known as *legacy applications*. Increasing volumes of traffic have necessitated the introduction of fast digital networks to cope with the demand.

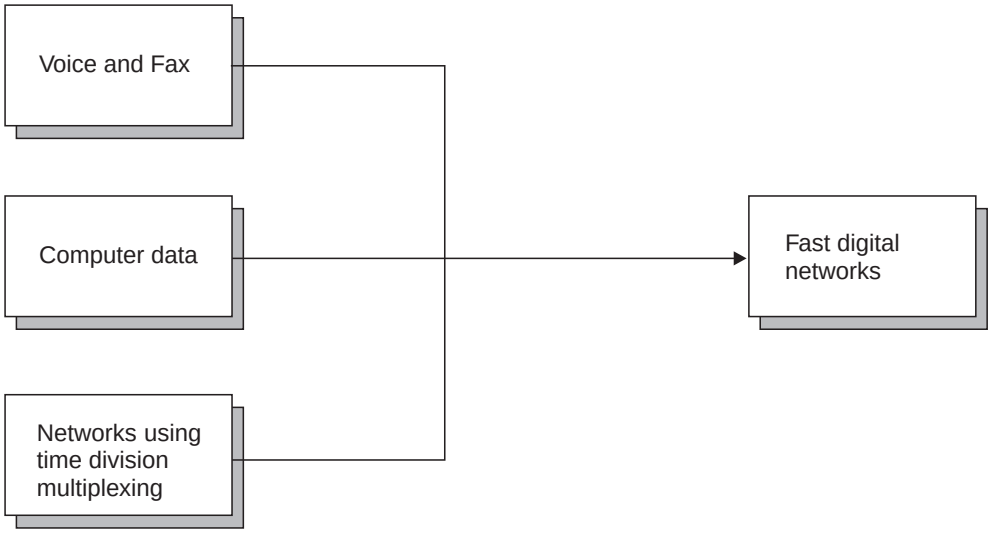

Figure 1. Legacy Applications Mix on Fast Digital Networks

In addition, we have emerging applications that each have different requirements:

- Network interconnectivity, giving *networks of networks* and distributed computer power
- Interactive video, such as:
  - Medical imaging and remote diagnosis
  - Remote viewing and control

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  - Video conferences
- Interactive computer applications.

They each require or generate large volumes of data and/or real-time responses, and are too demanding for existing networks. They would require expensive investment in new structures and dedicated networks for each kind of emerging application if we don't have some means to merge all forms into a single structure.

Evolving Requirements

Communication requirements are evolving for a variety of reasons.

The Need to Mix Different Types of Network Traffic

There are two broad categories of traffic:

1. *Isochronous* or constant bit rate traffic. This category includes protocols and traffic types (voice and video) that have low tolerances for network delay and delay variations (jitter). They have to be processed in real-time by the network.
2. *Bursty* or variable bit rate traffic where the time between data transmissions is not always the same. This category includes protocols and traffic types (compressed information and data files) that are less sensitive to network delay and delay variations. They are not handled in real-time by the network.

These two traffic types carry our legacy applications over fast digital networks shown in Figure 1 on page 3.

New Applications Are Too Demanding for Existing Networks

These new applications include:

- Local area network (LAN) interconnections and distributed processing with high-speed and bursty traffic between workstations and supercomputers, sometimes passing over multiple networks.
- Multimedia and video applications mixing data, voice, and image information in the same application *and at the same time*.
- Interactive computer applications requiring immediate response often with graphical or video data flowing between participants.

These new applications require high speed, high throughput, and high reliability. The volume and response of existing network solutions are not adequate for the new applications that will soon become commonplace. We need new solutions for both increasing traffic volumes of legacy applications, and for newer types of traffic. So how do we handle the new traffic requirements?

- Do we expand current networks to work with applications for which they weren't designed?

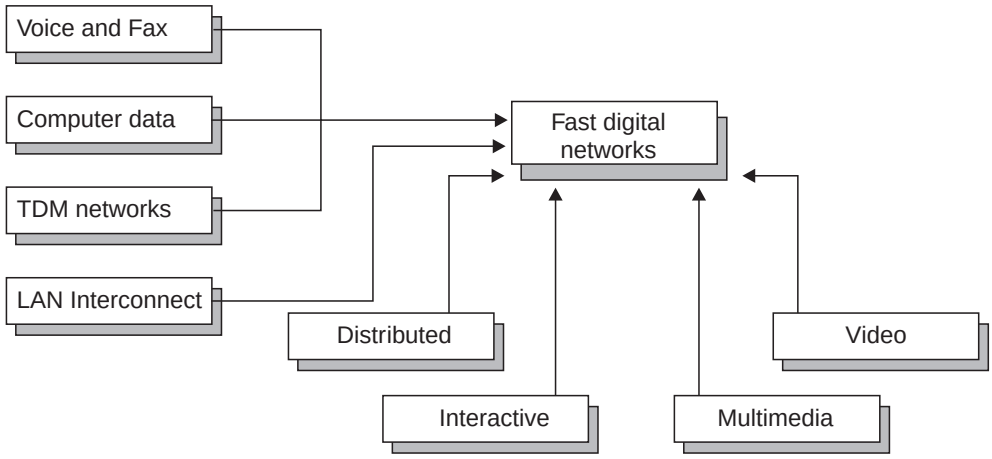

Figure 2. First Solution: Integrate Legacy and Emerging Applications Into Today's Networks?

- Do we invest in new structures for each emerging type of application to run parallel to existing structures?

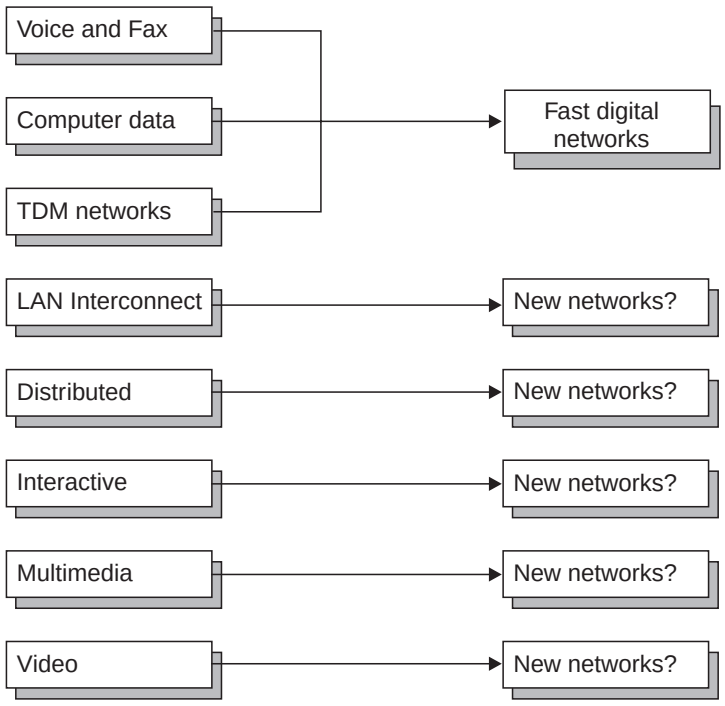

Figure 3. Second Solution: Build Parallel Infrastructures for Each New Application Type?

We do not have the resources to keep multiplying infrastructures for multiplying traffic requirements.

Evolving Technology

Networking technology continues to evolve:

- The introduction of optical fiber, has thoroughly transformed transmission technology: high bit rates can now be sustained with very low bit-error rates.
- Very high speed switching circuits can operate at high reliability providing much higher data throughput than previously possible.
- Frame relay and integrated services digital network (ISDN) standards were developed to carry all types of information, and are beginning to be supported throughout the world.
- The emerging ITU-T (ex-CCITT) asynchronous transfer mode (ATM) standard will soon become widespread.

It is now possible to build networks that can carry high volumes of data at high speed, coping with both legacy applications and emerging applications in a single network structure.

These networks mix data, voice, image, and video information by chopping them into packets or cells and switch them using cell relay technologies. The networks, called *broadband networks*, transport different traffic types over a single bandwidth, rather than dedicating a bandwidth channel for each type of traffic.

Figure 4 shows the types of applications that are driving the evolution of networking technology.

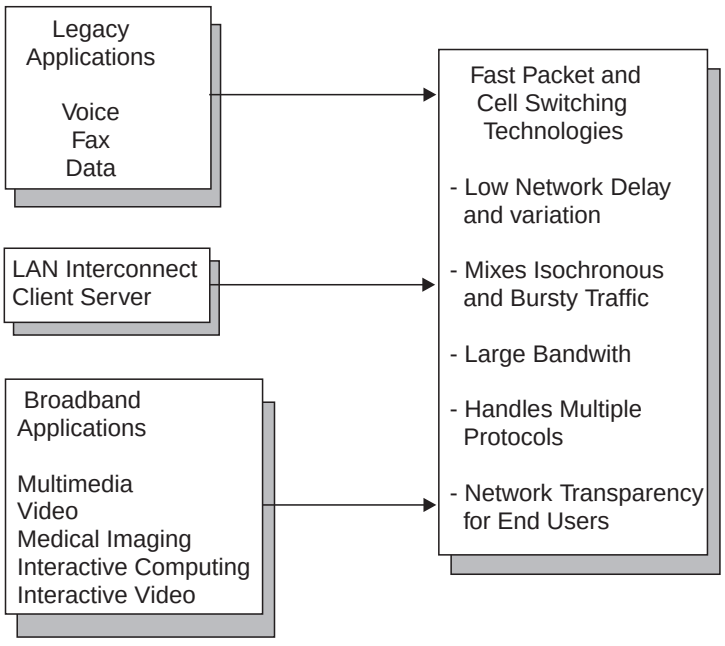

Figure 4. Evolution Toward Broadband Data Transport Networks

The multiple demands of a network today require it to work as *a general data transport network*, that is, one that carries many types of data traffic, rather than as a carrier for a specific type of traffic. This introduces another challenge: the network must be able to satisfy the radically different requirements of each type of data traffic.

Different Data Types Require Different Qualities of Service

Many new applications demand a high quality of service from a network if the applications are to maintain their usefulness to their end users. It's no use delivering a high speed service if much of the data has to be retransmitted because of losses on the network. Conversely, delivering data files at zero loss is probably more expensive than retransmitting lost data packets.

Connections have different networking needs depending on the application. Broadband networks, transporting different data types with different communication requirements must offer different guarantees to each data type transported. *Quality of service* (QoS) must be a deliverable network service that guarantees certain transmission characteristics for each data type.

Examples of QoS characteristics are:

- Maximum network delay allowed
- Maximum delay variation allowed
- Maximum packet or cell loss tolerance.

Figure 5 shows the mixture of cell loss and delay that can be tolerated by various data types.

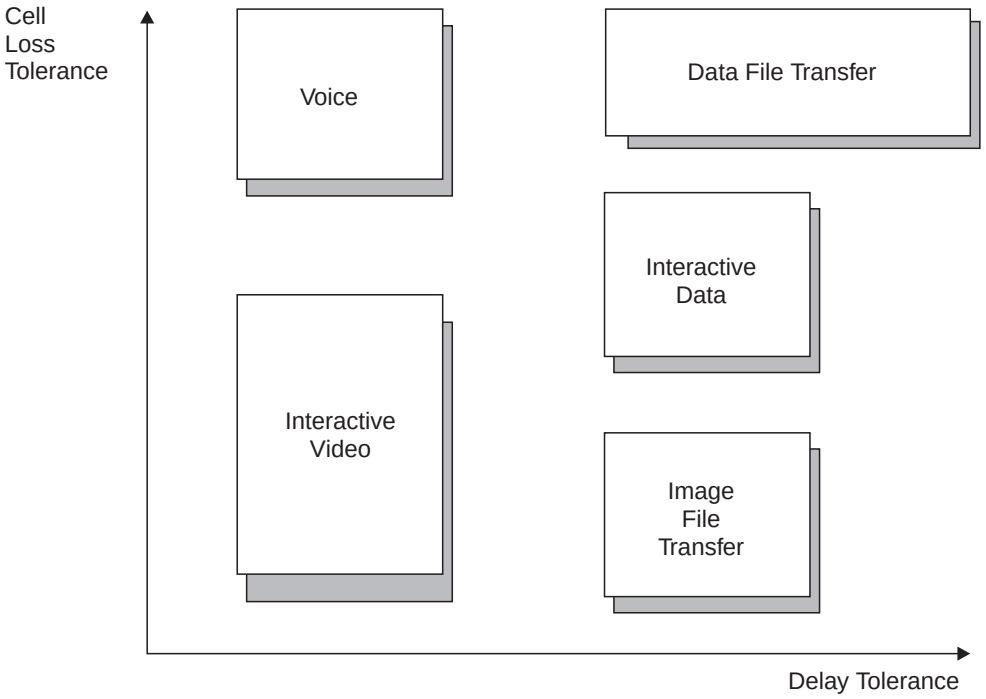

Figure 5. Quality of Service Characteristics for Different Data Types

Some data types can tolerate a lower QoS than others because:

- They are not interactive and minor delays have no significant impact on the overall service
- The original data is still held at the origin and can be retransmitted if any is lost in transit.

Some data types demand a very high QoS because:

- The data stream is required or produced in real time and is not reproducible.
- They are part of an interactive application and cannot be reproduced without degrading the performance or usefulness of the application.

For example, referring to Figure 5 on page 7 again:

- Transferring an image file is less sensitive to network time delay than an interactive video application.
- Loss of data cells is less serious for data file transfer than for an interactive video application, because data files can be retransmitted later with little loss of service.

While guaranteeing appropriate QoS characteristics to different data types, you also optimize bandwidth use of your broadband network.

New Network Products and Architectures Needed

The network evolution resulting from these new technologies, standards, applications, and traffic types requires the development of systems (products and architectures) based on new broadband networking strategies, as summarized in Figure 6 on page 9.

Protecting Your Investment in Current Systems

Any new technology must be able to work with equipment that is already in service. This means that a new system must be able to work with many current interfaces and protocols in order to attach a variety of user devices.

New broadband networks should be able to carry voice, fax, video, and data (high-level data link control (HDLC), frame relay, and ATM) by attaching to existing equipment.

Broadband Networks, the Solution to Evolving Needs

Merging legacy applications and emerging technologies into a single, unified, broadband network provides a solution offering high volume, high throughput, and at high reliability.

A broadband network can protect the end user's investment in current applications, protocols, and equipment while accepting the challenges of emerging applications and evolving networking technologies.

IBM's answer is the Networking BroadBand Services (NBBS) network and the IBM 2220 Nways BroadBand Switches.

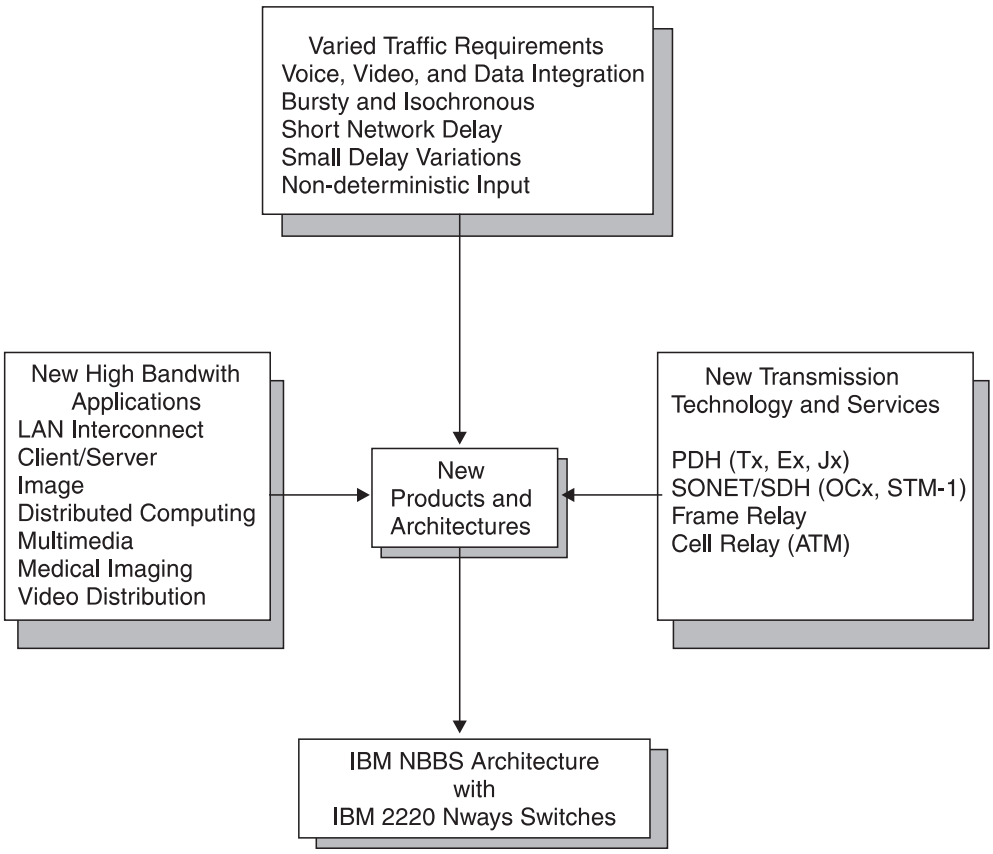

Figure 6. Driving Forces for New Products and Architectures

Chapter 2. IBM's Solution for High-Speed Broadband Networking

Today there is a tremendous interest in national and international information for data "superhighways" that can handle the traffic types described in "Chapter 1. Challenges Facing Present Infrastructures" on page 3. This means that we will soon make a major leap in the size, protocol availability, and speed (the bandwidth) of backbone and wide-area networks.

IBM can help you move into this future of high-speed bandwidth networks economically and at your own pace. Reflecting IBM's extensive experience in building large-scale networks, we are offering the *IBM 2220 Nways BroadBand Switch* family of networking products, which have a multiple-way switching capability. They are also referred to as the *Nways Switch* family.

2220 Nways Switches are designed to be the key elements of a wide-area network built on the *IBM Networking BroadBand Services* (NBBS) architecture. The IBM Nways Switch product line includes:

- IBM 2220 Nways BroadBand Switch based on a nonblocking cell switch with a throughput capacity of 3.7 Gbps. There are a variety of features described in later chapters to tailor the Nways Switch to your specific needs.
- IBM Nways BroadBand Switch Control Program (licensed program), which runs in the 2220s.
- IBM Nways 2220 Switch Manager for AIX (licensed program), which runs on AIX stations under NetView.

They offer you a new solution to the challenges of providing multiservices and broadband transport subnetworking as defined by the IBM Open Blueprint.

This chapter describes:

- Characteristics of the NBBS architecture that meet customer needs for a broadband network
- The relationship of the Nways Switches to the network
- How the 2220 network appears to end users.

How the IBM Nways Switch and NBBS Meet Customer Needs

The combination of the Nways Switches and the Networking BroadBand Services (NBBS) architecture offers you the following advantages:

- Easy migration from existing equipment and protocols
- Offering of value-added modes
- Support of multiple types of input equipment
- Consolidation of different types of traffic over the same network
- Guarantee of quality of service (QoS) levels for connections
- Continuous network operation with high availability provided by redundancy, and nondisruptive network growth
- Network management from single or multiple locations using the OSI Common Management Information Protocols and Common Management Information Services (CMIP/CMIS) protocols
- Bandwidth management using real-time or non-real-time processing

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- Online configuration changes
- Accounting information
- Network performance monitoring
- Security functions.

Each item is described in detail below.

Existing Systems and Nways Switch Mixing

Networks using Nways Switches under NBBS preserve the installed base of legacy systems. They connect to existing communication equipment and to high-bandwidth carrier services through standard port interfaces. This means that existing equipment and applications can all benefit from the greater bandwidth and configuration flexibility offered by 2220 Networks.

In fact, the design of the NBBS architecture is such that the external user devices need have no knowledge of the NBBS functions. They can communicate entirely in their native protocols.

Value-Added Modes

In the case of some protocols, such as HDLC, frame relay, and ATM, value-added modes are possible. There are functions provided by Nways Switches that are not available in the native protocols. For example, in the native frame-relay protocol the committed information rate (CIR) is generally fixed for each data link communication identifier (DLCI). NBBS frame relay provides a mode where the bandwidth for the DLCI is dynamically adjusted (within the user-specified QoS limits) to conform to the actual requirements. This provides better utilization of your network resources.

Support of Multiple Types of Input Equipment

In addition to legacy local area network (LAN) and wide area network (WAN) equipment, other types of input to an Nways Switch can be a private branch exchange (PBX), Integrated Digital Network Exchange (IDNX**), front-end processors (FEPs, like the IBM 3745/3746 Communication Controllers), and video coders/decoders (CODECs).

The 2220 network management is based on the OSI CMIP/CMIS, the emerging international standard for managing large networks. Also, the Nways Switch management facilities run on NetView for AIX platforms, which have Simple Network Management Protocol (SNMP) facilities. This means that the communication network management (CNM) for your 2220 network can also be used to manage other types of equipment at the same time.

Easy Network Migration

The Nways Switch products ease your network migration thanks to their:

- Support of existing and new equipment and interface links
- Modular and scalable hardware architecture allowing scalable-bandwidth networking
- Cellular switch design.

Consolidation of Different Traffic Types

Parallel wide area networks for different types of traffic are expensive. Using a WAN based on Nways Switches supports the integration of applications with different network requirements (voice, video, and data) onto a consolidated network that guarantees a QoS and also maximizes the link utilization.

The Nways Switch handles the following types of traffic:

- Circuit emulation service (CES) for video, fax, and synchronous data and private branch exchange attachment with pulsed coded modulation (PCM) voice
- High-level data link control (HDLC)
- Frame relay (FR)
- Asynchronous transfer mode (ATM)
- X.25 DCE
- Integrated services digital network (ISDN), optionally with Q signaling (QSIG).

Guarantee of QoS Levels

The Nways Switch guarantees a quality of service (QoS) by reserving the required bandwidth along the connection route. Also, every connection includes QoS parameters. Table 1 lists examples of QoS parameters.

Table 1. Some Quality of Service Parameters for a Connection

Parameter	Meaning
Traffic Delay	Type of traffic carried: real-time or non-real-time.
Packet Loss Ratio	Number of cells or packets lost in transmission divided by the total number transmitted.
Bandwidth Adjustment	Whether or not automatic bandwidth adjustment is performed.
Maximum Hops	Maximum number of hops (links) in a connection route.
Requesting Priority	Priority for the connection path setup.
Holding Priority	Priority for connection path preemption after connection setup.
Non-disruptive path switching	Whether or not nondisruptive path switching is performed.

High Availability of Network Resources

In a 2220 network, 2220 hardware and software components ensure continuous network operation.

Ensuring Network Availability

In order to ensure continuous data transmssion in a 2220 network, the Nways Switch Control Program and Nways 2220 Switch Manager provide non-disrupted network availability by means of the following functions:

- Path switching is used to recover from a path failure caused by link failure. If a backup path (for example, a trunk over ISDN) does not provide enough bandwidth for the additional traffic, an NBBS mechanism preempts bandwidth from lower priority connections and allocates it to higher priority connections. The lower priority connections are then either:

  - Rerouted to an alternate path (if available)
  - Stopped and resumed when enough bandwidth is available.
- Non-disruptive path switching (NDPS) provides automatic trunk backup for NBBS trunks that have parallel configurations. In case of trunk failure, the bandwidth of the parallel trunk is reduced to the amount configured for its initial value. This allows the path of each of the connections on the failed trunk to be switched over the parallel trunk.
- You can make online configuration changes to Nways Switches.

There is no single central network control-point that can fail and bring down the entire network. The network topology database, directory services, path selection, and congestion functions are distributed throughout the network in the control point adapters of each Nways Switch. This allows the network to survive a node failure with the minimum possible disruption.

Ensuring Node Availability

Redundancy improves Nways Switch availability:

- An optional feature duplicates the power modules.
- Redundant fans are basic on all Nways Switch models.
- The optional *redundant mode* feature duplicates the following key components and provides an automatic recovery in case of failure:
  - Cell switch module
  - Control point adapter module
  - Power module
  - Clock module (optional).
- For high-speed T3 trunk connections, you can attach the same physical link using a Y-cable to two different LICs and their associated trunk adapters. This provides a backup in case of LIC or trunk adapter failure.

You can perform the following operations online:

- Hot plug any module, adapter, or power supply
- Upgrade machine code and change some configuration parameters
- Perform line loopback and maintenance tests.

Graphic Management of Network Resources

A 2220 network is managed from a NetView for AIX workstation (called the *network management station*) using the Nways 2220 Switch Manager. This program consists of several applications that gather, consolidate, and manage data from up to 200 Nways Switches of medium size.

The Nways Switch Control Program in each 2220 notifies NetView for AIX of any addition, removal, or status change of key resources such as cell switches, adapters, or links. Using this information, NetView for AIX updates the network topology map, which consists of color-coded icons representing all the nodes in the network. This allows the network operator to quickly locate any resource in the network and take any necessary steps to diagnose and solve problems.

The Nways 2220 Switch Manager also allows you to customize the way in which individual resources contribute to the compound status of a node (reflected by the color of its icon).

Dynamic Bandwidth Allocation

The Nways Switch is based on the NBBS architecture and provides the necessary functions for a high-speed environment.

Non-disruptive path switching optimizes the use of trunk bandwidth and ensures network availability in case of trunk failure. The management of non-reserved frame relay and ATM traffic saves bandwidth by re-routing traffic when there is network congestion.

The processing of traffic by NBBS algorithms decreases the amount of bandwidth used by a 2220 network, compared to the bandwidth required by classical WANs (the peak rate), to transport the traffic across a network. This new, lower NBBS bit rate (the *equivalent capacity*) can result in a significant reduction in your bandwidth costs (see Figure 7). These functions optimize the bandwidth needed by a bursty connection by:

- ***Allocating an equivalent capacity***, which is the bandwidth required in the network to guarantee the QoS. This equivalent capacity lies between peak and mean rate, and is dynamically derived from active network measurements that are specific to the connection and the QoS.

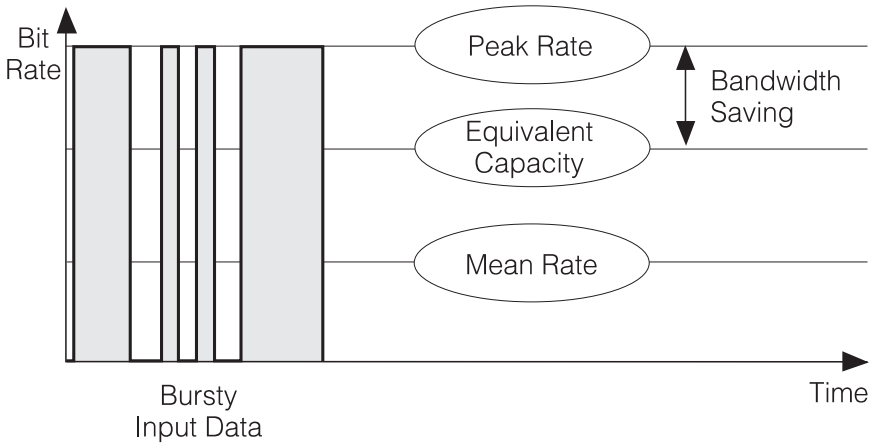

Figure 7. NBBS Equivalent Capacity Saves You Bandwidth and Money

- ***Changing the bandwidth allocation*** of a connection. As an option for frame relay and HDLC, the bandwidth allocated to the actual connection traffic can be dynamically adjusted (provided that it stays within the requested QoS).

Network Accounting and Traffic Load Information

The Nways Switch provides you with accounting and traffic-load analysis information in order to:

- Facilitate your day-to-day network load-balancing
- Predict traffic patterns
- Plan for new facilities
- Bill your customers.

At the user level, this information can account for each user's demands on the network (whether for billing or statistical purposes) and gives details on each user's QoS as well as their actual network usage.

At the network level this information helps you to minimize the network packet loss and transit delay. It helps to maximize the network throughput and availability. This information is available because the Nways Switch Control Program logs:

- Connection statistics, including the start and stop times, and QoS parameters
- Aggregate trunk statistics
- Network access and traffic statistics.

Performance records include the send and receive count of user data frames and user bytes, the count of conforming (to the QoS) and nonconforming packets sent, and the line interface event and error counters.

All of this data is logged into flat files [1], which are can be exported to a database management system.

Network Security

Access to the Nways Switch and its management applications is protected through passwords.

NBBS Network and Nways Switches

In an NBBS network, the Nways Switch provides the following functions:

1. Access services for attaching external devices via several different standard physical interfaces and protocols. The user premises connect to the Nways Switch via *port lines*.
2. Fast cell and packet switching for use as the backbone of your network via *trunk lines*.

Figure 8 on page 17 shows the relationship of the Nways Switch to the 2220 network.

1. A file that has no hierarchical structure. It is simply a linear collection of records.

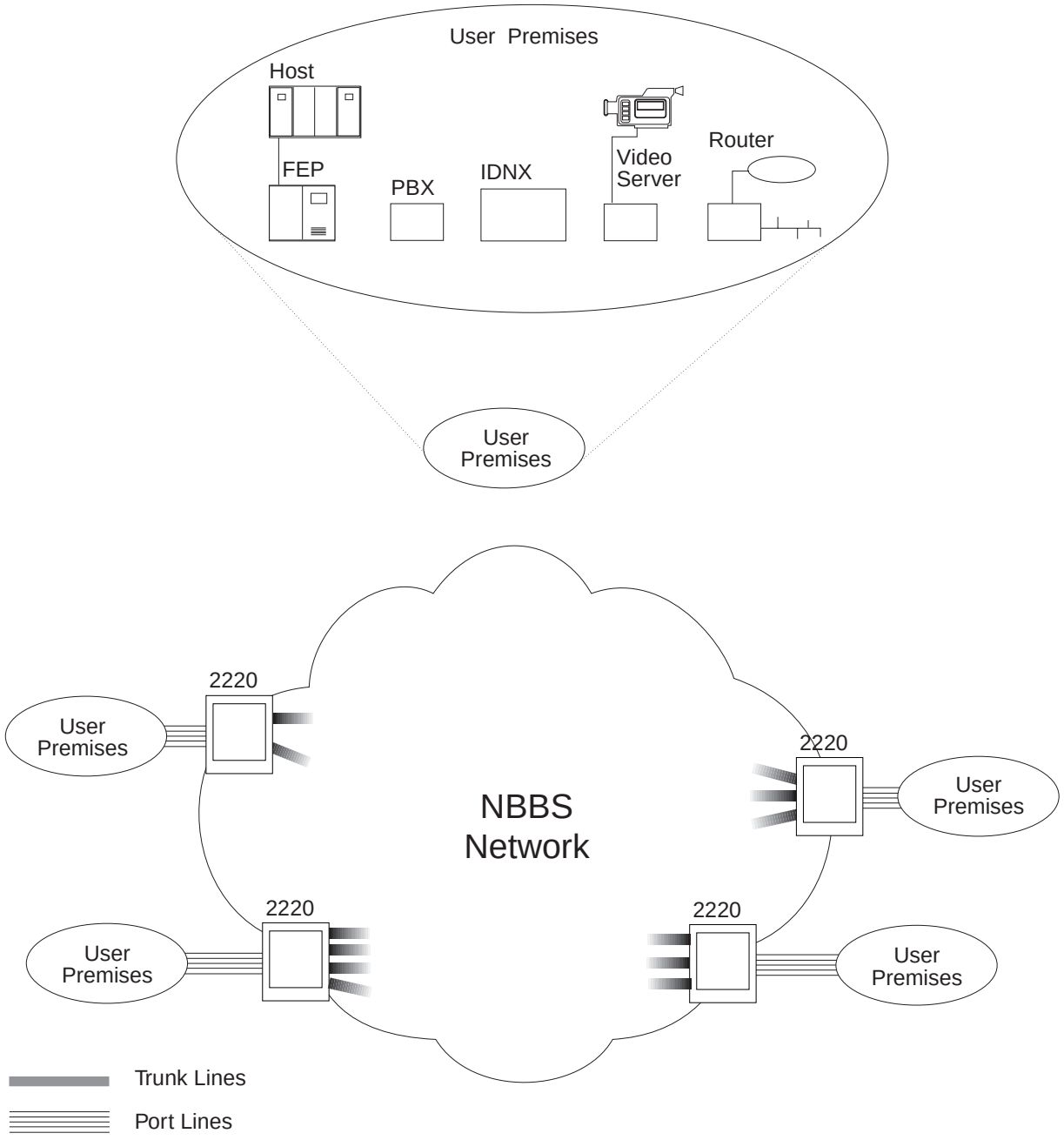

Figure 8. Relationship of the IBM Nways Switch to the 2220 network.

Once the traffic has entered the network, the data is transparently transported by the Nways Switches. From the end user's point of view, the network is virtually transparent.

Networks of Networks

The NBBS architecture offers interoperability with other networks. Although only one 2220 network is displayed in Figure 8, there can be several in the connection between the source and destination device. The interoperation of these networks is transparent for the communicating devices.

One of the transparent networks in the connection between two user devices may be a public ATM network as shown in Figure 9. Also, using the ATM Bearer Service, you can set up ATM VP trunks at any speed across an ATM service provider (transparent to end users) to interconnect 2220 nodes.

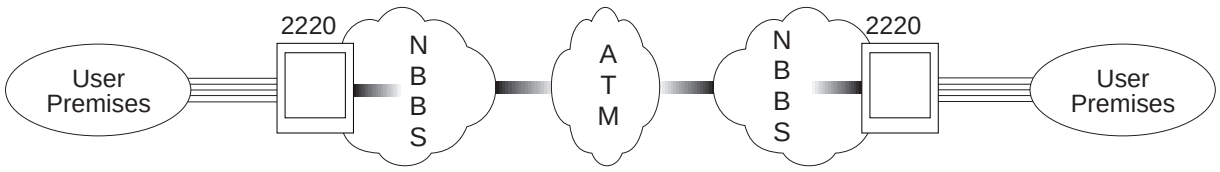

Figure 9. More than One Network between Users

Global traffic traversing oceans and continents could be switched in and out of both NBBS and ATM networks before traffic reaches its destination, all the networks being transparent to both source and destination of the traffic. This end user's view is explored in more details in "2220 Network Transparency" on page 22 later in this chapter.

Throughout this manual, the NBBS network is represented as shown in Figure 8 on page 17 . Note that the phrase *NBBS network* may represent not only a single network, but also a *network of networks* between two communicating devices.

The communication lines can be either port or trunk lines. Figure 8 on page 17 shows an example of a 2220 network with various types of equipment attached to the Nways Switches port lines, and Nways Switches interconnected by trunk lines.

Port Line

In a 2220 network, a port line connects an external user device to an Nways Switch. Thus it is a *port* to the NBBS network. Port lines can have different protocols and interfaces. They connect to devices such as routers, hubs, or private branch exchanges (PBXs) that concentrate the traffic from a large number of end-users.

On a port line, the traffic complies to the attached device protocol. For example, when a router attaches HDLC devices, the traffic is HDLC up to the Nways Switch. Then it is transformed into packets or cells before being transferred over trunk lines.

Trunk Line

In a 2220 network, a trunk line is a high-speed communication line that connects two Nways Switches. It can be copper cable, optical cable, or radio waves, and can be leased from telecommunication companies. The amount of bandwidth provided by the trunks is taken into account when the connections are activated.

Traffic Over Trunk Lines

Over a connection through a 2220 network, the source Nways Switch multiplexes the input traffic onto a trunk line connected to the next Nways Switch on the computed route. The traffic on the trunk line is made of ATM cells of fixed length and packets of variable length.

The maximum line bandwidth that can be used depends on the configured traffic rates, priorities, and qualities of service of each connection. Along the path, the data is routed by logical label swapping in each Nways Switch.

Traffic Delivery

On the destination Nways Switch, the traffic is delivered to the end-point devices (for example, a router or PBX) with the same protocol and in the same sequence as they were presented to the source Nways Switch. The end-point devices are in charge of distributing data to the end-users (host applications or PBX extensions).

Real-time traffic is delivered ahead of non-real-time and non-reserved traffic. The 2220 network does not check data integrity and does not recover lost data. This is the responsibility of the user's equipment at the connection end-points.

Line Adapters

The Nways Switch adapters come in various hardware types and provide multiple functions. They contain all the processing logic and are loaded with internal code of the Nways Switch Control Program.

Port adapters connect port lines to the Nways Switch. Trunk adapters connect trunk lines. Port and trunk adapters always have an associated line interface coupler (LIC) on which the physical lines are connected.

2220 Network Management

A 2220 network is managed on two levels:

- On the network level by the IBM Nways 2220 Switch Manager for AIX
- Locally on the 2220 switch level by the IBM Nways BroadBand Switch Control Program.

Figure 10 on page 20 shows the management facilities available.

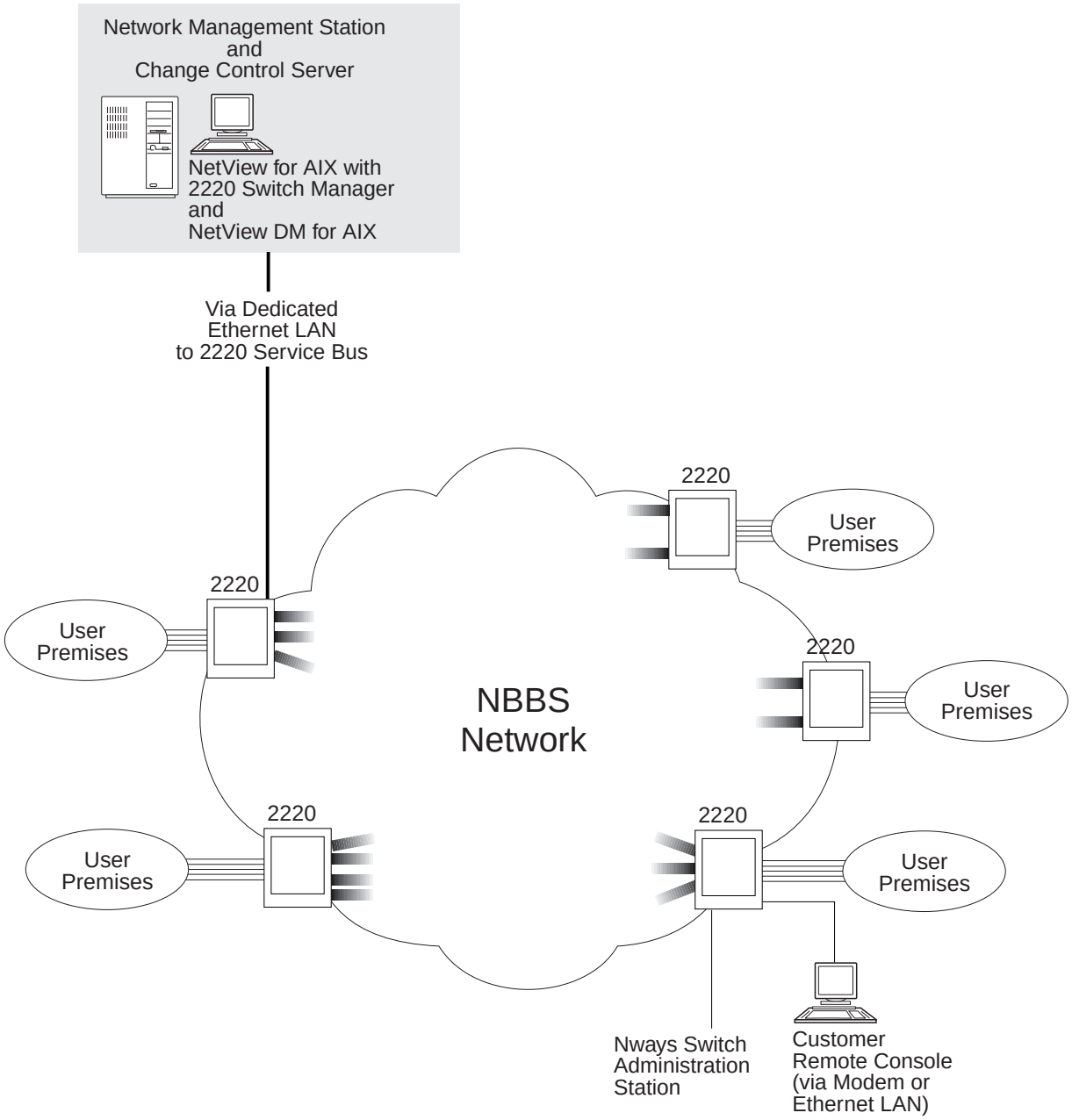

Figure 10. 2220 Network Management Facilities

Network Management: IBM Nways 2220 Switch Manager for AIX

2220 network-level management tasks are done using the *2220 Switch Manager* running in the network management station (a RISC System/6000 workstation). 2220 Switch Manager gathers, consolidates, and manages information from Nways Switches that make up a 2220 network.

2220 Switch Manager runs on one of the following platforms:

- Tivoli Management Environment (TME) 10 NetView for AIX Version 5
- Telecommunication Management Network (TMN) Version 2.2 with AIX 4.2

Router and Bridge Manager (RABM) and Alert Manager are not provided with 2220 Switch Manager as they were in the previous release of Nways Enterprise Manager.

The network management station can be used to manage several communication networks with different architectures. For more information about 2220 Switch Manager, refer to page 63.

Code Change Management: NetView Distribution Manager for AIX

The Nways Switch Control Program is updated using the *NetView DM/6000* licensed program running in a change control server (CCS, a RISC System/6000 workstation) which is attached to the network via the management access Nways Switch (see Figure 10 on page 20). The Nways 2220 Switch Manager cannot be updated from a change control server.

Node Management: IBM Nways BroadBand Switch Control Program

The *Nways Switch Control Program* operates and manages an Nways Switch using the NBBS architecture. It provides the access and transport services for the user protocols and helps ensure continuous Nways Switch and network availability.

The Nways Switch Control Program also includes the Nways Switch Configuration Tool Version 2 (NCT2) to perform Nways Switch configuration. For more information, refer to “Nways Switch Control Program and Node Management” on page 69 .

You can access node management functions of the Nways Switch Control Program in one of the following modes:

Locally
Through the *Nways Switch administration station* (NAS), a processor that is attached to the Nways Switch.

Remotely from the network management station
Through Nways 2220 Switch Manager using NetView menus and command line input.

Remotely from the change control server
Through NetView Distribution Manager for AIX using NVDM scripts.

Remotely from a user remote console
Through OS/2, TCP/IP, and the remote Nways Switch Resource Control application which is part of the Nways Switch Control Program.

Also, any NAS can remotely access any other Nways Switch in the same network.

RISC System/6000 Workstation

The same or separate RISC System/6000 workstations can be used as the network management station and change control server (see Figure 10 on page 20).

2220 Network Transparency

After presenting the challenges posed by emerging communication needs and technology, we looked at how IBM's solution consists of using the NBBS architecture and 2220 Nways Switches. This section presents how the 2220 network appears to end users and how 2220 services are accessed in a transparent way by two user devices that communicate over the network.

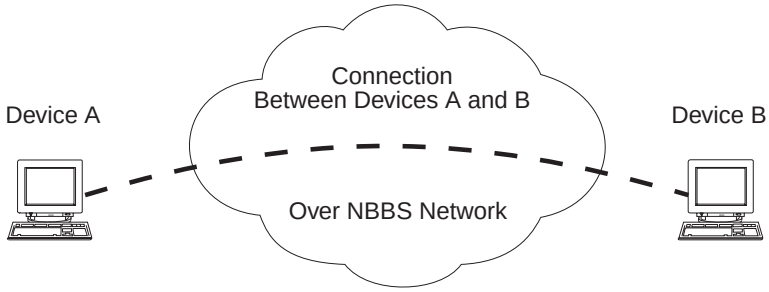

Figure 11. Two Devices Communicating Over the NBBS Network

NBBS Network and Permanent Virtual Circuits

This section describes how a 2220 network handles permanent virtual circuits (PVCs).

Permanent Virtual Circuit

A *permanent virtual circuit* (PVC) is a logical connection (also called circuit or channel) that is permanently established between two end-point devices. Such a circuit can be established, for example, between an ATM hub and an ATM router through an NBBS network. The virtual circuit is said to be permanent, because it remains activated even when there is no traffic.

The Nways Switch supports the following protocols in the PVC mode:

- High-level data link control (HDLC)
- Frame relay (FR)
- Circuit emulation service (CES)
- Asynchronous transfer mode (ATM).

Potential Connections

In order to allow two devices to communicate, you must establish a connection between them. Before establishing a connection, you must define it. At this stage, the connection is called a *potential connection*. When defining a potential connection, you are required to specify traffic characteristics and parameters. For example:

- Connection name
- Source device identification
- Target device identification
- Traffic characteristics and quality of service.

A potential connection is defined for one source and one target device. Therefore a same potential connection cannot be used for two different source-target pairs. For example, device A can potentially communicate with device B and device C. This means that two different potential connections must to be defined: one potential connection for communication between devices A and B, one for communication between devices A and C.

In order that the two devices actually communicate, the potential connection must be activated (see Figure 12). Only one potential connection can be activated at a time between two services.

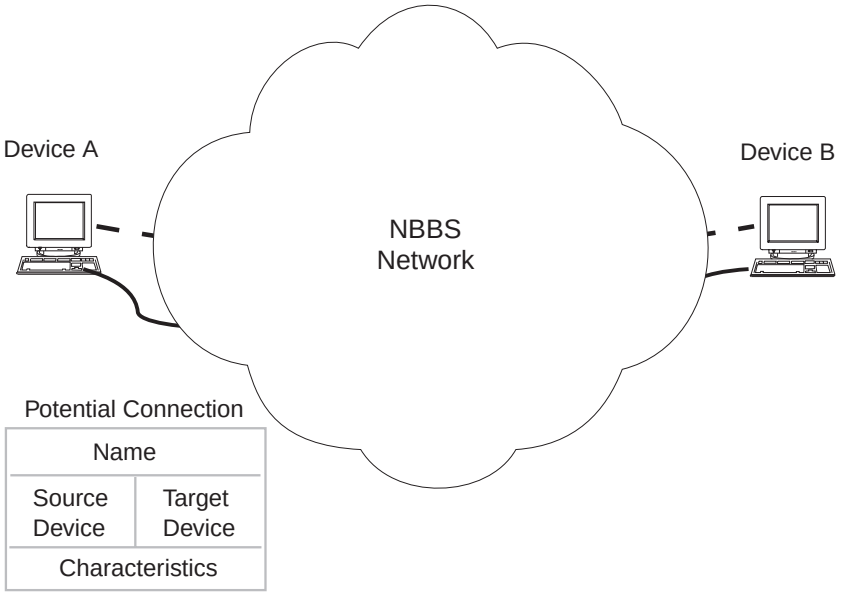

Figure 12. Connecting Two Devices Via a Potential Connection

From the user viewpoint, the kind of connection that actually exists at the time they communicate, does not really matter. More important is that there is an apparent direct path between them.

Initiating the Connections

Connections are initiated:

- Permanently when the connection is established during the Nways Switch Control Program initial loading into the Nways Switch
- At the network operator request
- Following a channel associated signaling (CAS) dynamic mode signal for voice calls.

Resources Required by Connections

As NBBS is a dynamic connection-oriented architecture, the resources needed to establish the connection are chosen across the network, defining the path used at that time. The connection activation process does not rely on any predefined path or routing, thus taking advantage of all the available resources.

The connection requirements and characteristics can be for example (but are not limited to):

- Required bandwidth and possible bandwidth adaptation
- Connection options (for example, bursty or not, burst size and duration)
- Transmission priority
- Type of traffic (real-time or not).

The only fixed parts of a connection are the hardware that connects both ends to their Nways Switch, as illustrated by Figure 13 on page 25:

- Device A and its cable
- Line attachment to which the device A is connected to its Nways Switch
- Device B and its cable
- Line attachment to which the device B is connected to its Nways Switch.

Depending on your network design and Nways Switches configuration, various levels of redundancy can be offered to the connections.

Multiple Connections for the Same Pair of Devices

In order to anticipate and quickly answer to the network need variations, you can define several potential connections for the same pair of devices, each tailored to specific network requirements. For example, from one connection to another, you can vary the bandwidth according to when during the day the connection is activated. Therefore, you can:

- Increase the bandwidth for a priority connection during day time peak periods to guarantee delivery of data traffic.
- Decrease the bandwidth of a non-priority connection when the devices have low traffic exchange, for example at night.

Logical Ports

When you configure your Nways Switches, you have to define a *logical port*, for example, for each:

- Physical line interface, such as OC3, T3, E3, and clear channel T1 or E1
- Channel on a TDM T1 or E1 line.

When you use the Nways Switch Configuration Tool Version 2, you name the 2220 logical ports as follows depending on their protocols:

- HDLC ports, FR ports, and CES ports
- ATM network interfaces, X.25 network interfaces, and ISDN network interfaces.

Figure 13 on page 25 shows how the user devices are associated with the logical resources through the logical port definition which includes the:

- Physical location of the line cable (rack, slot, and line position)
- Resource identification of the connected external device.

The next step after configuring the logical ports is creating potential connections for HDLC, FR, and CES traffic, and virtual connections for ATM traffic. Connection definitions mainly include the resource IDs of the source and target devices, and the traffic characteristics. No connections are configured for X.25 and ISDN traffic which is transported over switched virtual circuits.

Looking at Figure 13 again, you can see that the:

- Control Program in the source 2220 “knows” about device A through its port named XX and resource ID xxyyzz.
- Control Program in the target 2220 “knows” about device B through its port named AA and resource ID aabbcc.

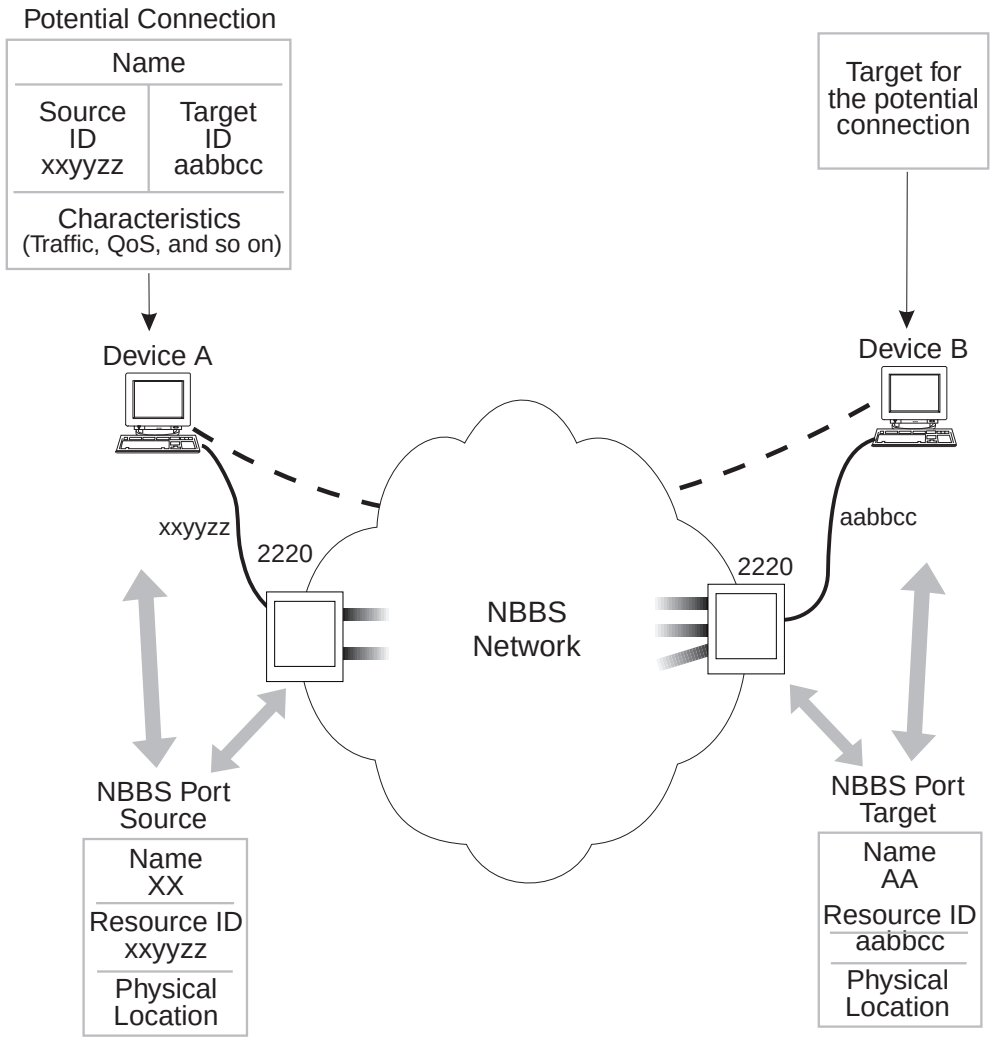

Figure 13. Physical Attachments and Logical Ports

Transparency in Operation

For an end user, to be told that new networking methods are coming often means that they may have to discard their present ways of working and learn a new set of technologies. The 2220 network solves this problem because it presents an *apparent* direct connection between user devices without any apparent intervening network.

Device A in Figure 13 sees only its connection to Device B. The data passing between the two devices could have been switched in and out of various intervening networks, perhaps over a common carrier ATM network, with protocols unknown to either device.

The two devices communicate with their native protocols without needing to handle network protocols, and the people using the two devices are virtually unaware of the intervening network between them.

You could change the physical location, the native protocols, the applications, the physical devices themselves at each end of the potential connection by reconfiguring only the logical resources on both end-points, without having to reconfigure the network. Similarly, characteristics of the network could be changed without any impact on end users' operations. As long as the potential connection remains the same between the two devices, you could make changes to either the network or the pairs of connected devices, without having to reconfigure the other. The 2220 network becomes a transparent network to its users.

NBBS Network and Switched Virtual Circuits

This section describes how a 2220 network handles switched virtual circuits (SVCs).

Switched Virtual Circuit

A *switched virtual circuit* (SVC) is a switched connection set up according to a call establishment protocol from a calling address to a called address. It is released when a clear request is received.

The Nways Switch supports the following protocols in SVC mode:

- X.25 DCE
- Integrated services digital network (ISDN).

Connections in SVC Mode

In the SVC mode, no logical connections are predefined with traffic parameters as in the PVC mode for the potential connections or ATM virtual connections. Instead, the traffic characteristics are defined at the network level at the same time as the addressing scheme.

When a switched virtual circuit is established, its traffic is bidirectional. A switched virtual circuit is not maintained permanently as a permanent virtual circuit is.

Customer Benefits

Using a switched voice protocol instead of a leased line protocol, such as common associated signaling (CAS), saves bandwidth when accessing a 2220 network, because it reduces the number of required port lines. ISDN tariffs also result in cost saving, compared to leased line costs which can be very expensive depending on the connection duration and the public network offering.

The capability to connect to ISDN equipment and build private voice networks with integrated facilities by using the Q signaling (QSIG), enhances your network options. QSIG provides the same switched connection benefits as ISDN.

Part 2. IBM Nways BroadBand Network

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In Part 2, we look at the features of the 2220 Nway Switch family and how the 2220 provides an integrated broadband network capability for both existing and emerging applications.

Chapter 3. How the Nways Switch Implements NBBS

The Nways Switch Control Program runs in the Nways Switch and implements the logical functions of the NBBS architecture:

1. Access services
2. Transport services
3. Network control
4. Node management.

Figure 14 shows some of the services of these functions.

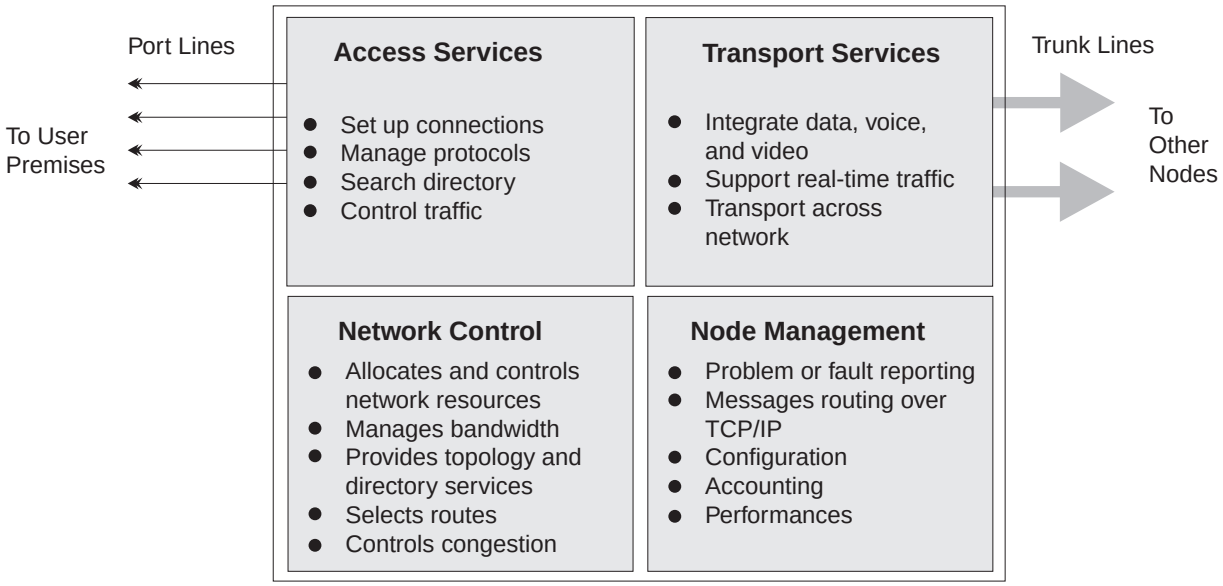

Figure 14. NBBS Functions Implemented in the IBM 2220 Nways BroadBand Switch

Access Services

In an Nways Switch, the *port adapters* provide the *access services*, which:

- Support the user protocols of the attached communication lines
- Set up the connection routes through the network
- Adapt the traffic for the transport services
- Control the input traffic rate (via source traffic policing and smoothing).

The access services provide an *access agent* for each type of user protocol (coming from the user premises) connected to a port. The access agent makes the entire NBBS appear as a subnetwork. No change is required to the attached devices, which are not aware of the underlying network. This makes the NBBS transparent to the user devices supported.

During a connection setup, the access services contact all the other Nways Switches in the NBBS network to find the optimum route for the connection and reserves the necessary bandwidth in each Nways Switch chosen for the route.

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There is an access agent at each end of the network connection, that is, in each end-point Nways Switch. The first access agent receives the user data, adapts it and sends it to the transport services. At the other end of the connection, the same type of access agent services, adapts, and sends it on to its destination device through an Nways Switch port.

Access Agents

The following types of access agents are supported by Nways Switches:

Circuit Emulation Service

Circuit emulation service (CES) traffic can be:

- PCM voice with connection to PBX
- Video
- Fax
- Synchronous data.

CES uses a real-time connection.

Pulse Code Emulation Voice

The pulse code modulation (PCM) protocol can be used to carry voice traffic encoded at 64 kbps across the network.

PCM voice traffic can be compressed. This includes both actual compression of the voice and silence removal. These services are provided by a voice server adapter and optionally its voice server extension.

In addition to the group special mobile (GSM) compression algorithm, the adaptive differential pulse code modulation (ADPCM) algorithm is available.

PCM voice traffic uses a real-time connection.

High-Level Data Link Control

The access agent for the high-level data link control (HDLC) protocol (and other similar protocols) removes the interframe idle characters to save network bandwidth.

HDLC uses non-real-time and real-time connections.

Frame Relay

The access agent for the permanent virtual circuit (PVC) frame-relay protocol removes the interframe idle characters to save network bandwidth. Both frame-relay data communication equipment (DCE) and data terminal equipment (DTE) connections are supported. This service:

- Complies with the ANSI T1.607/617/618 and ITU-T I.122 recommendations
- Is working in PVC mode
- Supports data link connection identifier (DLCI)
- Supports local management interface (LMI) flows.
- Allows frame relay DTEs to access 2220 frame relay ports over switched ISDN connections.

The Nways Switch supports non-real time and real time traffic over frame-relay connections.

Asynchronous Transfer Mode

Asynchronous transfer mode (ATM) ports provide an ATM cell relay service. This service:

- Complies with the ATM Forum UNI 3.0 and 3.1, and ITU-T B-ISDN recommendations
- Is working in PVC mode
- Provides virtual circuit (VC) and virtual path (VP) services
- Supports OAM (operation, administration, and maintenance) flows.
- Allows you to define several NBBS trunks for a 2220 ATM interface (ATM UNI and NNI) and map the trunks over ATM Virtual Paths (VPs).

This allows attachment of ATM devices such as hubs, routers, and stations. ATM uses a real-time or non-real-time connection depending on QoS.

X.25 DCE

The Nways Switch supports X.25 data circuit-terminating equipment (DCE) in switched virtual circuit (SVC) mode. Data terminal equipments (DTEs) can communicate with the same Nways Switch or another Nways Switch in the same X.25 network. DTEs are attached to the Nways Switch by leased lines.

Euro-ISDN DTE or DCE

The Nways Switch supports attachment to an integrated services digital network (ISDN) equipment through an ISDN primary rate access (30B+D) on an E1 port line. The Nways Switch can be a DTE or DCE.

The Nways Switch ISDN support has been extended to the INS-Net on a J1 port line (INS-Net being the ISDN service provided by NTT).

The Nways Switch also allows you to define backup trunks over a switched Euro-ISDN network. These trunks serve as backups in case of leased line failure and as additional trunks when more bandwidth is required.

QSIG on E1 and T1

The Q signaling (QSIG) method allows building private telephone networks with integrated facilities using primary rate access (30B+D) on E1. The Nways Switch is always a DCE.

QSIG on T1 is available with the Nways Switch Control Program V2R1.

For more detailed information about the supported protocols, refer to “Chapter 4. Protocols” on page 45.

Multiple Logical Ports

A physical port line can be split into several channels. The line is then channelized and the size of each channel can be different. One logical port is configured per channel. All these ports relate to the same physical port line attachment.

The following physical interfaces are supported with the multiple logical ports:

- E1 with LICs 515, 516, 545, 546, and 567
- T1/J1 with LICs 514 and 544

Transport Services

In an Nways Switch, the *trunk adapters* provide the *transport services,* which ensure the end-to-end data transport between two Nways Switch ports across the 2220 network. The transport services establish the network connections based on the information about the connections received from the access services.

The Nways Switch uses an optimized *packet transfer mode* (PTM) which is well adapted for the transport of voice or real-time application data requiring very short packets (as small as a few bytes). It allows also the transport of large size packets, thus reducing the required bandwidth thanks to the saving of packet header overhead. PTM is the native transfer mode of the NBBS architecture.

Benefits of this native mode are:

- Support of low-speed trunks, X.21 and V.35 interfaces at rate of 56 kbps to 2 Mbps, in addition to the support of high-speed trunks.
- Trunk bandwidth savings resulting from the variable-length packets over fixed cells (reduced herader overhead, no partly filed cell), and depending on the traffic distribution.
- Short end-to-end delay for voice, which is required for off-networks calls.
- ATM over existing trunks (in call/packet mixed mode).
- ATM trunks leased line.

  ATM trunks comply with the ATM Forum 3.0 and 3.1, and the ITU B-ISDN recommendations. They support the virtual path (VP) and virtual channel (VC) switching. ATM trunks support all types of NBBS traffic, not only ATM, on high bandwidth lines.

For a connection, four delay priority levels can be defined:

- Real-time 1 (constant bit rate (CBR) if ATM) for voice applications requiring very low delay and jitter.
- Real-time 2 (constant bit rate (CBR) or variable bit rate (VBR) real time if ATM) for applications supporting higher delay and jitter.
- Reserved (variable bit rate (VBR) non real-time if ATM) for data applications that are not sensitive to delay and jitter.
- Non-reserved for applications that do not require a reserved bandwidth.

The transport services support non-disruptive path switching. This allows a network connection to be automatically rerouted without loss of the connection if there is a trunk line or transit node failure. Same QoS and traffic characteristics are kept.

Multiple Logical Trunks

The multiple logical trunk (MLT) function offers the possibility to split one physical line interface into several logical (NBBS) trunks. (An ATM interface can be split into several logical trunks that are in turn mapped over an ATM service provider as ATM VP trunks.) The line interface must be channelized and the size of each logical trunk is a multiple of 64 kbps.

A trunk configured as an MLT works as a single NBBS trunk. Up to 32 different logical trunks can be defined per adapter. A trunk with the same configuration must be defined in the remote 2220 node.

The following physical interfaces are supported in MLT:

- E1 with LICs 515, 516, 545, and 546
- T1/J1 with LICs 514 and 544
- J2 with LIC 562 using selected speeds (192, 265, 512, 768, and 1536 kbps).
- ATM DS3/E3/STM1 (UNI or NNI) interfaces with ATM adapter Type 2 (ATMA2 FC 5451)

A low-speed adapter LSA3 is required for MLT support.

The MLT support results in several benefits:

- Possibility to benefit from the service offered by a carrier or a private network and based (as an example) on the use of time division multiplexing (TDM).
- Optimization of the physical-link bandwidth utilization, resulting in cost savings
- Possibility to connect to the J1 multi-access/sub-rate service in Japan.

ATM Bearer Service Trunks

The ATM Bearer Service allows you to split ATM interfaces (ATM UNI and NNI) into several logical trunks. The logical trunks are mapped over ATM virtual paths on an ATM service provider.

ATM interfaces DS3/E3/STM1 in trunk mode with ATM Type 2 adapters (FC 5451) are supported. You can define up to 32 logical trunks for each ATM adapter. For LICs with two interfaces (for example, LIC 551 with two DS3s and LIC 552 with two E3s), the 32 logical trunks are shared between the two interfaces.

Euro-ISDN Backup Trunks

The 2220 function for creating backup trunks over a Euro-ISDN network allows you to define Euro-ISDN trunks to:

- Back up other leased line trunks in case of failure
- Serve as temporary trunks that can be activated by the network operator when more bandwidth is needed

The 2220 function for creating Euro-ISDN backup trunks requires the attachment of LIC563 to an LSA3 adapter. LIC563 supports inverse multiplexing.

Non-Reserved Traffic

In a backbone network, trunk use is optimized when non-reserved traffic can be used to fill up the reserved bandwidth on lines whose bandwidth is not completely being used by current traffic.

In 2220 networks, non-reserved traffic is supported with the following restrictions and characteristics:

- It is possible to configure non-reserved connections for both frame-relay and ATM access services.

  Frame Relay non-reserved traffic uses a flow control mechanism that sets an F/R FECN bit when traffic congestion is found along a data path. The congestion threshold is handled globally in trunks and on a per-connection basis in frame relay ports.

  ATM non-reserved traffic supports the use of Explicit Forward Congestion Indication (EFCI) in ATM port and trunk adapters. Early Packet Discard (EPD) is supported on Virtual Circuit (VC) connections for ATM Bearer Service trunks and on ATM ports. EPD-like support is provided on Virtual Path (VP) connections. Also, to improve performance on ATM Bearer Service trunks, the cell buffering size has been increased to 16 000 cells.
- The data for non-reserved connections flow through the non-reserved trunk queues which, by default, are served on the lowest priority, as compared to

real-time and non-real-time queues. This ensures SNA-traffic priority over non-reserved IP traffic and guarantees its quality of service.

- Non-reserved traffic is supported using the unspecified bit rate (UBR). This means that no delay or loss probability can be specified.
- At configuration time, a fixed amount of bandwidth can be specified for non-reserved connections, if a minimal throughput is guaranteed. This amount cannot be used by reserved connections, and does not alter the priority order in the trunk queues.
- At configuration time, you can also define the maximum amount of traffic that can be transmitted over the network.
- No flow control is provided across the network. Therefore, packets can be lost or discarded.

The benefits of this function are:

- Optimized use of network resources and capabilities
- Handling non-reserved IP traffic while maintaining the quality of service for reserved SNA traffic.

Network Control

In an Nways Switch, the *control point adapter* provides the *network control* functions, which manage the 2220 network resources and allocate them to users. There must be at least one control point adapter in each Nways Switch. This adapter can be duplicated for availability reasons.

Each network resource is defined only once in its Nways Switch and the resulting network topology is distributed throughout the 2220 network to each Nways Switch. This means that adding or removing resources does not require re-IPLing Nways Switches for configuration changes. Also, the failure of an Nways Switch does not lead to the failure of the entire network. Local-only resource definitions and distributed control result in a high-availability network.

In addition, each Nways Switch is only responsible for routing a packet to the next Nways Switch. The processing time for each packet is, therefore, very short and is measured in nanoseconds. This allows the packet to be moved quickly to the next link of the connection.

Network control includes the following enhanced network functions:

- Topology services
- Fast distribution of control information
- Directory services
- Route computation and automatic network-load balancing
- Bandwidth management by contract
- Traffic policing.

Each is described in more detail below.

Topology Services

Each Nways Switch has a complete and identical view of the network topology because a topology database exists in each Nways Switch: it is built and updated automatically. This topology database contains essential information about:

- Configuration. This is the topological information about the network and includes:
  - All the links and Nways Switches
  - How they are connected
  - Their associated characteristics.
- Bandwidth reservation. This includes measurements of the currently reserved bandwidth for every link in the network.
- Link utilization. This is the latest information about each link and is used to choose the best path for connections.

When the graphical view of the network topology is refreshed with new information from agents, a message window opens to inform the network operator about how the network rediscovery is progressing.

Fast Distribution of Control Information

Given the mix of traffic, protocols, equipment, and applications using the networks, controlling each individual switch to play its part in the overall networking scenario is a high priority task. Any change in the operating characteristics of an Nways Switch, for example the availability of bandwidth, lines, or trunks, must be communicated to all other switches in the network. They must adjust their view of the network through the topology database, and change their use of the network immediately. There are powerful internal protocols within the Nways Switch to communicate control information both within the switch and to other switches in the network.

Directory Services

These services allow the dynamic location of remote resources. This reduces the number of network definitions because a given resource is defined only once and only locally.

Route Computation

The route between two ports in a 2220 network is dynamically allocated. Path selection chooses the best route optimally that satisfies the following criteria:

- Connection measurements
- Required quality of service (QoS)
- Preferred route
- Minimum number of hops
- Best balance of the traffic load in the network.

Automatic Network-Load Balancing

The route computation function allows the program to periodically re-compute the path for established connections in order to find a better path. If there is one, the connections are re-routed to this path.

This function ensures a faster and better utilization of the network resources after recovering from a network failure, and also results in the automatic network-load balancing.

Bandwidth Management by Contract

A key requirement for new multiservice platforms is to allocate a bandwidth to users close to their needs and avoid wasting resources. The Nways Switch:

- Guarantees an agreed QoS by reserving the required bandwidth along the connection route.
- Optimizes the bandwidth used by a connection by:
  - Allocating an equivalent capacity bandwidth
  - Optionally and dynamically adjusting the bandwidth to the actual current needs of the connection.

When the system accepts a request for a new connection, it provides a 'contract' which is a credit of network resources. This contract is guaranteed for the duration of the connection.

Re-Allocating Spare Bandwidth

When spare bandwidth is momentarily available, for example a voice, video, or image circuit is inactive, that spare bandwidth is allocated to other transmissions currently in progress. This maximizes utilization of network resources, while avoiding congestion at the same time.

Using Idle Time

On a typical HDLC connection for example, the traffic contains a large proportion of idle patterns that are transmitted between packets of valid data. The Nways Switch removes these idle patterns at the origin so they do not take valuable bandwidth resources from other traffic. Missing idle patterns are recreated at the destination. Neither source nor destination applications are aware that this has happened. The resources that would otherwise be wasted in transmitting idle patterns are released for other traffic.

Similarly, traffic such as voice contains a large amount of silence. Removal of silence, and its reconstruction at the destination, means that valuable bandwidth is not taken up with meaningless transmissions.

Non-Disruptive Path Switching

Explain what is NDPS and the Release 4.3 improvement. Also add index entry because NDPS was not documented so far.

Rate-Based Congestion Control

Increased bit rates require very rapid low-level switching. To meet voice and video real-time needs, transit Nways Switches must process and forward information so quickly that there is not enough time left for hop-by-hop flow control or error recovery. These functions must be moved to the edge of the network (the access points). This is possible because of today's very low network bit-error rates.

On the other hand, for non-real-time traffic that must be 100 percent correct, error recovery is performed by user applications at the final connection end-points (outside the network).

For bursty data, the Nways Switch replaces traditional window-based flow control mechanisms with adaptive rate control and congestion control mechanisms. They

allow the network to dynamically adjust the bandwidth used if the needs of a connection change and to guarantee a specified QoS to the user.

Rate-based congestion control is based on three steps:

Bandwidth reservation

Access control (traffic policing)

Transit Nways Switch congestion control

Traffic shaping.

Bandwidth Reservation

For each new connection, a given amount of network bandwidth is reserved on each link of the route. The new connection is only allowed to use the link if enough bandwidth can be reserved on it.

The network reserves the bandwidth capacity according to the user-specified and predefined:

- Source characteristics (peak and average rates of utilization and burstiness)
- QoS parameters (such as cell loss and network delay).

Traffic Policing

To protect the network (and other users) from any excess bandwidth that a newly accepted connection might try to use, control is applied in the access Nways Switch. The access agent marks any traffic over the connection's assigned bandwidth for possible discard. The excess packets can be discarded in any one of the transit Nways Switches along the connection route if there is no bandwidth available to send these packets on.

The traffic can be monitored to automatically adjust the bandwidth reservation of the connection as its traffic characteristics change over a period of a few minutes.

Transit Nways Switch Congestion Control

As long as the user input does not exceed its negotiated source characteristics (which is part of the connection definition) multiplexing of its traffic through the network is guaranteed to meet the connection QoS.

Incoming data on a trunk line that is in excess for the connection QoS (the packets marked as excess in the access node control step) can be discarded without notice if there is no extra bandwidth available. This might be necessary to guarantee the QoS of other connections sharing the same link and to prevent overloading of the network.

Traffic Shaping

The Nways Switch provides a shaping function to the ATM traffic at the 2220 network exit. The shaping can be performed at virtual circuit level, virtual path level, or group level.

Node Management

In an Nways Switch, the Nways Switch administration station (NAS) supports the local *node management* functions. The NAS:

- Stores the Nways Switch Control Program
- Conducts node initialization
- Controls node operation
- Collects node alarms and reports them to the network management station
- Collects accounting and performance data
- Handles the Nways Switch configuration
- Controls and services the local resources.

In a 2220 network, NASs, management stations, and user remote consoles are assigned IP addresses that are used to route the network control messages. For IP addressing details, see “IP Network Addressing” on page 67. Node management is explained in details in “Nways Switch Control Program and Node Management” on page 69 .

Dual Code-Level Management

Starting with Nways Switch Control Program V2R1 (shipped with a more powerful NAS hardware), two levels of the Control Program can be managed on the NASs. Also, the time required for installing a new version of the program has been significantly reduced.

If you have a problem running a new version of the Nways Switch Control Program, you can easily reload the previous version that you were using. Dual code-level management improves and eases the migration to new versions of the Nways Switch Control Program. For further information about new NAS hardware, see “Hardware Evolution” on page 96.

You can manage two levels of code for the Nways Switch Control Program in the following ways:

- Locally from a NAS
- Remotely from the network management station using 2220 Switch Manager
- From the change control server using NetView DM/6000 (NVDM).

Internal Organization of the Nways Switch

Figure 15 on page 41 is an illustration of the Nways Switch from a logical-unit point of view showing the importance of the switch module. It is the heart of the Nways Switch, it interconnects all the modules and adapters.

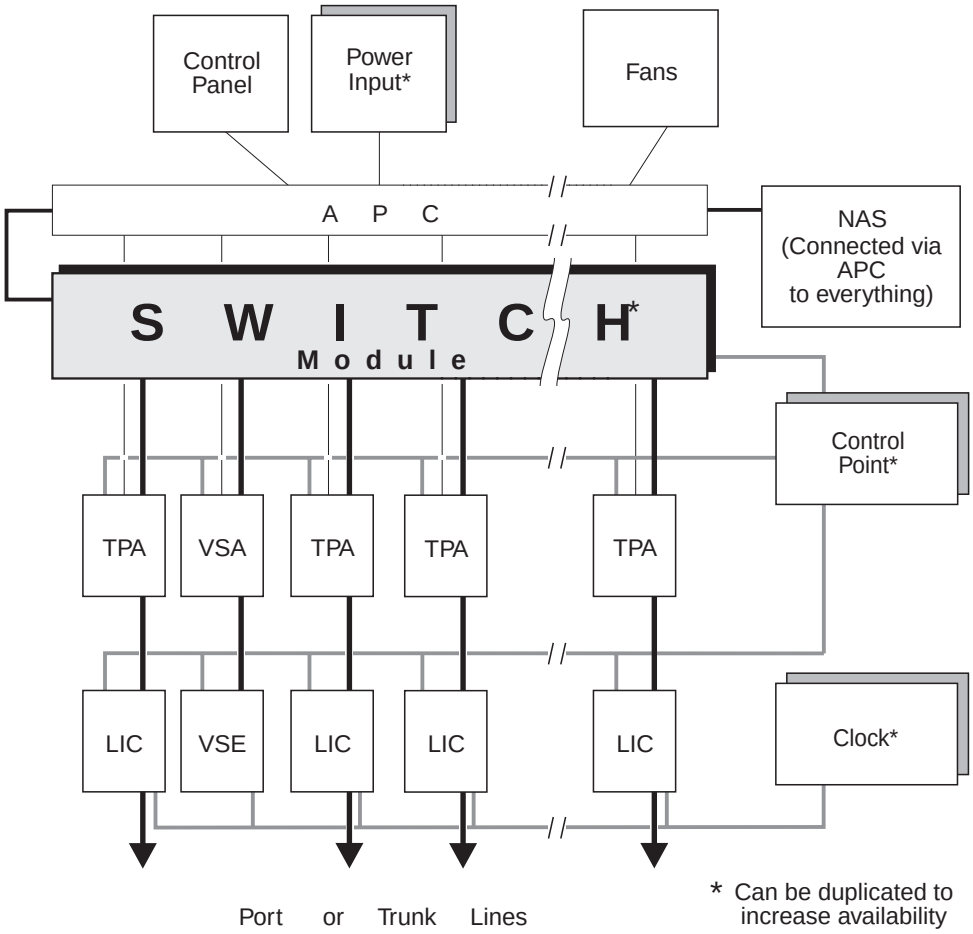

Figure 15. Nways Switch Internal Organization

Legend:

TPA Trunk or port adapter

APC Alarm and power control

LIC Line interface coupler

NAS Nways Switch administration station

VSA Voice server adapter

VSE Voice server extension

Nways Switch Modules

The Nways Switch contains several types of hardware features and modules to perform the NBBS functions:

Adapter Modules

The adapters can be housed in the following modules:

- Low-speed adapter (LSA) supporting speeds from 2400 bps to 8 × 2.048 Mbps.
- High-speed adapter (HSA) supporting speeds up to 51.84 Mbps

- ATM adapter (ATMA) supporting speeds up to 155.52 Mbps
- Voice server adapter (VSA) providing advanced voice functions (voice compression, silence removal, echo-canceling, and touch-tone forwarding).

When loaded with the appropriate microcode from Nways Switch Control Program, they become one of the following:

Port adapter
: Provides the NBBS access service functions. It attaches user devices to the Nways Switch.

Trunk adapter
: Provides the NBBS transport service functions. It interconnects the Nways Switches through trunk lines. The trunk function can be performed concurrently with the control point function.

Control point adapter
: Provides the NBBS network control functions, such as path selection and network topology updates. The control point functions can be performed concurrently with the trunk function. Duplication of the control point prevents the loss of the network management of the Nways Switch in case of a control point failure.

Line Interface Coupler (LIC) Modules

Provide the line attachments and physical interfaces for the port and trunk adapters.

Voice Server Extension (VSE) Modules

Increase the number of voice channels supported by the voice server adapters.

Cell Switch Module

Distributes the user traffic to and from all the adapters by switching data cells (that contain this traffic) between the adapter attachments to the switch module. Data cell switching is very fast (cell processing time is measured in nanoseconds).

The switch is non-blocking and self-routing. Duplication of the switch prevents the loss of the Nways Switch in case of a switch module failure.

Clock Module

Controls the external and internal timing sources used to synchronize the Nways Switch with the rest of the network.

This module is optional and has a Stratum 3 accuracy and stability when used as an internal timing source. It can be duplicated to prevent loss of network synchronization in case of a clock failure.

Includes a tailgate to connect an external oscillator with a Stratum 1 or 2 accuracy.

Alarm and Power Control Module

The alarm and power control (APC) module:

- Controls the power input circuits and fans
- Operates the control panel
- Checks for adapter presence and, if necessary, resets them

- Switches from the active to the backup switch module, if necessary
- Reports alarms
- Connects the Nways Switch administration station.

Nways Switch Administration Station

The Nways Switch administration station (NAS) is a processor mounted in the 2220-300 and 2220-500 rack which supports the node management functions. For more information about the:

- NAS functions, refer to “NAS Functions” on page 70
- NAS hardware, refer to “Nways Switch Administration Station” on page 95.

Network Synchronization

Network synchronization is performed via the clock modules. The clock module of an Nways Switch receiving an accurate (usually Stratum 1B level) clock signal synchronizes its own oscillator on this signal, and propagates it through selected lines. The receiving Nways Switches use this signal to synchronize their own clock oscillator.

The clock module is optional depending on your needs. For example, it is required for synchronization of:

1. Circuit emulation services (CES) devices that need an accurate network clock, such as a private branch exchange (PBX), a hub, or an isochronous device like a time division multiplexer.
2. Nways Switches that are part of the network synchronization plan.

A clock module is not needed for:

1. HDLC and frame-relay protocols
2. CES devices that receive an accurate reference clock from outside the 2220 network.

The clock module operates at Stratum 3 accuracy when in free-running mode. It can be stabilized by an external reference clock of higher accuracy, for example a Stratum 1. It can connect to an external oscillator with a Stratum 1 or 2 accuracy.

Nways Switch Clocking Strategy

A 2220 network can be a synchronized network: one Nways Switch is connected to, and stabilized by, an external reference (Stratum 1) clock, and propagates this reference clock accuracy through its trunk lines to adjacent Nways Switches. In the same manner, each adjacent Nways Switch sends the reference on to others. This propagation continues until all Nways Switches in the network that need to be synchronized receive the reference clock.

This is called the network synchronization plan. It must follow some rules such as the maximum number of intermediate stages between a given Nways Switch and the origin of the clock. Refer to the *2220 Nways BroadBand Switch Planning Guide*, GA33-0293 for details on the synchronization plan.

The network can be either synchronized from a unique reference clock, or organized in plesiochronous islands, each of them being synchronized from a different source. This is generally the case in international networks.

Clock Reference Lines

Up to four different clock references can be defined for an Nways Switch through LICs connected to lines providing or propagating a reference clock. The reference clock is automatically switched to a secondary source if the primary reference fails.

Chapter 4. Protocols

This chapter describes the types of protocols that are supported in the Nways Switch:

- Circuit emulation service (CES) with pulse-coded modulation voice (PCM)
- High-level data link control (HDLC)
- Frame relay in permanent virtual circuit (PVC) mode
- Asynchronous transfer mode (ATM)
- X.25 data circuit-terminating equipment (DCE)
- Integrated services digital network (ISDN) with, optionally, Q signaling (QSIG).

There is an access agent (which is part of the port access services) for each protocol. “2220 Network Transparency” on page 22 showed that users are not aware of any intervening network or networks. As an example, an organization could have a network mix of HDLC, frame relay, X.25, and be upgrading to ATM. Individual users connected through, for example, X.25 networks are not aware that they share a network with HDLC, frame relay, and ATM users.

To know what line interface couplers (LICs) are available for each protocol, refer to Table 10 on page 92

Circuit Emulation Service

The circuit emulation service (CES) protocol carries information over channels that have an isochronous traffic (constant input and output). This traffic can be PCM voice, video, fax, or synchronous data such as binary synchronous communication (BSC), airlines line control/serial link architecture (ALC/SLA), and others.

Structured data transfer (SDT) is supported: this transfer mode helps to ensure channel integrity.

CES uses real time connections and supports the line interfaces shown in “Chapter 8. Physical Line Attachment (Layer 1) Specifications” on page 105.

For more detailed information refer to the *2220 Nways BroadBand Switch CES Interface Specifications*, GA33-0376.

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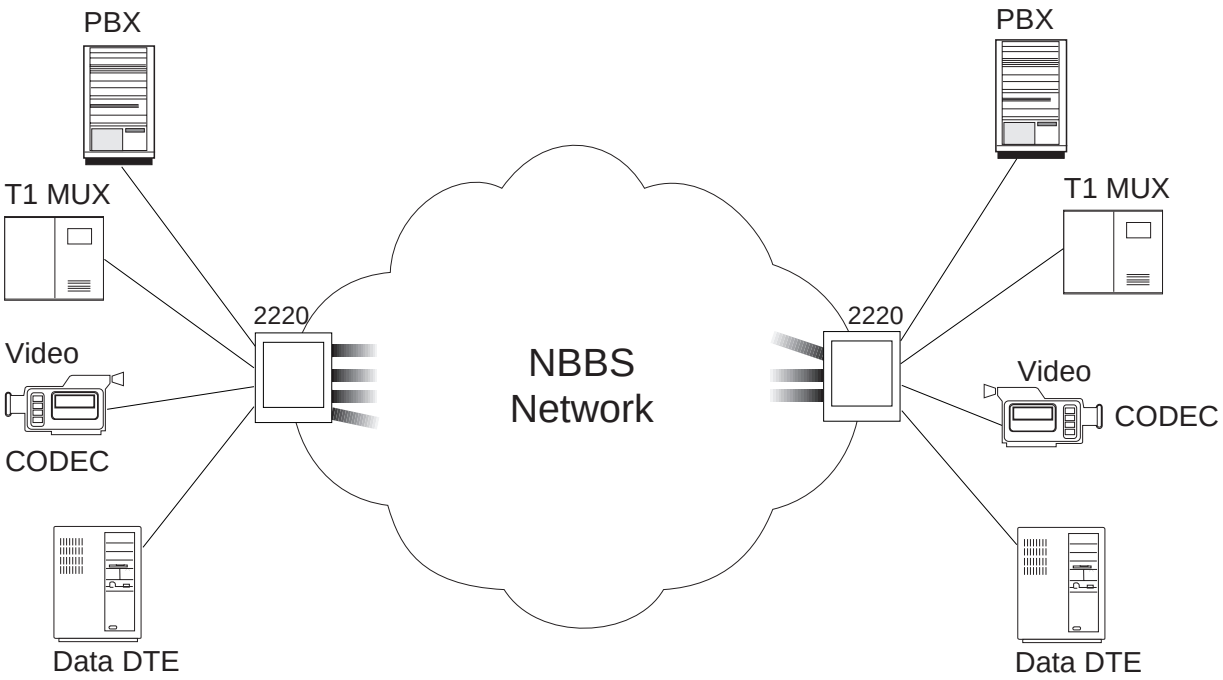

Figure 16. CES Connection

PBX Signaling Modes

Pulse code modulation (PCM) voice traffic, encoded at 64 kbps, can provide enhanced voice services with the voice server adapter (VSA) feature.

Private branch exchange (PBX) voice information is carried in three signaling modes:

- Transparent mode
- Channel associated signaling (CAS) permanent mode
- Channel associated signaling (CAS) dynamic mode.

Transparent Mode

In PCM transparent mode, a channel transparently transports the traffic (both voice and signaling) over a full or fractional T1/E1 line. In particular, this mode can be used to support a PBX using *common channel signaling* (CCS), like that used in ISDN.

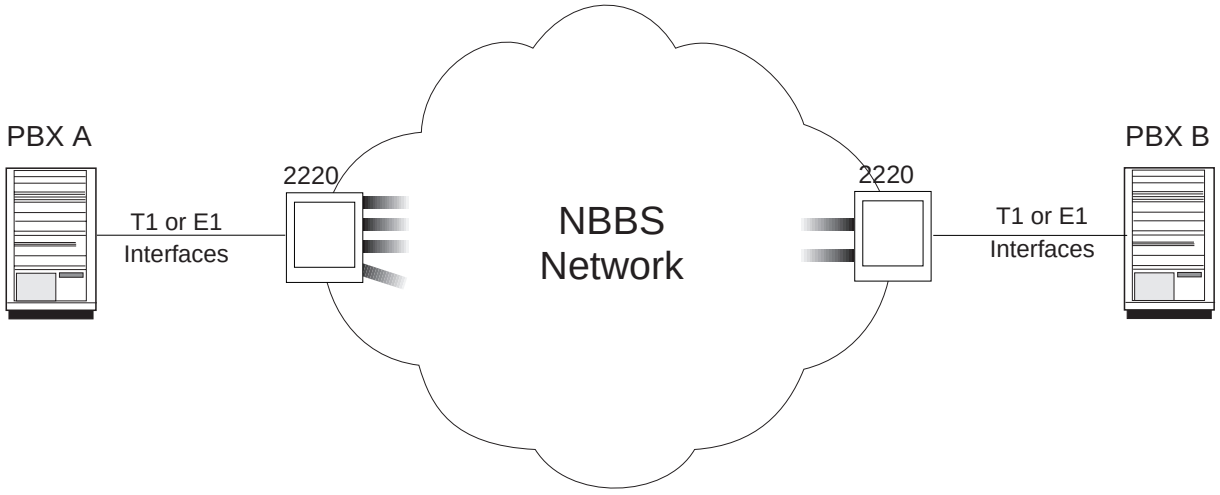

Figure 17. Transparent CCS Voice Connection

Channel Associated Signaling Permanent Mode

In this mode, voice traffic is transported over permanent connections between T1/E1 source and destination channels; the bandwidth is allocated permanently, whether or not a voice call is actually transported. A local PBX can communicate with multiple remote PBXs.

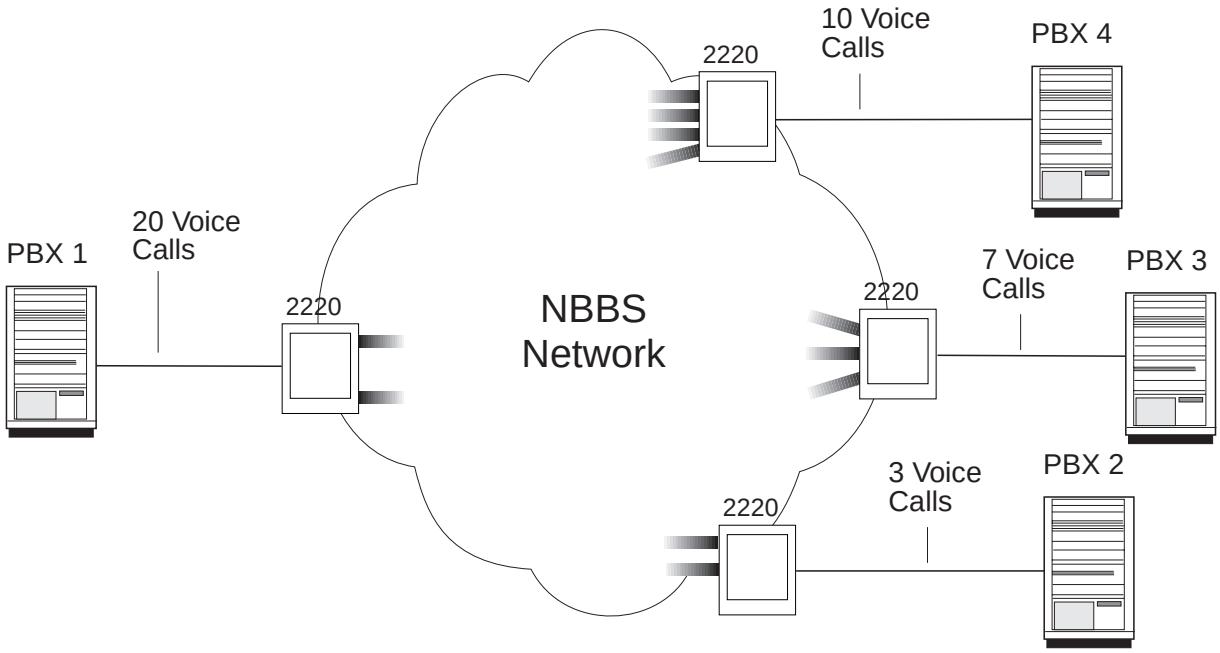

Figure 18. Permanent CAS Voice Connection

Channel Associated Signaling Dynamic Mode

This mode is the same as the CAS permanent mode except that the PBX CAS traffic is monitored to allocate and release channel bandwidth when a call starts or

stops. CAS dynamic mode support is available if approved in your country. In the dynamic mode, the continuous signaling earth and mark (E&M) wink start is supported.

In the U.S.A. the T1 PBX interface is supported and in Europe, E1 is supported. Also, the Nways Switch provides a low-delay transport mode that allows off-networking of calls. Analog PBXs are supported via an external channel bank.

Voice Server Functions

A voice server adapter (VSA), possibly with an associated voice server extension VSE), provides the following functions to CES voice connections operating in PCM at 64 kbps.

- Voice compression
- Fax demodulation
- Compression law conversion
- Echo cancellation
- Silence removal
- Idle signal removal.

Voice Compression

Voice compression is performed by a VSA or VSE using one of the following algorithms:

- Group special mobile (GSM): A 64 kbps connection is reduced so that only 12.8 kbps carries the same capacity. On the remote Nways Switch, a VSA or VSE decompresses the voice.
- Adaptive differential pulse code modulation (ADPCM): The 64 kbps bandwidth is reduced to 32 kbps. With this type of compression, up to six successive encoding and decoding processes are accepted with no voice quality degradation.

GSM and ADPCM compression modes are supported on the same Nways Switch, but not on the same voice server adapter. One type of voice compression mode is assigned per VSA or VSE.

Voice compression is selected when configuring CES potential connections.

Fax Demodulation

GSM voice compression is turned off when a fax is detected on the connection. To save bandwidth, the fax signal is demodulated and transported at 12.8 kbps. In ADCPM, faxes are transported as compressed voice.

Compression Law Conversion

A-law and M-law are compression laws used for PCM voice. A-law is used in Europe. M-law is used in the USA. Conversion is done by a VSA or VSE when the compression law used is different at both ends of a CES voice connection.

Compression law conversion is specified when configuring the Nways Switches. One of the compression laws must be selected for each Nways Switch of the network. To activate compression law conversion, another voice function (such as voice compression) must be specified when configuring CES potential connections.

Compression law conversion is independent of the selected voice compression mode (GSM or ADPCM).

Echo Cancellation

Because a VSA or VSE induces a propagation delay, voice connections using analog to digital converters need echo cancellation when they pass through a VSA or VSE. For pure digital transmission, echo cancellation is not required.

Echo cancellation can be done by an external echo canceller, or by a VSA or VSE:

- External echo cancellation is specified when configuring E1, T1, or J1 port line attachments and requires no VSA or VSE.
- Internal echo cancellation by a VSA or VSE is specified when configuring CES potential connections and requires one voice slot of a VSA or VSE.

Echo cancellation applies to both the GSM and ADPCM-compressed voice data.

Silence Removal

On voice connections, silence removal can be performed by a VSA or VSE. A 64 kbps channel is then reduced so that only 32 kbps carries the equivalent capacity. If silence removal is used with voice compression, the equivalent capacity is further reduced to 10 kbps. On the remote Nways Switch, a VSA or VSE regenerates silences.

Silence removal is specified when configuring CES potential connections and applies to both the GSM and ADPCM-compressed voice.

Idle Signal Removal

To free a maximum bandwidth, idle signal removal is performed each time a CES voice connection passes through a VSA or VSE. When an Nways Switch receives the same idle character from a PBX during more that 60 ms, it stops packet transmission and forwards this idle pattern to the Nways Switch on the remote end of the connection. On the remote Nways Switch, a VSA or VSE regenerates the idle characters.

Note: There is no need to define the idle character to play back, since the NBBS transfers the appropriate pattern from one side of the network to the other side each time the function is activated.

The saved trunk bandwidth is available for non-reserved traffic. This process also decreases the transmission delay and the bit error rate for non-real time traffic and NBBS control information. The process is transparent to the PBX protocol and particularly efficient in common channel signaling (CCS) where potential connections are permanently set up.

To activate idle signal removal, another voice function (such as echo cancellation, voice compression, or silence removal) must be specified when configuring CES potential connections.

Idle signal removal is automatically performed on GSM and ADPCM-compressed voice data.

High-Level Data Link Control

Valid HDLC and HDLC-like (such as the SDLC, LAPD, and IBM LAPE) protocol frames are transported between Nways Switch ports. The frames are transmitted end-to-end without modification.

Included in the data is the frame cyclic redundancy check (CRC), but the HDLC access agent removes the X'7E' flags and stuffed zero-bits. This removes the idle periods and can save bandwidth usage if the bandwidth adaptation function is active. This function can vary the amount of actual bandwidth used (always remaining at or under the assigned bandwidth) according to the short-term needs of the connection. Data field sizes are between 5 bytes and 8 KB.

The Nways Switch supports HDLC in non-real-time and real-time over permanent virtual circuits. It also provides a non-reserved logical queue for applications that do not require delay and bandwidth guarantee, only best-effort delivery. The supported HDLC line interfaces are shown in "Chapter 8. Physical Line Attachment (Layer 1) Specifications" on page 105.

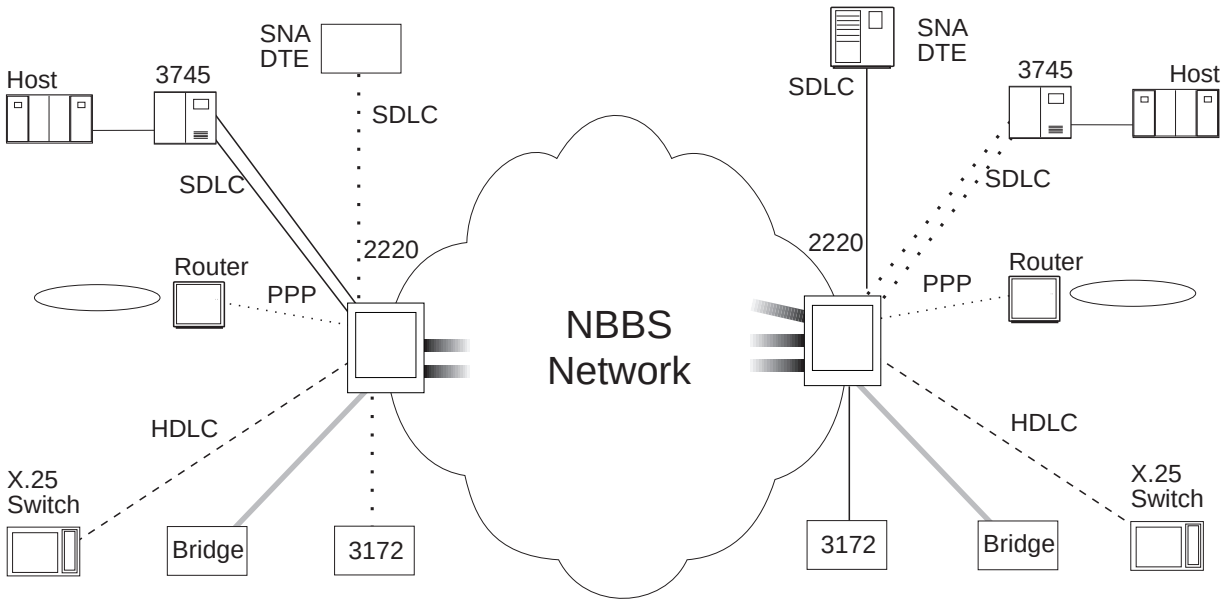

Figure 19. HDLC Connection

For more detailed information refer to the *2220 Nways BroadBand Switch HDLC Interface Specifications*, GA33-0375.

Frame Relay

The ITU-T I.122 permanent virtual circuit (PVC) frame-relay protocol is supported. The Nways Switch can act as either a DCE (frame-relay frame handler: FRFH) or a DTE (frame-relay terminal equipment: FRTE).

Included in the data is the CRC frame, but the frame-relay access agent removes the X'7E' flags and stuffed zero-bits. This removes the idle periods and can save bandwidth usage if the optional Nways Switch dynamic bandwidth adaptation

function is active. This function can vary the amount of actual bandwidth used (the bandwidth never exceeds the assigned bandwidth but may drop below that value or remains always at or under the assigned bandwidth) according to the short-term needs of the connection.

The Nways Switch provides the line interfaces shown in “Chapter 8. Physical Line Attachment (Layer 1) Specifications” on page 105. It supports both non-real-time and real-time traffic over low-speed frame-relay connections.

The frame-relay access agent also handles the data link connection identifier (DLCI) and does DLCI swapping.

Frame-relay DCE and DTE connections have the following additional characteristics (also see Figure 20):

- Support of the user-to-network interface (UNI) and the network-to-network interface (NNI)

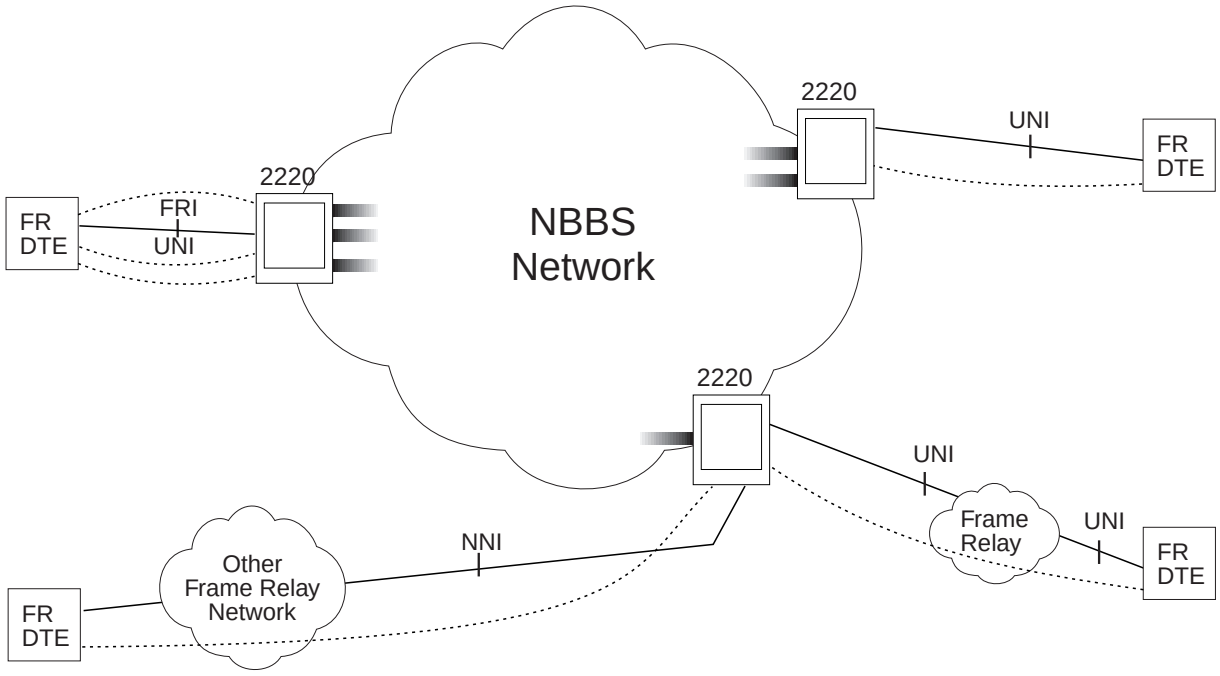

Figure 20. Frame Relay Connection

- Support of the local management interface (LMI). The Nways Switch ports are also able to connect to frame-relay DTEs that do not support LMI.
- Two modes of traffic management:
  1. Standard mode using the frame-relay parameters CIR, Bc, Be and a fixed bandwidth allocation
  2. Enhanced mode using NBBS QoS parameters and bandwidth adaptation.

Figure 20 is an example of a frame-relay connection. For more detailed information refer to the *2220 Nways BroadBand Switch Frame Relay Interface Specifications*, GA33-0374.

Real-Time Traffic

The compressed voice generated by frame-relay access devices (FRADs) is transported in real-time with a low transport delay. Real-time connections are configured with a quality of service (QoS) that provides real-time class 2 (RT2) and a maximum 200 ms end-to-end delay.

Frame-relay real-time traffic is only guaranteed on low-speed ports. On high-speed ports, the actual end-to-end delay may be greater than the specified one because, for the high-speed ports, the real-time traffic does not have priority over the non-real-time traffic.

Non-Reserved Traffic

For frame-relay access services, NBBS connections can be configured as non-reserved. The data flow for such connections goes through the trunk non-reserved queues, which are served with the lowest priority versus real-time and non-real-time queues.

Refer to “Non-Reserved Traffic” on page 35 for more information about non-reserved traffic support.

Voice Traffic in Frame Relay

Compressed voice is transported in RT2 (compression delay). Not compressed voice is transported in RT1.

Frame Relay over ISDN

The Frame Relay over ISDN function allows frame relay Data Terminal Equipment (DTE) to access 2220 frame relay ports through dial-up ISDN connections in addition to accessing the 2220 network through direct attachments and leased lines. Frame Relay over ISDN allows you to:

- Reduce costs when remotely accessing the 2220 frame relay network for a few hours each day with limited traffic from several business locations. End-to-end digital connections at 64 Kbps with a low error rate are provided at approximately the cost of a telephone call.
- Reduce costs in backing up leased lines between an Nways Switch and frame relay DTE over ISDN. You pay for the backup ISDN connection only for the time of the leased line failure.
- Handle frame relay overflows on leased lines by dialing up the Nways Switch over ISDN to set up additional frame relay PVCs. The establishment and release of the switched ISDN connection is controlled by the frame relay DTE.

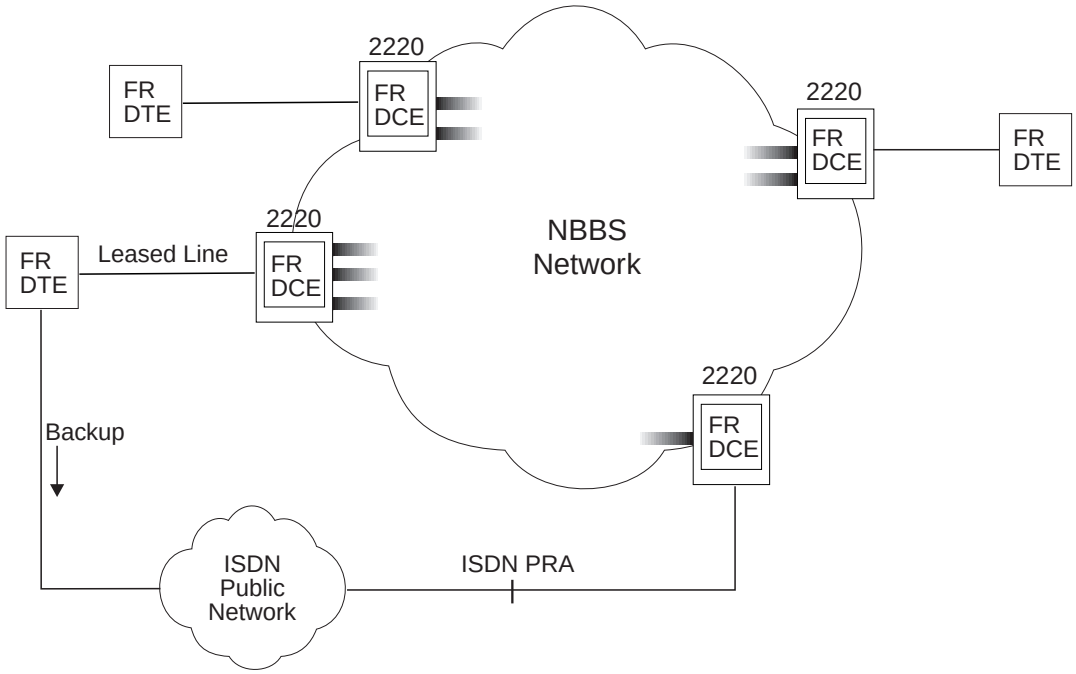

Figure 21. Frame Relay Over ISDN

The following interfaces are supported for Frame Relay over ISDN:

- Euro-ISDN Primary Rate Access (PRA) E1 compliant with ETS 300–1 on 4–port E1 (LICs 515, 516, and 567) and 8–port E1 (LICs 545 and 546). (LIC 567 is required to access public networks that require Euro-ISDN homologation.)
- Japan NTT Primary Rate Access (PRA) J1 compliant with the INS-Net 1500 specification with 4–port J1 (LIC 514) or 8–port J1 (LIC 544).

Asynchronous Transfer Mode (ATM)

The Nways Switch supports ATM in non-real-time and real-time over permanent virtual circuits. It also provides a non-reserved logical queue for applications that require only best effort delivery.

Figure 22 on page 54 shows various types of ATM and non-ATM traffic supported by Nways Switches over an 2220 network.

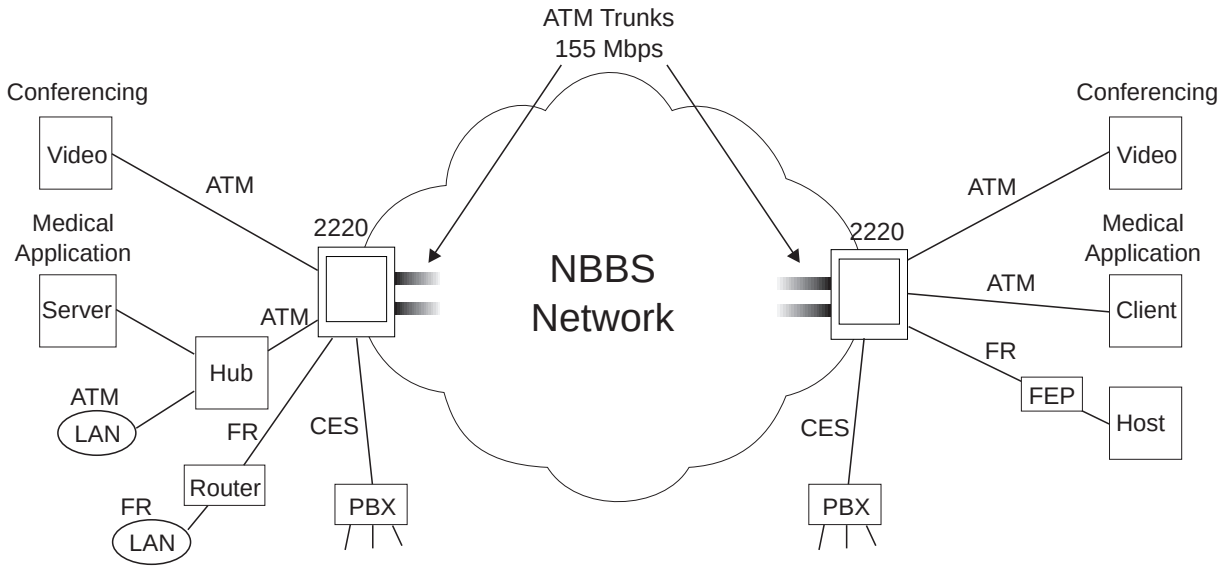

Figure 22. ATM Traffic Supported by 2220 Network

Legend:

ATM Asynchronous transfer mode

CES Circuit emulation services

FEP Front-end processor

FR Frame relay

LAN Local area network

PBX Private branch exchange

ATM traffic is transported over various combinations of ATM and non-ATM port and trunk lines, thus allowing an easy way for migrating existing networks and devices toward ATM. The supported configurations are:

- ATM traffic across 2220 network over ATM or non-ATM trunk lines.
- Non-ATM traffic across 2220 network over ATM or non-ATM trunk lines. ATM trunks are leased lines.
- NEW: ATM VP trunks for bearer services

ATM Network Interfaces

On its ATM network interfaces (layer 2 of the OSI reference model), the Nways Switch provides an ATM cell relay service, which:

- Complies with the ATM Forum UNI 3.0 and 3.1, and ITU B-ISDN recommendations,
- Uses the permanent virtual circuit (PVC) mode,
- Provides virtual path (VP) and virtual channel (VC) services,
- Provides input traffic policing at VP and VC level through the cell loss priority (CLP) mechanism according to the negotiated QoS,
- Provides output traffic shaping in DCE mode at VP and VC level according to the DTE characteristics,

- Supports OAM (operation, administration, and maintenance) flows. The 2220 network handles the ATM alarms at the connection level on VP connections, or VC connections.

This access service allows attaching ATM devices such as hubs, routers, and stations.

The ATM traffic descriptors are the standard traffic descriptors defined in the ATM Forum.

ATM Trunks

On its ATM logical trunks (layer 2), the Nways Switch provides transport services, which:

- Comply with the ATM Forum 3.0 and 3.1, and the ITU-T B-ISDN recommendations,
- Provide high-bandwidth,
- Support virtual path (VP) and virtual channel (VC) switching,
- Support all types of NBBS traffic, not only ATM,
- Do not support the OAM flows.

From a user's standpoint, the 2220 network handles the ATM traffic in the same way, whether it flows over ATM or non-ATM trunks.

ATM trunks are defined as leased lines and transport both ATM cells and non-ATM traffic in frame relay, HDLC, or CES protocols. This traffic is supported in the ATM adaptation layer 5 (AAL5) by segmenting packets into ATM cells.

Non-ATM trunks transport ATM cells natively and non-ATM traffic in packet transfer mode (PTM). For more detailed information, see the *2220 Nways BroadBand Switch ATM Interface Specifications*, GA33-0378.

ATM VP Trunks (Bearer Service)

Starting with the Nways Switch Control Program V2R2 release, in addition to defining ATM leased line and fractional trunks, you can also define a set of ATM VP trunks on an ATM interface (ATM UNI or NNI) using the ATM Bearer Service. This facility allows you to take full advantage of your ATM service provider. The ATM VP trunks are shaped in each direction according to the VP bandwidth.

The ATM Bearer Service allows you to split a physical ATM interface into up to 32 logical NBBS trunks that are mapped over ATM virtual paths (VPs) in an interconnecting ATM network as shown in Figure 23 on page 56. On LICs that have two interfaces (LIC 551 and 552), the 32 logical trunks are shared between the two interfaces.

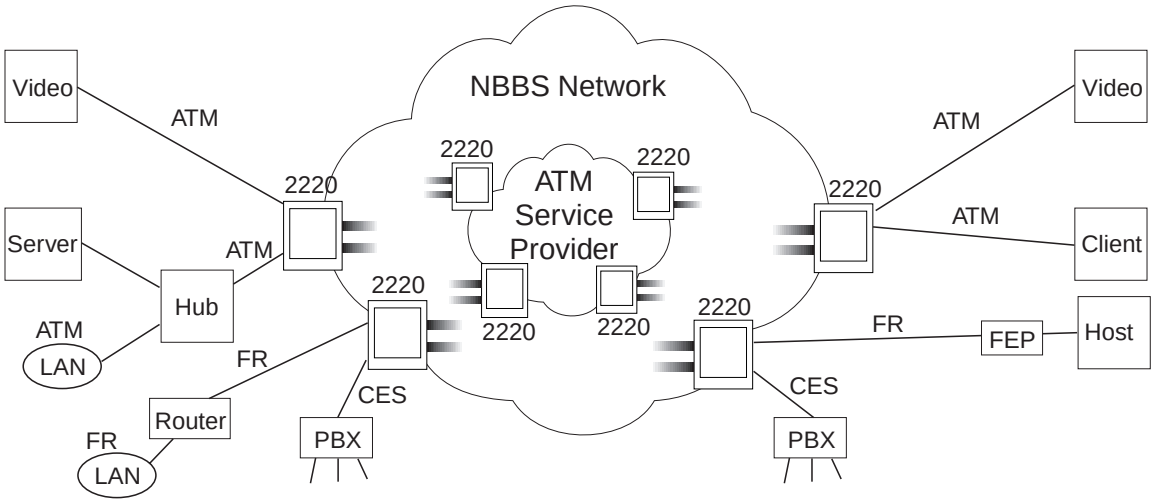

Figure 23. ATM Virtual Path (Bearer Service) Trunks

The ATM Bearer Service is supported on ATM DS3/E3/STM1 (in trunk mode) interfaces with ATM Type 2 adapters (FC 5451).

Each ATM VP trunk must be defined either in Virtual Circuit Connection (VCC) or Virtual Path Connection (VPC) mode. You cannot use both modes on the same VP trunk. On a physical ATM interface, however, you can combine a set of ATM VP trunks in VCC mode with a set of ATM VP trunks in VPC mode.

In ATM VP trunks in VCC mode, voice, CBR, X.25, Frame Relay, ISDN, and ATM VC connections can be freely mixed until the trunk's throughput capacity is reached. ATM VP trunks do not support ATM VPC connections.

ATM VP trunks in VPC mode can accept only one VPC. Because only one connection is accepted, the remaining bandwidth is set to 0.

ATM VP trunks support OAM fault management and OAM loopbacks in coformance with ITU I.610.

Non-Reserved Traffic

For ATM access services, virtual connections can be configured as non-reserved. The data flow for such connections goes through the trunk non-reserved queues, which are served with the lowest priority versus real-time and non-real time queues. Refer to "Non-Reserved Traffic" on page 35 for more information about non-reserved traffic support.

X.25 Protocol

The Nways Switch provides an X.25 private network service as a data circuit-terminating equipment (DCE) and connects X.25 DTEs through leased lines at speeds from 2400 bps to 2.048 Mbps. In a 2220 network, the X.25 connections are processed in switched virtual circuit (SVC) mode. An X.25 attachment requires a low-speed adapter type 3 (LSA3) and a LIC type 511 or 522.

X.25 Network Interface

X.25 logical ports (layer 2 of the OSI reference model) are called *X.25 network interfaces*. They are generated by the Nways Switch Control Program to provide access services to physical port lines. An X.25 network interface sets up and maintains connections between calling X.25 subscribers and called subscribers attached to other Nways Switches.

X.25 Subscriber

An *X.25 subscriber* is an end-user connected to an X.25 network interface through a DTE. A subscriber is defined by an address and a logical name.

X.25 Hunt Group

An *X.25 hunt group* includes several X.25 network interfaces associated with a common subscriber address. If an interface is busy, the connection searches (hunts) for the other interfaces of the group until a free one is found.

Supported User Facilities

The Nways Switch implements a subset of the CCITT optional user facilities, see Table 2 for a description of each facility. For the Nways Switch's handling of unsupported facilities, see "Transporting Unsupported User Facilities" on page 58 .

Table 2. X.25 User Facilities Supported by the Nways Switch

User Facility	Brief Description
Incoming calls barred	Prevents incoming virtual calls from being presented to the DTE. The DTE may originate outgoing calls.
Outgoing calls barred	Prevents the DCE from accepting outgoing virtual calls from the DTE. The DTE may originate outgoing calls.
One-way logical channel outgoing	Restricts the use of logical channels to originating outgoing virtual calls only.
One-way logical channel incoming	Restricts the use of logical channels to receiving virtual calls only.
Nonstandard default packet sizes	Provides for the selection of a default packet size from those set by network administration. The default packet size is 128 bytes.
Nonstandard default window sizes	Provides for the selection of a default window size from those set by network administration. The default window size is 2.
Default throughput classes assignment	Provides for the selection of a default throughput class from those set by network administration. If not selected, the default is that from the user class of service of the DTE but must not exceed that for the network.
Flow control parameter negotiations	Permits negotiation on a per call basis of flow control parameters.

Table 2. X.25 User Facilities Supported by the Nways Switch (continued)

User Facility	Brief Description
Throughput class negotiation	Permits negotiation on a per call basis of the throughput classes. Throughput classes can be negotiated for each direction independently.
Fast select	Authorizes the DCE to transmit to the DTE, during the DTE's *wait state*, a *call connected* or *clear indication* packet with a data field of up to 128 bytes.
Reverse charging	Authorizes the DCE to transmit to the DTE incoming calls which request *reverse charging*. If this facility is not selected, then calls requesting reverse charging will not be transmitted.
Hunt group	Distributes calls to a group of associated addresses (the *hunt group*). Addresses are distributed in a *round robin* fashion, that is: 1. An incoming call is assigned to the next free address on the list. 2. If the last used address was the last on the list, then the first address on the list is tried. 3. If all addresses on the circular list have been tried, the call is rejected.

Transporting Unsupported User Facilities

You can select, per port, how you want the Nways Switch to handle any request for user facilities that the Nways Switch does not support.

Transport unsupported user facilities:
You set the **Transport Facilities** parameter to **Yes** for any port you want to forward unsupported facilities. When a call packet is received on a port with this parameter set, the length parameter field of the call packet is checked but no further processing takes place and the call is forwarded.

Do not transport unsupported user facilities:
The call is rejected.

This parameter is useful for X.25 gateway ports where unsupported facilities could be sent by external networks. For more detailed information refer to the *2220 Nways BroadBand Switch X.25 Interface Specifications*, GA33-0413.

ISDN and QSIG Protocols

The Nways Switch connects to:

- Integrated services digital network (ISDN) equipment over public and private telephone networks, complying with the Euro-ISDN standard. INS-Net in Japan is also supported.
- Private branch exchanges (PBXs) using Q signaling (QSIG) on E1 and T1 lines.

Euro-ISDN Port DCE and DTE

The Euro-ISDN port access services allow connecting ISDN equipment to an Nways Switch port using a primary rate access (30B+D). This attachment is based on the following European telecommunication standards (ETS):

- ETS 300 011 for layer 1 with a maximum speed of 2.048 Mbps
- ETS 300 125 for layer 2
- ETS 300 102 for layer 3.

When attaching a PBX, the Nways Switch acts as an Euro-ISDN DCE with the NT2 interface. When attaching to a public or private Euro-ISDN network, the Nways Switch acts as a DTE with the NT1 interface (provided by the carrier).

The Euro-ISDN protocol requires a low-speed adapter type 3 (LSA3) and a LIC of the following type:

515, 516, or 567 (four E1 lines)

545 or 546 (eight E1 lines).

The LIC type 567 is designed for public telephone networks where approval is required from the telephone authorities.

INS-Net Support

INS-Net is the ISDN service provided by NTT in Japan.

The ISDN port access services allow connecting INS-Net equipment to an Nways Switch port. This attachment is based on the following standards:

- TTC JT-431 based on ITU-T I.431 for layer 1 with a maximum speed of 1544 kbps
- TTC JT-921 based on ITU-T I.921 for layer 2
- TTC JT-931 based on ITU-T I.931 for layer 3

When attaching a PBX, the Nways Switch acts as an ISDN DCE with the NT2 interface. When attaching to a public or private ISDN network, the Nways Switch acts as a DTE with the NT1 interface (provided by the carrier).

The ISDN protocol requires a low-speed adapter type 3 (LSA3) and a LIC type 514 (four J1 lines) or 544 (eight J1 lines).

ISDN support in Japan is available on J1 lines with the following characteristics:

- A J1 line supports 24 channels instead of 32 channels on an E1 line.
- 56 kbps per channel instead of 64 kbps.
- Signaling is transported over channel number 24 instead of channel number 16.

QSIG Port DCE on E1 Lines

Q signaling (QSIG) is a European Computers Manufacturers Association (ECMA) standard used with the ISDN protocol. It is based on the following ECMA standards:

- ETS 300 011 for layer 1 with a maximum speed of 2.048 Mbps
- ECMA 141 for layer 2
- ECMA 143 for layer 3

- ECMA 165 for the generic function protocol (GFP).

The QSIG port attachment of the Nways Switch allows building private networks with integrated facilities using primary rate access (30B+D) on E1 physical interfaces. QSIG ports are fully inter-operable with ISDN ports.

The Nways Switch acts as a DCE and provides the QSIG transit function to private branch exchanges (PBXs) connected at the Q reference point. The NBBS services are provided between these access points. The Nways Switch acts as either a transit or gateway private exchange.

The following signaling modes are offered:

- Basic call
- Call related generic function transport (GFT)
- Call independent GFT.

QSIG on E1 physical interfaces requires the same hardware features as ISDN. Refer to “Euro-ISDN Port DCE and DTE” on page 59.

QSIG on T1 Lines

QSIG on T1 physical interfaces requires a low-speed adapter type 3 (LSA3) and a LIC type 514 or 544 (LIC514 or LIC544).

Supplementary Services

The Nways Switch supports the ISDN and QSIG supplementary services such as:

- Direct dialing-in (DDI): enables a public subscriber to directly call a private subscriber without operator intervention
- Calling line identification presentation (CLIP): presents the calling party identification to the called party
- Calling line identification restriction (CLIR): prevents the presentation of the calling party identification to the called party
- Connected line identification presentation (CLOP): presents the connected party identification to the calling party
- Connected line identification restriction (CLOR): prevents the presentation of the connected party identification to the calling party
- Subaddressing (SUB): allows a supplementary address field to be used after an ISDN address
- User-user signaling level 1 (UUS1): allows a user to exchange information over the D channel (not available for QSIG).

Other QSIG supplementary services are supported or transported transparently (without being processed).

Network Functions

The Nways Switch supports the ISDN network functions described in this section.

Bearer Service Profiles

In order to optimize network resource utilization, the Nways Switch dynamically selects one of the bearer service profiles that you have configured, on a call per call basis, according to the destination number and bearer capability.

Dynamic selection of a profile applies to voice and data. The traffic is transported as PTM packets over the NBBS network on 64 kbps channels using the CES with voice server functions or HDLC protocol with idle character removal. This allows, for example, non-compressed voice for a call that is transmitted over the public network.

Numbering Plans

E.164 and private numbering plan (PNP) are allowed. E.164 is supported for both network and subscriber access (private and public).

Call configuration is made simple through:

- Single local declaration of ISDN numbers
- Wildcards which speed-up declarations
- Numbering plan tables which allow simple number changes (for example, adding or suppressing a digit)
- Open and closed private numbering plans.

The NBBS architecture supplies automatic discovery of the network topology and directory numbers.

ISDN Network Interface

An *ISDN network interface* is a logical resource generated by the Nways Switch Control Program to provide access services to a physical ISDN or QSIG port line. An ISDN network interface sets up and maintains links between calling ISDN equipments and called terminal equipments attached through other Nways Switches.

Virtual Private Network

With the virtual private network function, service providers can build several virtual networks, thus sharing the same physical network between different customers.

The PBX numbering plans are not modified and this function is transparent for the end-user. The virtual private networks are configured in the NBBS network using virtual private identifications.

ISDN Trunk Backup

The ISDN Trunk Backup function allows you to define trunks over an ISDN switched network (ISDN Primary Rate Access) and use the ISDN trunks in the following ways:

- To back up leased line trunks in a cost effective way that ensures high network availability and avoids the need for permanent leased line backup trunks
- To set up temporary trunks that can be activated by the network operator when more bandwidth is required.

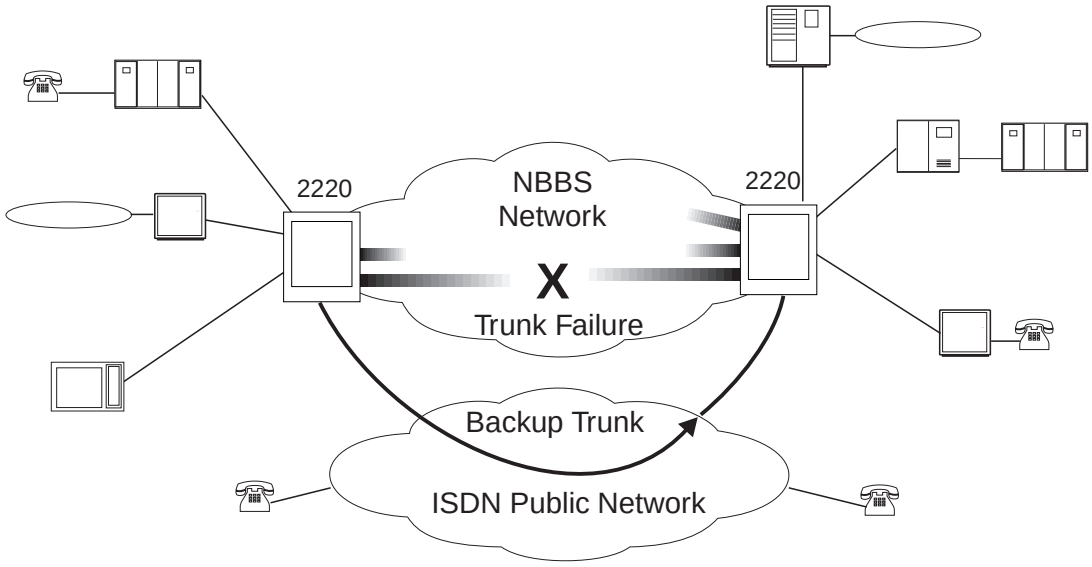

Figure 24. ISDN Trunk Backup

The ISDN Trunk Backup function requires the use of LIC563 attached to an LSA3 adapter in trunk mode. LIC563 contains an inverse multiplexing unit that groups up to 30 B-channels (Euro-ISDN) on each of the two ISDN Primary Rate Access (PRA) lines attached to LIC563.

When using the ISDN Trunk Backup function, note the following limitations:

- The maximum amount of bandwidth allowed on each of the two ISDN PRA lines attached to the LIC is 1920 Kbps.
- The maximum amount of trunks that can be configured for each LSA3 adapter is 32.
- The minimum amount of bandwidth allowed for each ISDN trunk is 64 Kbps (one B-channel).

The ISDN (ISDN/QSIG) feature in the Nways Switch Control Program is also required to run the ISDN Trunk Backup function.

For more detailed information, refer to *2220 Nways BroadBand Switch ISDN Interface Specifications*, GA33-0447.

Chapter 5. Resource Management

The resources in a 2220 network are managed by the programs shown in Figure 25 on page 64:

- The 2220 network is managed using the IBM Nways 2220 Switch Manager for AIX (2220 Switch Manager) running on a RISC System/6000 workstation.
- 2220 nodes are managed locally by the Nways Switch Control Program that is updated from a RISC System/6000 workstation using IBM NetView Distribution Manager for AIX (NetView DM/6000).
- The 2220 nodes in your network are remotely configured using the Nways Switch Configuration Tool Version 2 (NCT2) running on an OS/2 or AIX workstation.

Note: If you run all three management programs on AIX, you can use the same RISC System/6000 workstation, providing it has sufficient storage space and processing power.

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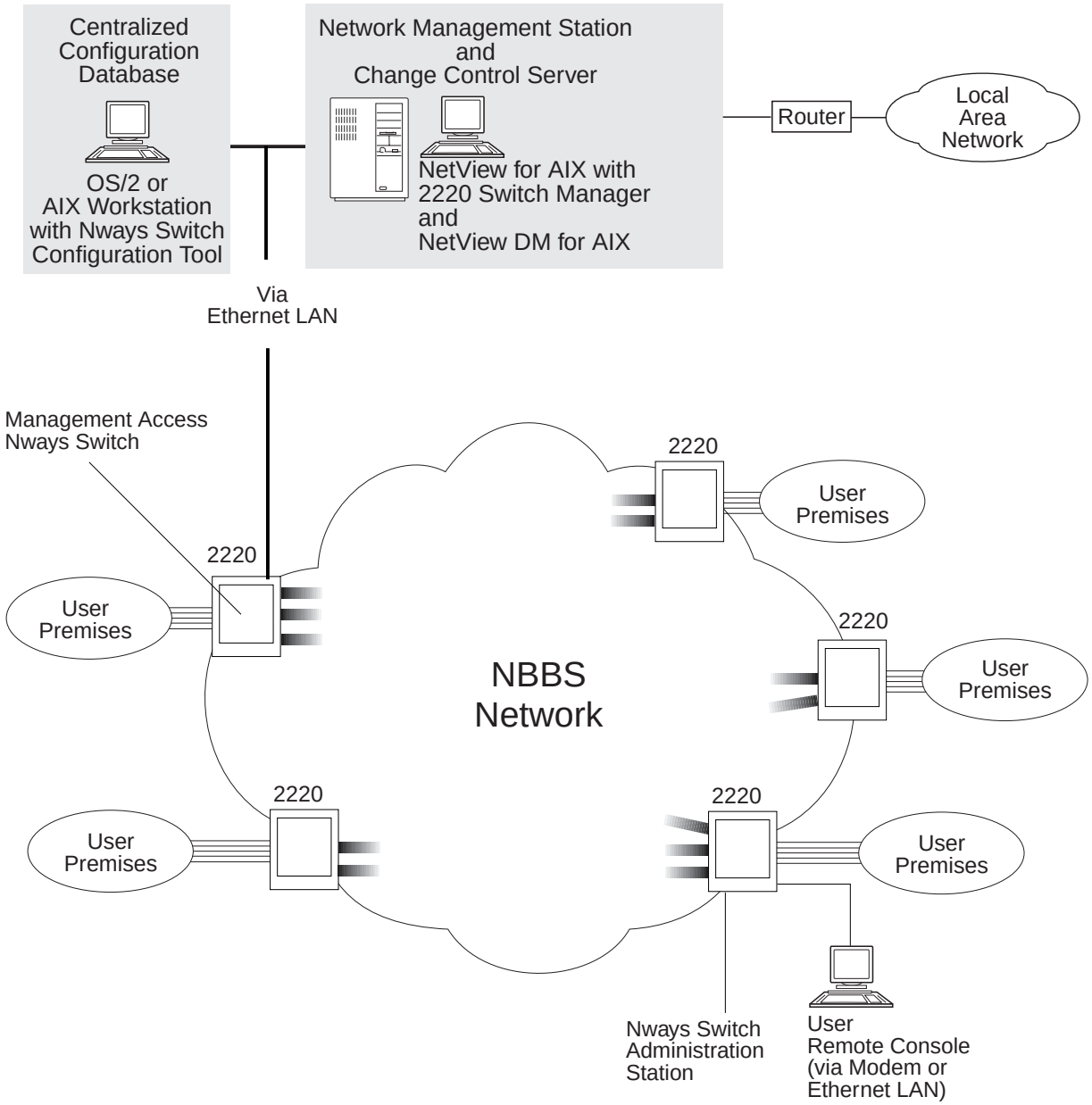

Figure 25. The Network Management Facilities

Nways 2220 Switch Manager and Network Management

The *IBM Nways 2220 Switch Manager for AIX* program (2220 Switch Manager) runs on Tivoli Management Environment (TME) 10 NetView for AIX Version 5 or Telecommunication Management Network (TMN) Version 2.2 with AIX 4.2 and is year-2000 compliant.

2220 Switch Manager Functions

The *2220 Switch Manager* allows you to manage Nways Switches through a set of CMIP-based management functions, including:

- Managing up to 200 medium-size Nways Switches.

- Providing topology maps that show Nways Switches and backbone trunks (NBBS and ATM). These are represented using icons of different colors. By selecting an icon, you can display details about the resource (represented by the selected icon).
- Dynamically managing the Nways Switch resources; which includes activating and deactivating an adapter, locking and unlocking a line, or switching over to a backup switch module.
- Displaying, starting, stopping, and rerouting NBBS and ATM connections.
- Managing ISDN connections through an ISDN view instead of an NBBS view.
- Dynamically configuring the resources; which includes creating, deleting, or updating the configuration of physical and logical Nways Switch resources. Connections can be configured on-line with their QoS and traffic descriptors. An Nways Switch can be restarted on-line using its current configuration or a new configuration.
- Managing the performance by monitoring the lines and connections in real time. Each protocol has specific counters.
- Managing the accounting by logging traffic information for later billing.
- Contributing to problem management by displaying the Nways Switch alarms and state changes. Alarms and events can be filtered using thresholds. AIX scripts can be invoked when receiving specific events.

  Also available are operation administration and maintenance (OAM) functions on ATM connections and loopback tests on trunk and port lines.
- Creating event desk report.
- Providing security files to define accesses by category of operators.
- Operating in a client/server environment where several operators can be connected through client RISC/6000 stations to a server station which is the network management station.
- Recording audit-log in an ASCII file that can be edited using an AIX editor.
- Offering a web-browser interface, via which several functions can be run.
- Providing on-line help and documentation.
- Importing and exporting 2220 configuration files.

  By importing a 2220 configuration, you can install new configuration settings in a 2220 node. The new configuration is used the next time the node is restarted.

  By exporting a 2220 configuration, you copy the configuration database of a 2220 node to the hard disk of the Nways Switch administration station (NAS). You must then send the configuration file to the workstation running the Nways Switch Configuration Tool Version 2 (NCT2) so that it can be used as the new configuration of a 2220 node.
- Customizing the relative importance given to the status of individual resources in a node and the way they are combined to produce the compound status displayed by the color of the node icon.
- Changing the color of a resource icon to acknowledge that a network operator has begun troubleshooting a problem on the resource. You can also undo the acknowledgment so that the resource redisplays the color of its actual status in the network topology map.
- Removing a failing resource (*unmanaging*) from network management so that its status is not taken into account in the calculation of the compound node status. The color of the resource icon changes to show that it is no longer managed from the network management station. Network management commands are sent to the resource only after the network operator has restored normal network discovery functions for the resource.

- Displaying progress messages during rediscovery of the network topology
- Managing two levels of Nways Switch Control Program code from the network management station; that is, updating and activating the version of inactive code or reloading the current version (if necessary).
- Forwarding alarms received on the network management station to an SNMP platform, such as HP/OpenView or NetView for AIX, so that the events can be viewed as SNMP messages.
- Using AIX command scripts from a telnet session or when NetView for AIX is not running to:
  - Reset network adapters.
  - Activate and deactivate network ports and trunks.
  - List all trunks for a given Nways Switch.
  - Export and import configurations of Nways Switches.

The 2220 Switch Manager uses the OSI Common Management Interface Protocol and Common Management Interface Services (CMIP/CMIS).

Network Resource Management

Nways Switches notify NetView for AIX of the addition, removal, or status change of key resources such as trunks, port lines, or adapters. Using these notifications, the NetView for AIX immediately updates and displays the graphic network topology map.

The Nways Switches and trunks are represented as object icons that are color-coded to show their current status. Selection of an object with the mouse opens a zoom window showing details such as physical location and status. These windows have menus with device-specific commands.

Network Operator Control

The Nways 2220 Switch Manager supports operator interactions via a graphical-user-interface (GUI). This easy-to-use GUI:

- Reduces operator training time
- Improves operator productivity
- Reduces the time required to become aware of, and respond to, network problems.

Management Task Automation

AIX provides a shell script interface that allows you to store command programs. These scripts can be automatically triggered when NetView for AIX is notified of specific events in the 2220 network (via alarms, for example). They can then issue commands to the Nways 2220 Switch Manager applications, or they can automate complex management tasks (including problem recovery).

Distributed Management

The minimum management configuration requires one NetView for AIX workstation connected to one Nways Switch (the management access Nways Switch) per network. Connections to the other Nways Switches are through the management access Nways Switch and the 2220 network over trunk lines.

More sophisticated configurations can be developed with several instances of NetView for AIX arranged in a flat distributed-manager structure or in a hierarchical manager-of-managers structure. Therefore, depending on your needs, you can choose:

- To ensure the continuous availability of your communication network management support
- To balance the network management load
- To partition a large backbone into separately managed subnetworks.

The client/server architecture allows several operators to perform concurrent management operations and some of them can be connected via X-stations to different client stations.

IP Network Addressing

Network management information uses the OSI CMIP over TCP/IP (CMOT) protocol for communication between:

- Network management station (NMS)
- Change control server (CCS)
- Nways Switch administration stations (NASs)
- User remote consoles.

This requires a logical IP network to be constructed for your 2220 network. Each IP address is unique throughout the IP network. This process is handled by the Nways Switch configuration tool (NCT) during the initial network configuration phase. The user intervention is limited to defining the network IP address and the number of Nways Switches, plus a limited number of inputs related to the network management station and change control server.

Performance Monitoring

You can monitor the performance of the NBBS resources. For more accurate performance data and increased network efficiency, you can adjust some parameters. The Nways Switch software includes control packages which allow you to specify how the resources are to be monitored. A control package specifies:

- The resources to monitor by type (port, trunk, connection or line), and by type of line or protocol.
- Parameters (counters) to monitor. A wide choice is available according to the type of resource.
- Threshold values for the selected parameters. Thresholds can be selected for event recording, or alarm triggering.

A control package can be public or private. Public control packages are delivered with predefined monitoring parameters, while private package is a package you create from a public one by modifying the default parameters and renaming the control package.

New parameters, based on existing ones, are called derived parameters. These are built by combining existing parameters and functions.

In order to actually monitor the performance, you:

- Select resources for monitoring

- Initiate or stop performance data collection
- Retrieve performance data
- View performance data as either tables or graphs
- Edit, create, and apply new control packages for new performance monitoring sessions.

The collected data includes:

- Send and receive count of user data frames and user bytes
- Count of bytes and packets discarded
- Count of conforming and nonconforming packets sent
- Physical line interface event and error counters.

Accounting

NBBS architecture provides accounting functions for charging for the use of the network. The information, collected in accounting records provides accounting data at the connection level. You can select the level of accounting for:

- All NBBS networks that are managed by the Nways 2220 Switch Manager
- For a selected set of Nways Switches
- For a selected set of 2220 networks.

Accounting is based on the network usage of selected potential connections. When you configure a network you should set the accounting functions active for each connection for which you want to collect accounting information, and for each Nways Switch you want to include in the accounting regime. (You might not want to include, for example, an Nways Switch that is providing a free global service of some kind.)

Accounting information is collected into *connection records*. Each record contains a variable number of *connection vectors* that can be of three kinds of data:

- **Basic record information** consisting of:
  - Reason for record collection
  - User defined connection identifier
  - Network defined connection identifier
  - Time stamp of record creation.
- **Static Data** consisting of data about the potential connection that stays the same for the lifetime of the connection, or until you change it. 'Lifetime' is considered to be for as long as the potential connection has a definition within the network. These data are defined either during configuration or at activation of the potential connection.
- **Dynamic Data** that is generated each time the connection is used and so represents a usage record.

The data collected includes:

- Start and stop times of each connection
- The reason an accounting record was sent
- End points of the connection
- Bandwidth reservation parameters
- QoS parameters
- Connection statistics records

- Connection setup duration.

Connection records created in the connection initiator and completor will be different for each instance of use. So connection records should be collected to provide a complete accounting of that instance. The accounting functions produce a 'flat' file, that is, one that has no structure other than a linear collection of connection records.

The accounting file can be used by your accounting programs. Detailed specifications of connection records and connection vectors are given in the *Managing the Accounting and Performance Monitoring* manual, GA33-0366.

Intermediate Accounting

Accounting data is collected at the connection establishment time or release time. This prevents intermediate recording of accounting data. This could be a real problem for long and permanent connections.

With the Nways Enterprise Manager Release 3, the accounting function offers the possibility to collect accounting data at any time for any connection. This can be done either manually at the operator's request, or automatically according to a predefined schedule.

Benefits of this function are:

- Improved accuracy of the accounting
- Possibility to have an accurate status of all the connections crossing a given node at a given time.

Event Desk Report Creation

To create event reports, you use the Event Desk application of 2220 Switch Manager as an AIX daemon. This daemon allows you to log events in a file.

Security

Access to the Nways 2220 Switch Manager management functions is password-controlled. There are three levels of operators. An operator can either:

1. Use basic functions to monitor the network.
2. Monitor the network and perform configuration operations.
3. Monitor the network and use accounting functions.

Remote access to a Nways Switch administration station (NAS) is also password-controlled.

Nways Switch Control Program and Node Management

The *Nways Switch Control Program* includes the code that runs in the Nways Switch adapters, line interface couplers, and Nways Switch administration station (NAS). The Control Program implements the main components of the NBBS architecture:

- Access services supported by the port adapters
- Transport services supported by the trunk adapters
- Network control supported by the control point adapters

- Node management supported by the NAS.

NAS Functions

The Nways Switch administration station (NAS):

- Stores the Nways Switch Control Program.
- Brings up the Nways Switch and restarts it on operator request.
- Controls the Nways Switch operation.
- Collects node alarms and reports them to the Nways 2220 Switch Manager in the network management station.
- Collects accounting and performance data.
- Handles configuration parameters through the Nways Switch Configuration Tool Version 2 (NCT2).
- Controls and services the local resources through the Nways Switch Resource Control component.
- Manages code changes.

For a NAS hardware description, refer to “Nways Switch Administration Station” on page 95 .

Dual Code-Level Management

Starting with the Nways Switch Control Program V2R1, two levels of the Control Program can reside on the same station. This allows you to easily switch between one level of code and the other, and to quickly reload your current code if you have problems running a new version.

Preloaded Nways Switch Control Program Selection

When ordering a new Nways Switch for your network, you can select the level of the Nways Switch Control Program to be loaded in the Nways Switch. This ensures that the level of the Nways Switch Control Program is consistent across Nways Switches in your network. The program level is selected using a specify code (SC). The following program versions are available:

- Version 1 Release 5 (SC 9015)
- Version 2 Release 1 (SC 9021)
- Version 2 Release 2 (SC 9022)

You must provide the specify code when you order a new Nways Switch. The Nways Switch Control Program Version 2 Release 2 is installed by default.

Nways Switch Configuration Tool Version 2

The *Nways Switch Configuration Tool Version 2* (NCT2) is a component of the Nways Switch Control Program and is used in the following ways:

- From the NAS
- As a stand-alone version running on AIX or OS/2 on a dedicated Nways Switch configuration station (see page “Configuration Station” on page 71).

Use the Nways Switch Configuration Tool Version 2 (NCT2) to:

- Configure the physical and logical resources of the Nways Switches in your NBBS network.
- Generate the IP addresses for NASs, Nways Switch adapters, management stations, and remote consoles, which are all viewed as IP hosts.
- Create the working configuration by manually entering parameters or importing configuration files.
- Ensure consistency between configuration parameters in each Nways Switch configuration. Error messages are displayed when there are conflicting configuration settings.
- Import and export configuration files to and from the working configuration.
- Generate configuration files in ASCII format to manage Nways Switch configurations.

Nways Switch Resource Control

The *Nways Switch Resource Control* application is a component of the Nways Switch Control Program. It is used from the NAS or a user remote console to manage the resources and configuration files of an Nways Switch (see page “User Remote Console” on page 72).

The main functions of the Nways Switch Resource Control application are:

- Displaying the status of the Nways Switch resources.
- Locking or unlocking the traffic on the communication lines.
- Deactivating a resource for configuration or service purpose, for example. When a resource is deactivated, its hardware is reset and its traffic is disrupted.
- Activating a resource to restart the traffic on it. When a resource is activated, its code is upgraded if its level is lower than the code level on the NAS hard disk.
- Restarting the Nways Switch or NAS, possibly with a new configuration.
- Forcing a switchover to a backup resource (for example, control point, switch module, or clock).
- Managing the dual Control Program levels stored on the NAS.
- Running tests on the machine or on a specific resource.
- Getting local time from the NAS.
- Disconnecting the NAS from the Nways Switch.
- Importing configuration files into the new configuration.
- Exporting configuration data from the current configuration.

Configuration Station

The *Nways Switch configuration station*is **mandatory** and can be an OS/2 or AIX station that runs a stand-alone version of the Nways Switch Configuration Tool Version 2 (NCT2). The configuration station stores a *centralized configuration database* of the NBBS network and allows you to:

- Define the IP addresses of your NBBS network in a single database.
- Easily add new Nways Switches or IP hosts.
- Maintain a backup configuration for each Nways Switch (if the database is kept up-to-date).

An OS/2 configuration station can be connected to the 2220 network as a user remote console. Using a configuration station and the NCT2, you can configure very large networks. As your network grows, simply increase the disk storage as required.

User Remote Console

The user remote console is a workstation that runs the following programs:

- OS/2 2.1 or above
- OS/2 TCP/IP Version 2.0 or above
- Remote Nways Switch Resource Control (part of the Nways Switch Control Program).

The remote console is locally connected to the network via an Ethernet LAN or remotely connected to the asynchronous port of the NAS via a public switched telephone network. From the remote console, you can:

- Run all NAS functions.
- Export and import Nways Switch configurations.
- Manage the network configuration database using the NCT2.
- Access Nways Switch files.
- Access the change control server if the NetView Distribution Management Agent/2 program is installed on the console.

Chapter 6. Overview of Planning Tasks

This section summarizes the 2220 Nways Switch installation planning tasks.

Planning Tasks

Figure 26 shows the planning tasks for ordering, configuring, and operating a broadband network using IBM 2220 Nways BroadBand Switches.

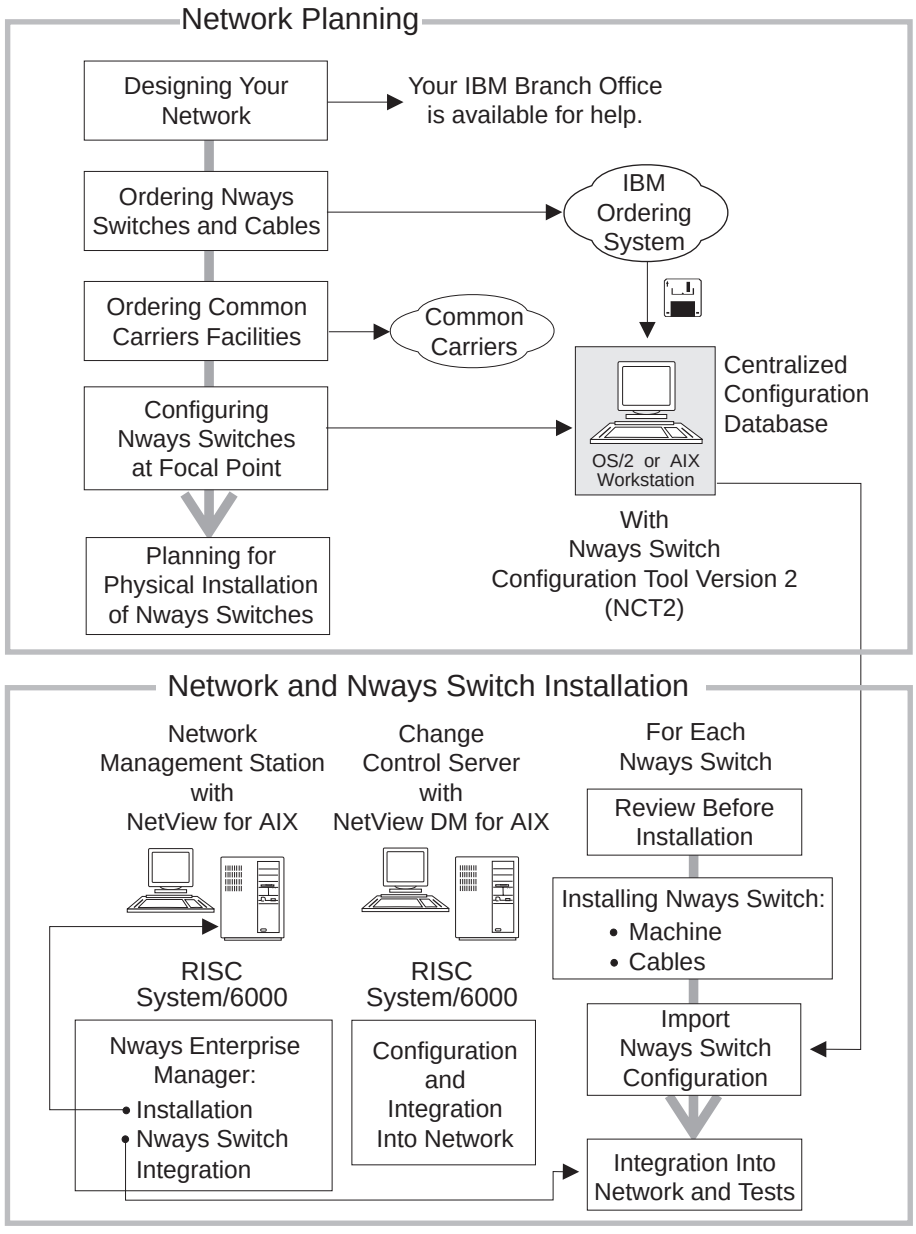

Figure 26. Nways Switch Planning

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Education

The IBM 2220 Nways BroadBand Switch is an IBM product using the new Networking BroadBand Services (NBBS) architecture. The manuals listed in “Bibliography” on page 131 can help your network administrators and operators learn about the 2220 Nways Switch and understand how an NBBS network is configured and operates.

You may also check with your IBM marketing representative for information about available classroom and self-study courses.

IBM Service Facilities

You may contact your IBM Branch Office for technical help and information about the services available during your:

- Network planning
- Installation planning
- Normal operation of your network.

Network Support Center

The modem supplied with each Nways Switch provides you with the benefits of the IBM Remote Support Facility (RSF). Through the RSF, the IBM Network Support Center (NSC) may, with your authorization, access each node. This provides you with highly skilled support for fast problem determination and resolution.

Part 3. Technical Specifications

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In Part 3, we look at some specifications of the 2220 Nways Switch family.

Chapter 7. Nways Switch Hardware

This chapter describes 2220 Nways Switch hardware features and summarizes the hardware configuration rules.

2220 Nways Switch Models

The IBM 2220 Nways Switch is available in the following models:

- 300
- 500
- 501 (Model 500 expansion).

All models of the Nways Switch are installed in a 19-inch rack (see Figure 27). Some components of the Nways Switch are accessed from the front, such as adapters; others are accessed from the rear, such as line interface couplers (LICs).

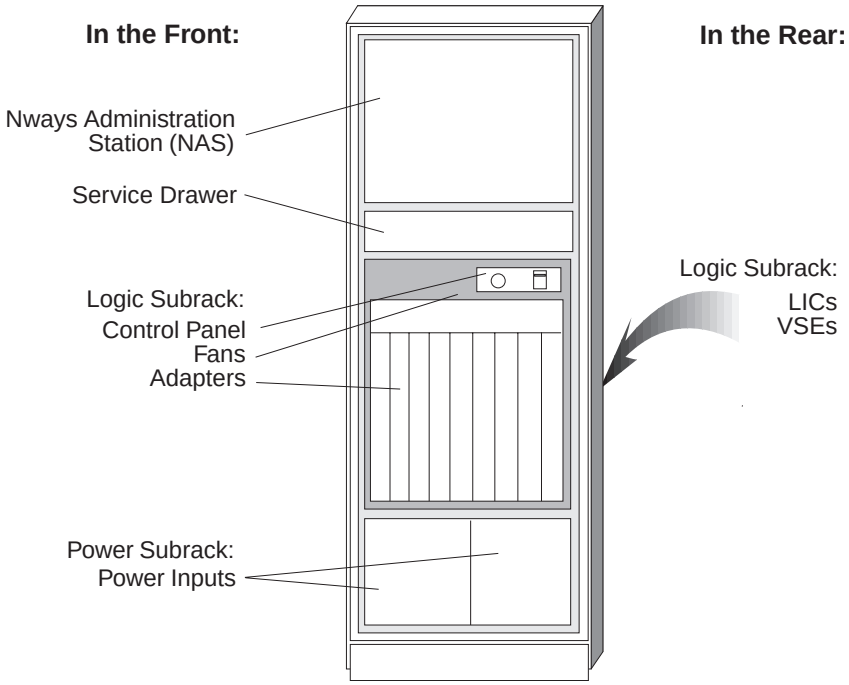

Figure 27. Inside the 2220 Nways Switch Model 300 or 500

Rack, Slot, and Position

When configuring an Nways Switch physical resource, the **rack** parameter indicates the 2220 Model. *Rack A* is the 2220 base frame (Model 300 or 500), *rack B* is the expansion frame (Model 501).

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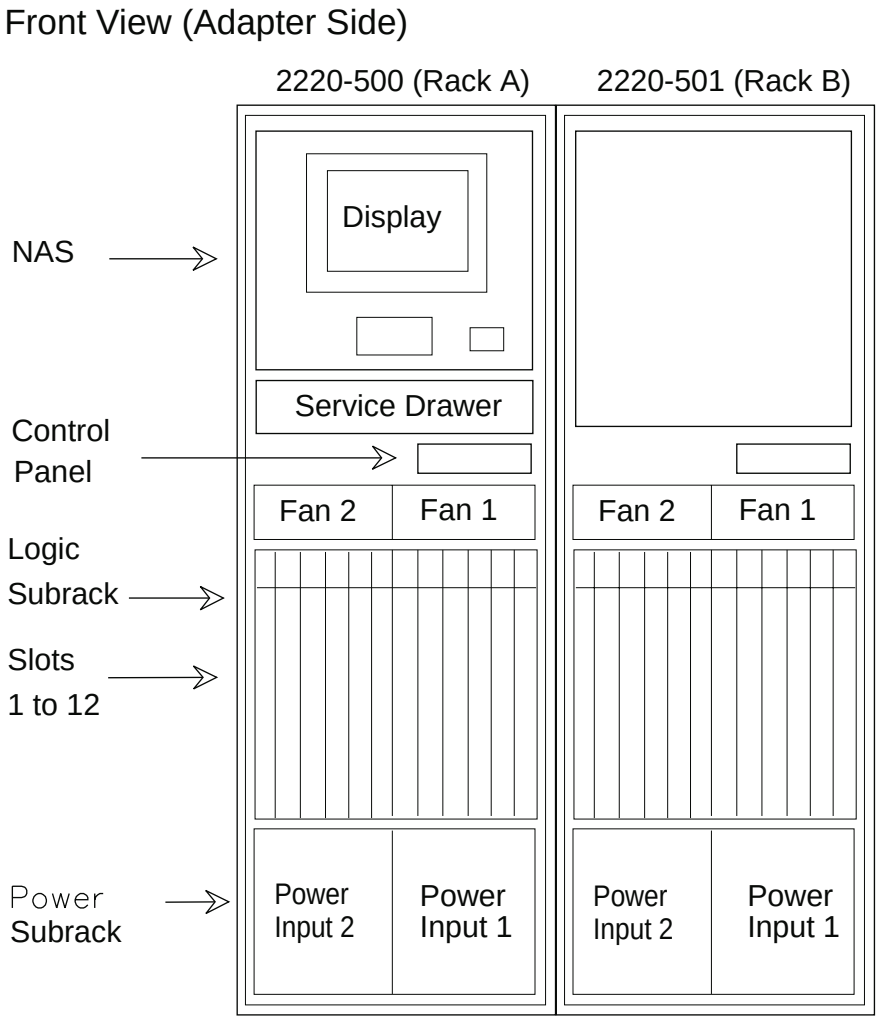


Figure 28. 2220 Models 500 and 501 (Racks A and B)

The **slot** parameter indicates the module location (1 to 12) in the logic subrack.

The **position** parameter indicates the line attachment number on the LIC module (1 to 8, depending on the LIC type).

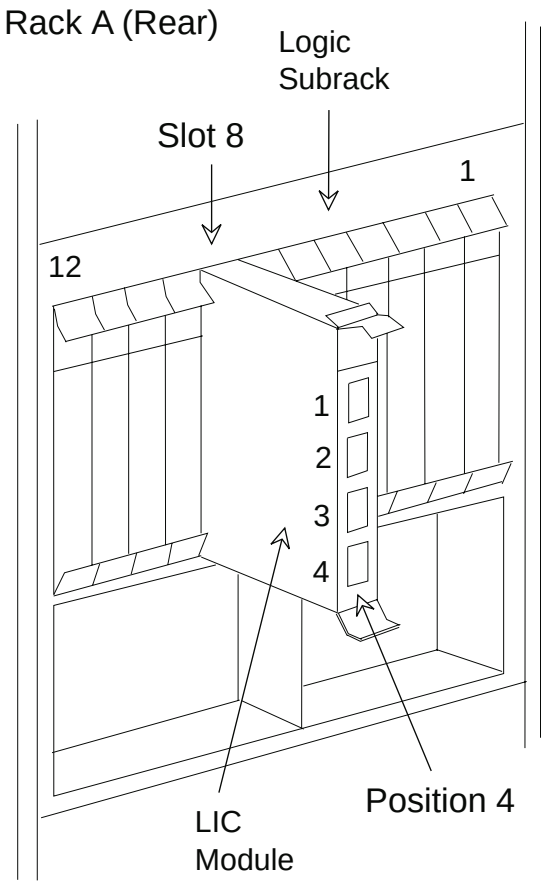


Figure 29. Rack, Slot, and Position

The sequence ″Rack, Slot, and Position″ identifies the location of the Nways Switch physical resources and also associates physical and logical resources. For example, the line attachment shown on Figure 29 is identified by Rack=A, Slot=8, and Position=4.

Line Cables

There are two ways to obtain your external line cables for the Nways Switch. You can order:

- Standard complete external cables. Short (2m or 6.56 ft) stub cables are also available to adapt OEM cables to the LIC connectors.
- Cable connector kits. These kits allow you to build your own cables. They contain connectors that match the LIC514 (RJ-48 for T1) and the LIC530 (HSSI) connectors.

  There is also a kit for the LIC516 with flying leads for the E1 interface.

For details about physical line interfaces and line cables, see *2220 Nways BroadBand Switch Physical Lines Interface Specifications, External Cable References*, GA33-0379.

Hot Pluggable Features

The Nways Switch features are *hot pluggable,* that is they can be installed or removed without disturbing the resources that are not connected to or dependent on them. For example, a port or trunk adapter can be exchanged without stopping the other adapters. Also, a line cable can be unplugged without disturbing the other line attachments on the same LIC.

Resource Usage and Machine Capacity

Each component of the Nways Switch uses machine resources (electrical power, processing power, a physical location, and cooling). The IBM ordering system assigns each of these components a resource usage level. These usage levels are then used to ensure that the proposed machine resource configuration is compatible with the total machine capacity.

Adapter Functions and Configuration

The Nways Switch adapters are ordered as the following features:

- Asynchronous transfer mode (ATM) adapter type 2 (ATMA2)
- High-speed adapter type 3 (HSA3)
- Low-speed adapter types 2 and 3 (LSA2 and LSA3)
- Voice server adapter (VSA). For details, refer to “Voice Server Features” on page 94 .

Adapter Functions

Depending on its hardware type and the code that it runs, an adapter can be a:

- Port adapter (provides access services to port lines)
- Trunk adapter (provides transport services to trunk lines)
- Control point adapter (provides the network control functions to the Nways Switch)
- Trunk and control point adapter (provides both transport services and network control).

Table 3 summarizes the functions that each adapter can perform.

Table 3. Adapter Functions

Adapter Function	LSA2	LSA3	HSA3	ATMA2
Port adapter	Yes	Yes	Yes	Yes
Trunk adapter	Yes	Yes	Yes	Yes
Control point adapter	Yes	Yes	Yes	No
Trunk and control point adapter	Yes	Yes	Yes	No

Control Point Configuration

The following configuration rules apply to control points:

1. There must be at least one control point in each Nways Switch.

2. A control point can be duplicated for availability reasons.
3. The control point function can be housed in a low-speed adapter type 2 (LSA2) or type 3 (LSA3), or a high-speed adapter type 3 (HSA3).

   The ATM adapter type 2 (ATMA2) cannot be used as a control point.
4. Defining the control point in slots 10 or 12 of the logic subrack dedicates the adapter to the sole control point function. It is then a *control point adapter* (CPA).

   In the other slots of the subrack (1 to 6 for Model 300, or 1 to 8 for Model 500), the control point is housed by a trunk adapter and is then a *trunk and control point adapter* (TCPA).
5. The control point function cannot be defined on a port adapter, whatever the slot in which the adapter is plugged.
6. The maximum number of Nways Switches and trunk lines supported by a control point depends on the adapter type.
7. The control point function cannot be located in an adapter plugged in a Model 501.

Duplicated Control Point

Duplicating the control point increases the availability of the machine by providing a backup if the active control point fails. Control point duplication is provided by the *redundancy mode* and applies to the control point and switch module and to the clock module when it is installed.

IP Gateway Adapter

The network control messages between Nways Switch administration stations (NASs) and network management stations use IP addresses and are routed through a port adapter in each Nways Switch. This adapter is called *IP gateway adapter*. It must have the lowest traffic among all the port adapters, and can be duplicated.

Maximum Number of Adapters per 2220 Model

Table 4 summarizes the number of adapters allowed in each Nways Switch model:

Table 4. Maximum Number of Adapter Features Per Nways Switch Model

2220 Model	Low-Speed Adapters and LICs	High-Speed Adapters and LICs	ATM adapters and LICs	VSAs (and VSEs)	Control Points (CPAs and TCPAs)	Total (See Note)
300	4	4	4	2	2	8
500	8	8	8	4	2	10
501	6	6	6	6	0	6
500 and 501	14	14	14	10	2	16
Note: The totals can include a mixture of LSA, HSA, VSA, and ATMA for the front of the subracks, and a corresponding mixture of LIC and VSE for the back of the subracks. For the Model 300 and Model 500, the figures include the control point adapters in slots 10 and 12.						

Asynchronous Transfer Mode (ATM) Features

ATM Adapter Type 2 (ATMA2)

The ATMA2 adapter attaches port or trunk lines with speeds up to 155.520 Mbps. It is used as a port or trunk adapter, but cannot be used as a control point.

The types of links and protocols supported are given in the following ATM LIC descriptions.

DS3 Line Interface Coupler (LIC551)

The LIC551 attaches two DS3 port or trunk lines. Each attachment provides one channel at 44.736 Mbps. The LIC551 requires an ATMA2 configured as port or trunk adapter. The access services are ATM.

E3 Line Interface Coupler (LIC552)

The LIC552 attaches two E3 port or trunk lines. Each attachment provides one channel at 34.368 Mbps. The LIC552 requires an ATMA2 configured as port or trunk adapter. The access services are ATM.

SDH/SONET Electrical Line Interface Coupler (LIC553)

The LIC553 attaches one electrical 155.520 Mbps port or trunk line. The connection uses BNC connector. The range is limited to 450 m (1476 ft). The LIC553 requires an ATMA2 configured as a port or trunk adapter. The access services are ATM.

SDH/SONET Optical Line Interface Coupler (LICs 554, 555, and 556)

The LIC554, 555, or 556 attaches one optical 155.520 Mbps port or trunk line. The connection is through an SC transceiver. The allowed distances are:

- Up to 40 km (24.86 mi) for LIC554
- Up to 20 km (12.43 mi) for LIC555
- Up to 2 km (1.24 mi) for LIC556.

The LIC554, 555, or 556 requires an ATMA2 configured as a port or trunk adapter. The access services are ATM.

ATM LIC and Adapter Compatibility

Table 5 shows which ATM adapter can be used with each ATM LIC.

Table 5. ATM LIC and Adapter Compatibility

LIC Type	ATMA1 (Note)	ATMA2
551 (Two DS3)	Port or trunk	Port or trunk
552 (Two E3)	Port or trunk	Port or trunk
553 (One SDH/SONET electrical)	Port or trunk	Port or trunk
554 (One SDH/SONET optical long range)	Port or trunk	Port or trunk
555 (One SDH/SONET optical short range)	Port or trunk	Port or trunk
556 (One SDH/SONET optical multi-mode)	Port or trunk	Port or trunk
Note: ATMA1 is no longer available.		

High-Speed Features

High-Speed Adapter Type 3 (HSA3)

The HSA3 attaches port or trunk lines with speeds up to 51.84 Mbps. It can be used as one of the following:

- Port adapter
- Trunk adapter
- Control point adapter
- Trunk and control point adapter.

The types of links and protocols supported are given in the following high-speed LIC descriptions.

T3 Line Interface Coupler (LIC513)

The LIC513 attaches one clear channel T3 port or trunk line at 44.736 Mbps. The LIC513 requires an HSA3 configured as a port or trunk adapter. The access services are high data link control (HDLC) and frame relay.

For a trunk attachment, a second LIC513 can be used as a backup. A ″Y″ cable can connect both LICs to the same line. One HSA3 is required per LIC513.

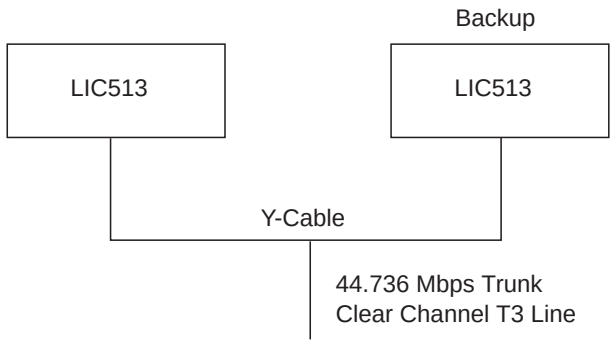


Figure 30. LIC513 Connectivity with Backup and Y-Cable

E3, E2, and J2, Line Interface Coupler (LIC523)

The LIC523 attaches one E3, E2, or J2 port or trunk line at speeds up to 34.368 Mbps. The LIC523 requires an HSA3 configured as a port or trunk adapter. The access services are HDLC and frame relay.

HSSI Line Interface Coupler (LIC530)

The LIC530 attaches one HSSI port or trunk line at speeds up to 51.84 Mbps for DTE and DCE interfaces. The LIC530 requires an HSA3 configured as a port or trunk adapter. The access services are HDLC and frame relay.

High-Speed LIC and Adapter Compatibility

Table 6 shows which high-speed adapter can be used with each high-speed LIC.

Table 6. LIC Compatibility with High-Speed Adapters

LIC Type	HSA1 (Note)	HSA2 (Note)	HSA3
513 (One T3)	Port or trunk	Port or trunk	Port or trunk
523 (Four E2/J2/E3)	Port or trunk	Port or trunk	Port or trunk
530 (One HSSI)	Port or trunk	Port or trunk	Port or trunk
Note: HSA1 and HSA2 are no longer available.			

Low-Speed Features

Low-Speed Adapter Type 2 (LSA2)

The LSA2 attaches port or trunk lines with speeds from 2400 bps up to 2.048 Mbps. It can be used as one of the following:

Port adapter

Trunk adapter

Control point adapter

Trunk and control point adapter.

Low-Speed Adapter Type 3 (LSA3)

The LSA3 attaches port or trunk lines with speeds up to 2048 kbps. It can be used as one of the following:

Port adapter

Trunk adapter

Control point adapter

Trunk and control point adapter.

LSA3 is required for:

- X.25 on LIC511 or LIC522
- Merged line protocols on low-speed LICs except LIC517 (for details, see "Merged Line Protocols" on page 91)
- ISDN on LIC types 515, 516, 545, 546, and 567
- Trunk J2 MA/SR on LIC type 562
- Multiple logical trunk (MLT) support.

The types of links and protocols supported are given in the following low-speed LIC descriptions.

X.21, V.24, and V.35 Line Interface Coupler (LIC511)

The LIC511 attaches up to 60 port lines at speeds up to 256 kbps. Each LIC511 connector attaches one or two line connection boxes (LCBs) with their active remote connectors (ARCs). Also see Figure 31 on page 85. The ARCs provide links for DCE direct attachments and DTE attachments.

The LIC511 supports the following ITU-T interfaces:

- X.21 for leased lines at speeds up to 256 kbps
- V.24 (RS-232) for leased lines at speeds up to 19.2 kbps
- V.35 for leased lines at speeds up to 256 kbps.

The LIC511 requires an LSA2 or LSA3 configured in port adapter. The access services are HDLC, frame relay, CES, X.25, and merged line protocols, which allows frame relay, HDLC, and CES traffic to run on the same adapter. One protocol per line is supported. Merged line protocols and X.25 require an LSA3.

Table 7 gives the maximum number of low-speed communication lines supported by each Nways Switch model using LIC511.

Table 7. Maximum Number of Low-Speed Lines and LIC511 per Nways Switch Model

2220 Model	**Maximum Number of Low Speed Lines**	**Maximum Number of LIC511**
300	120	2
500	240	4
501	360	6
500 and 501	600	10

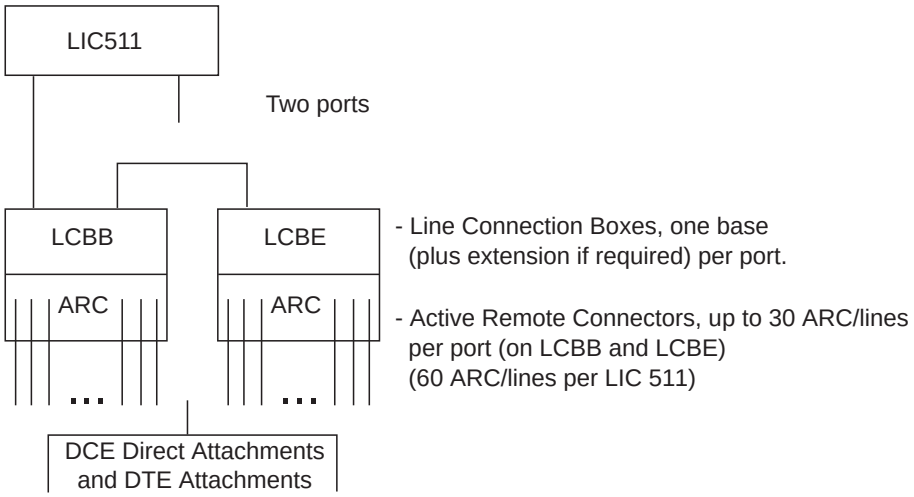


Figure 31. LIC511 Connectivity

For more information, refer to “Line Connection Box Features” and “Active Remote Connector Features” on page 86 .

Line Connection Box Features

The *line connection boxes* (LCBs) provide multiplexing of up to 30 communication lines to each LIC511 connector using only one cable. This reduces the cable requirements between the Nways Switch and the modem room.

Each of the two LIC511 connections can connect four LCBs and each LCB connects up to 15 lines. This allows up to 60 low-speed lines to be multiplexed into

the two LIC511 ports. The actual number of lines depends on their speed. For example, only 16 lines can be supported at 256 kbps.

The LCBs can be located in a standard 19-inch rack up to 103.5 m (341 ft) from the Nways Switch.

Note: This rack must be metallic.
They can also be housed in the rear of the Nways Switch rack.

There are two types of LCBs, which are functionally equivalent:

- Line connection box base (LCBB), which connects directly to the LIC511.
- Line connection box expansion (LCBE), which connects to the LCBB.

They are connected as shown in Figure 32.

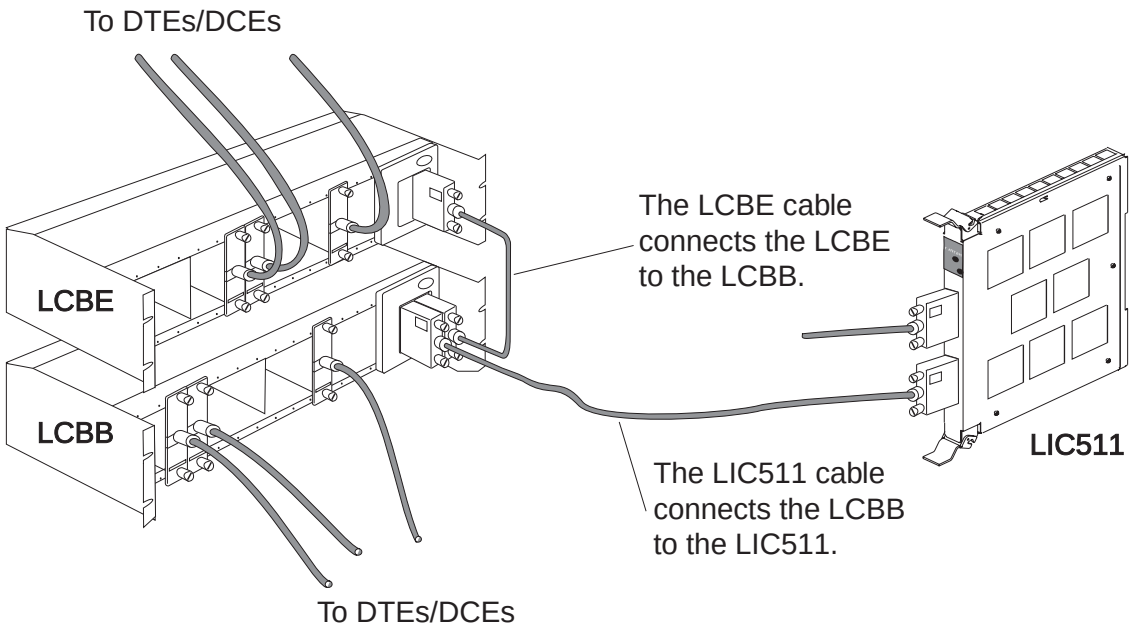


Figure 32. LCB Connections. The ARCs are housed in the LCBs and connect to the DTEs and DCEs.

Active Remote Connector Features

The *active remote connectors* (ARCs) are housed in the LCBs and provide the electrical and physical interfaces between the DCE (modem) or DTE (terminal) and the LIC511. The cable type depends on the interface type and whether the attachment is DTE or DCE.

There are three types of ARCs. They attach to a DTE or DCE through standard ITU-T interfaces:

ARC/X.21
Uses the X.21 interface connector at speeds up to 256 kbps.

ARC/V.24
Uses the V.24 interface connector at speeds up to 19.2 kbps.

ARC/V.35
Uses the V.35 interface connector at speeds up to 256 kbps.

There are several different ARC features depending on the interface, attachment (DCE or DTE), and cable length.

T1 and J1 Line Interface Coupler (LIC514)

The LIC514 attaches four T1 or J1 port or trunk lines. Each attachment provides from one channel at 1.536 Mbps to 24 channels at 64 kbps. Multiple aggregate 64 kbps channels and fractional T1 and J1 services are supported. The multiple logical trunk is also supported on T1 and J1 lines.

The LIC514 requires an LSA2 or an LSA3 configured as a port or trunk adapter. The access services are HDLC, frame relay, CES, PCM voice (T1 only), ISDN/QSIG, or merged line protocols (HDLC, frame relay, CES, and ISDN/QSIG).

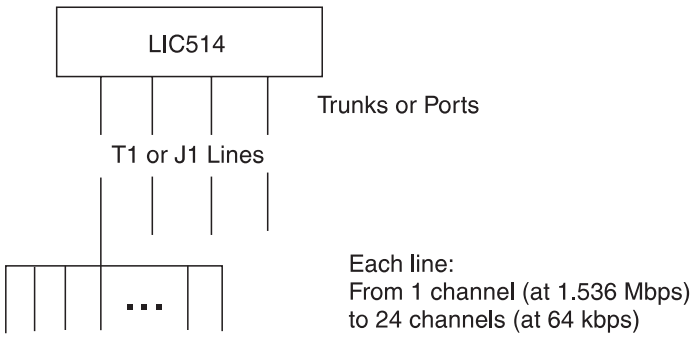


Figure 33. LIC514 Connectivity

Each attachment provides:

- In T1/J1 mode, from one channel at 1.536 Mbps to 24 channels at 64 kbps.
- In ISDN mode, 23 channels at 64 kbps plus the D-channel (primary rate access 23B+D).

E1 Line Interface Coupler (LIC515)

The LIC515 attaches four E1 port or trunk lines and uses coaxial connectors with a terminating impedance of 75 ohms. Multiple aggregate 64 kbps channels, or fractional E1 services are supported. The multiple logical trunk function is also supported on E1 lines.

The LIC515 requires an LSA2 or an LSA3 configured as a port or trunk adapter. The access services are:

- HDLC
- Frame relay
- CES
- PCM voice
- ISDN
- Merged line protocols (HDLC, frame relay, CES, and ISDN).

Each attachment provides:

- In E1 mode, from one channel at 1.984 Mbps to 31 channels at 64 kbps.

- In ISDN mode, 30 channels at 64 kbps plus the D-channel (primary rate access 30B+D).

E1 Line Interface Coupler (LIC516)

The LIC516 attaches four E1 port or trunk lines and uses RJ 48 (telephone-type) connectors with a terminating impedance of 120 ohms. Multiple aggregate 64 kbps channels and fractional E1 services are supported. The multiple logical trunk function is also supported in E1 lines.

The LIC516 requires an LSA2 or an LSA3 configured as a port or trunk adapter. The access services are HDLC, frame relay, CES, PCM voice, ISDN, or merged line protocols (HDLC, frame relay, CES, and ISDN).

Each attachment provides:

- In E1 mode, from one channel at 1.984 Mbps to 31 channels at 64 kbps.
- In ISDN mode, 30 channels at 64 kbps plus the D-channel (primary rate access 30B+D).

JJ-20 TTC Line Interface Coupler (LIC517)

The LIC517 attaches four JJ-20 TTC port lines to Japanese PBX interfaces. Each interface handles from one channel at 2048 kbps to 30 channels at 64 kbps.

The LIC517 requires an LSA2 configured as a port adapter. The access services are PCM voice and CES.

X.21, V.35, and V.36 Line Interface Coupler (LIC522)

The LIC522 attaches four X.21, V.35, or V.36 port or trunk lines. DTE and DCE interfaces with clock extraction are supported.

The LIC522 requires an LSA2 or LSA3 configured as a port or trunk adapter. The access services are HDLC, frame relay, CES, X.25, and merged line protocols (HDLC, frame relay, and CES).

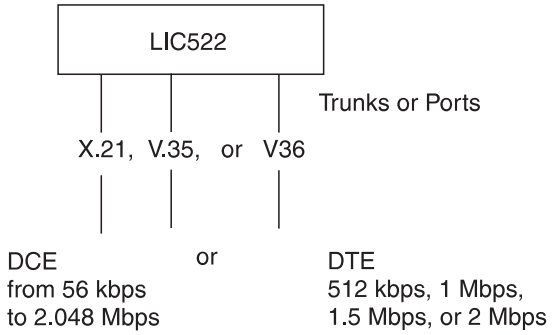


Figure 34. LIC522 Connectivity

Note: When connecting a 2220 to a 2210 router through a V.35 interface (LIC522), the 2210 must be configured as **DTE** and the corresponding 2220 port as **DCE**.

T1 and J1 Line Interface Coupler (LIC544)

The LIC544 attaches eight T1 or J1 port or trunk lines. Each attachment provides from one channel at 1.536 Mbps to 24 channels at 64 kbps. Multiple aggregate 64 kbps channels and fractional T1 and J1 services are supported. The multiple logical trunk function is also supported in T1 and J1 trunk lines.

The LIC544 requires an LSA3 configured as a port or trunk adapter. The access services are HDLC, frame relay, CES, PCM voice (T1 only), ISDN/QSIG, or merged line protocols (HDLC, frame relay, CES, and ISDN/QSIG).

Each attachment provides:

- In T1/J1 mode, from one channel at 1.536 Mbps to 24 channels at 64 kbps.
- In ISDN mode, 23 channels at 64 kbps plus the D-channel (primary rate access 23B+D).

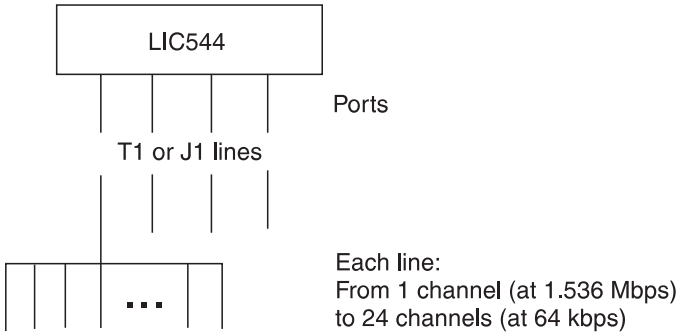


Figure 35. LIC544 Connectivity

E1 Line Interface Coupler (LIC545)

The LIC545 attaches eight E1 port lines and uses a terminating impedance of 75 ohms. Multiple aggregate 64 kbps channels and fractional E1 services are supported. The multiple logical trunk function is also supported in E1 lines.

The LIC545 requires an LSA3 configured as a port or trunk adapter. The access services are HDLC, frame relay, CES, PCM voice, ISDN, or merged line protocols (HDLC, frame relay, CES, and ISDN).

Each attachment provides:

- In E1 mode, from one channel at 1.984 Mbps to 31 channels at 64 kbps.
- In ISDN mode, 30 channels at 64 kbps plus the D-channel (primary rate access 30B+D).

E1 Line Interface Coupler (LIC546)

The LIC546 attaches eight E1 port or trunk lines and uses a terminating impedance of 120 ohms. Multiple aggregate 64 kbps channels and fractional E1 services are supported. The multiple logical trunk function is also supported in E1 lines.

The LIC546 requires an LSA3 configured as a port or trunk adapter. The access services are HDLC, frame relay, CES, PCM voice, ISDN, or merged line protocols (HDLC, frame relay, CES, or ISDN).

Each attachment provides:

- In E1 mode, from one channel at 1.984 Mbps to 31 channels at 64 kbps.
- In ISDN mode, 30 channels at 64 kbps plus the D-channel (primary rate access 30B+D).

J2 Multi-Access/Sub-Rate Interface (LIC562)

The LIC562 attaches one J2 multi-access/sub-rate (MA/SR) trunk line at a speed limited to 1.536 Mbps. However, because it supports the multiple logical trunk (MLT) function, speeds of 3 Mbps, 5 Mbps, and 6 Mbps can be reached by using respectively two, three, or four logical NBBS trunks.

The LIC562 requires an LSA3 configured as trunk adapter.

Euro-ISDN Trunk Backup (LIC563)

LIC563 is required with an LSA3 adapter for setting up trunks over a Euro-ISDN switched network. The bandwidth of each ISDN trunk ranges from 64 Kbps to 1920 Kbps.

LIC563 attaches four E1 trunk lines that support:

- E1 G-703, G-704, and G-706 interfaces with or without CRC-4
- ETSI recommendations

Each E1 line is defined as a trunk and provides one channel at 1.920 Mbps dedicated to ISDN traffic (slots 0 and 16 are reserved) or to an E1 channelized interface to a leased line.

In LIC563, lines 1 and 2 contain the inverse multiplexing unit used for backup trunks over ISDN. Inverse multiplexing supports the grouping (bonding) of 2 to 30 B-channels in each trunk across the ISDN network.

Lines 3 and 4 function without inverse multiplexing and are used as standard E1 leased lines with a terminating impedance of 120 ohms.

E1 ISDN Line Interface Coupler (LIC567)

The LIC567 attaches four E1 ISDN/QSIG port lines and uses a terminating impedance of 120 ohms. This LIC is designed for public telephone networks where Telecommunications approval is required.

The LIC567 requires an LSA3 configured as a port adapter. The access services are HDLC, frame relay, CES, PCM voice (without CAS), ISDN, or merged line protocols (HDLC, frame relay, CES, and ISDN).

Each attachment provides:

- In E1 mode, from one channel at 1.984 Mbps to 31 channels at 64 kbps.
- In ISDN mode, 30 channels at 64 kbps plus the D-channel (primary rate access 30B+D).

Low-Speed LIC and Adapter Compatibility

Table 8 shows which low-speed LICs can be used with the low-speed adapters.

Table 8. Compatibility with Low-Speed Adapters

LIC Type	LSA1 (Note)	LSA2	LSA3
511 (60 V.24, V.35, or X.21)	No	Port	Port
514 (Four T1 or J1)	Port or trunk	Port or trunk	Port or trunk
515 or 516 (Four E1)	Port or trunk	Port or trunk	Port or trunk
517 (Four JJ-20)	No	Port	No
522 (Four V.35, V.36, or X.21)	No	Port or trunk	Port or trunk
544 (Eight T1 or J1)	No	No	Port or trunk
545 (Eight E1, 75 ohms)	No	No	Port or trunk
546 (Eight E1, 120 ohms)	No	No	Port or trunk
562 (One J2, 75 ohms)	No	No	Trunk
563 (Two Euro-ISDN, two E1 120 ohms)	No	No	Trunk
567 (Four E1, 120 ohms)	No	No	Port
Note: LSA1 is no longer available			

Merged Line Protocols

The low-speed adapter type 3 (LSA3) allows merging multiple protocols (frame relay, HDLC, CES, and ISDN) on its attached LIC. With CES, channel associated signaling (CAS) and channel common signaling (CCS) are available. With ISDN, Q signaling (QSIG) can be used. Except for LIC type 517 (four JJ-20 line attachments), all the low-speed LICs support merged line protocols.

The following configuration rules apply to merged line protocols:

1. Merging line protocols requires an LSA3.
2. On LIC types 511 and 522, protocols are selected at line level. Each line attachment of a LIC can be configured with a different protocol (frame relay, HDLC, or CES).
3. On the other LIC types (T1, J1, or E1), each line attachment can be configured without channels (clear-channel mode) or with channels (channel mode).
   - In ***clear-channel mode***, protocols are selected at line level, as for LIC511 or LIC522. Each line attachment can be configured with a different protocol (frame relay, HDLC, or CES). ISDN is not available in clear-channel mode.
   - In ***channel mode:***
     a. Frame relay, HDLC, and CES protocols are selected at channel level. Each channel can be configured with a different protocol.
     b. CAS and CCS signaling modes are selected at line level. Each line attachment can be configured with a different signaling mode.
     c. ISDN and QSIG are available on E1 lines.
     d. In ISDN, each B-channel can be dynamically assigned to data or voice in HDLC, frame relay, or CES. Data traffic is transparently transported end-to-end over the 2220 network. Voice traffic can use voice server functions as required.

Table 9 shows how protocols and signaling modes can be merged on low-speed LICs.

Table 9. Low-Speed LICs and Merged Line Protocols

LIC Type	HDLC or FR	CES	CAS	CCS	ISDN QSIG
511	Yes	Yes	No	No	No
522	Yes	Yes	No	No	No
514 or 544 in clear channel mode	Yes	Yes	No	No	No
514 or 544 in channel mode	Yes	Yes	Yes	Yes	No
515, 516, 545, or 546 in clear channel mode	Yes	Yes	No	No	No
515, 516, 545, or 546 in channel mode	Yes	Yes	Yes	Yes	Yes
567 in clear channel mode	Yes	Yes	No	No	No
567 in channel mode	Yes	Yes	No	Yes	Yes

LICs and Protocols

Table 10 shows the physical interfaces and protocols that are available for each LIC. (For LIC and adapter compatiblity, refer to Table 11 on page 93.)

Table 10. LIC Physical Interfaces and Protocols

LIC Type	CES	PCM Voice	HDLC and FR	ISDN/QSIG (1)	ATM	X.25 (1)	Protocol Merge (1)
511 (Sixty V.24, V.35, or X.21)	Yes	No	Yes	No	No	Yes	Yes (2)
513 (One T3)	No	No	Yes	No	No	No	No
514 (Four T1 or J1)	Yes	T1 only	Yes	Yes(6)	No	No	Yes (3)
515 (Four E1 75 ohms)	Yes	Yes	Yes	Yes (5)	No	No	Yes (3) (4)
516 (Four E1 120 ohms)	Yes	Yes	Yes	Yes (5)	No	No	Yes (3) (4)
517 (Four JJ-20 TTC)	Yes	Yes	No	No	No	No	No
522 (Four V.35, V.36, or X.21)	Yes	No	Yes	No	No	Yes	Yes (2)
523 (Four E2, J2, or E3)	No	No	Yes	No	No	No	No
530 (One HSSI)	No	No	Yes	No	No	No	No

Table 10. LIC Physical Interfaces and Protocols (continued)

LIC Type	CES	PCM Voice	HDLC and FR	ISDN/QSIG (1)	ATM	X.25 (1)	Protocol Merge (1)
544 (Eight T1 or J1)	Yes	T1 only	Yes	Yes (6)	No	No	Yes (3)
545 (Eight E1 75 ohms)	Yes	Yes	Yes	Yes (5)	No	No	Yes (3) (4)
546 (Eight E1 120 ohms)	Yes	Yes	Yes	Yes (5)	No	No	Yes (3) (4)
551 (Two DS3)	No	No	No	No	Yes	No	No
552 (Two E3)	No	No	No	No	Yes	No	No
553 (One SDH Sonet electrical)	No	No	No	No	Yes	No	No
554 (One SDH Sonet optical LR)	No	No	No	No	Yes	No	No
555 (One SDH Sonet optical SR)	No	No	No	No	Yes	No	No
556 (One SDH Sonet optical multi mode)	No	No	No	No	Yes	No	No
567 (Four E1 ISDN 120 ohms)	Yes	Yes (no CAS)	Yes	Yes (5)	No	No	Yes (3) (4)

Notes:

1. Requires an LSA3.
2. Each line can have a different protocol (HDLC, frame relay, or CES).
3. Each clear-channel line or channel can have a different protocol (HDLC, frame relay, or CES).
4. In ISDN, each B-channel can be dynamically assigned to data or voice in HDLC, frame relay, or CES.
5. LIC567 may be required depending on country certification.
6. INS-Net Support (ISDN in Japan) on J1-type line only. QSIG in USA on T1-type line only.

LIC and Adapter Compatibility

Table 11 shows the adapters that are available for each LIC type.

Table 11. LIC and Adapter Compatibility

LIC Type	LSA2	LSA3 (Note)	HSA3	ATMA2
511 (Sixty V.24, V.35, or X.21)	Yes (port)	Yes (port)	No	No
513 (One T3)	Yes (port or trunk)	Yes (port)	No	No
514 (Four T1 or J1)	Yes (port or trunk)	Yes (port or trunk)	No	No
515 (Four E1 75 ohm)	Yes (port or trunk)	Yes (port or trunk)	No	No
516 (Four E1 120 ohm)	Yes (port or trunk)	Yes (port or trunk)	No	No
517 (Four JJ-20 TTC)	Yes (port)	No	No	No

Table 11. LIC and Adapter Compatibility (continued)

LIC Type	LSA2	LSA3 (Note)	HSA3	ATMA2
522 (Four V.35, V.36, or X.21)	Yes (port or trunk)	Yes (port or trunk)	No	No
523 (Four E2, J2, or E3)	No	No	Yes (port or trunk)	No
530 (One HSSI)	No	No	Yes (port or trunk)	No
544 (Eight T1 or J1)	No	Yes (port or trunk)	No	No
545 (Eight E1 75 ohm)	No	Yes (port or trunk)	No	No
546 (Eight E1 120 ohm)	No	Yes (port or trunk)	No	No
551 (Two DS3)	No	No	No	Yes (port or trunk)
552 (Two E3)	No	No	No	Yes (port or trunk)
553 (One SDH Sonet electrical)	No	No	No	Yes (port or trunk)
554 (One SDH Sonet optical LR)	No	No	No	Yes (port or trunk)
555 (One SDH Sonet optical SR)	No	No	No	Yes (port or trunk)
556 (One SDH Sonet optical multiple mode)	No	No	No	Yes (port or trunk)
562 (One J2)	No	Yes (trunk)	No	No
563 (Two Euro-ISDN, two E1 120 ohms)	No	Yes (trunk)	No	No
567 (Four E1 ISDN 120 ohm)	No	Yes (port)	No	No
Note: LSA3 is required for X.25, ISDN, J2 and merged line protocols.				

Voice Server Features

Here are the voice server features.

Voice Server Adapter (VSA)

The VSA handles voice processing on twenty 64 kbps channels. It offers the following functions:

- Voice compression using the GSM or the adaptive differential pulse code modulation (ADPCM) algorithm (with a five-to-one compression ratio)

  Note: The two algorithms cannot be used in the same voice server adapter.
- Silence removal (with a two-to-one compression ratio)
- Echo cancellation
- Idle signal removal
- Silence removal
- Fax demodulation (using the GSM algorithm)
- Compression law conversion.

The voice server adapter can detect voice-band data signals (fax or modem) and automatically switch from one of the first three modes to the pass-through mode for the duration of these signals.

There is a digital echo canceler built into the VSA. It can compensate for up to 32 ms of local delay. Voice digital echo cancellation is subject to the approval of appropriate country regulatory authorities.

Dual-tone multifrequency (touch-tone) dialing is transparently forwarded. If voice compression, silence removal, and echo canceling are used together, then fewer channels are supported for voice processing (for details, see Table 12).

Voice Server Extension 1 (VSE1) and 2 (VSE2)

The voice modules (VSA, VSE1, and VSE2) are built with digital signal processors (DSP) that have:

- Five voice slots each (when configured as GSM)
- Four voice slots each (when configured as ADPCM).

Table 12 gives the maximum number of voice slots available for a VSA alone, a VSA with a VSE1, or a VSE2.

Table 12. Voice Server Adapter Channel Capacities

Voice Modules	DSP	GSM Slots	ADPCM Slots
VSA only	4	20 (4x5)	16 (4x4)
VSA and VSE1	16	80 (16x5)	64 (16x4)
VSA and VSE2	28	140 (28x5)	112 (28x4)

Note:

If echo cancellation is required, the figures in Table 12 must be divided by 2.

2220 Model 500 Configuration

Inside the 2220 Model 500, from top to bottom, there are three main areas:

- Nways Switch administration station (NAS)
- Logic subrack
- Power subrack.

To identify these three areas, see Figure 27 on page 77.

Nways Switch Administration Station

The Nways Switch administration station (NAS) is a processor mounted in the rack of the 2220 Model 500 or 300. It is used to locally control and service the 2220 Nways Switch and consists of:

- Display, keyboard, and mouse.
- Hard-disk drives (primary and backup).
- Diskette drive.
- Modem for connection to a remote user console and an IBM Network Support Center through the public switched network.
- Integrated battery backup.

- If the Nways Switch is a network management access switch, an attachment to the network management station (running the Nways 2220 Switch Manager) via an Ethernet LAN.
- If the Nways Switch is a change management access switch, an attachment to the change control server (running the NetView Distribution Manager for AIX) via an Ethernet LAN.

Hardware Evolution

In order to support the dual code-level management function and benefit from the improved performance, the Nways Switch must be equipped with a more powerful NAS. Two migration paths are possible. You can either:

- Replace the hard disks by larger disks in order to use the new functions
- Replace the NAS in order to benefit from both the new functions and performance.

You can visually check the level of a NAS. If the rear of the NAS is equipped with six adapter slots, and if there is no connector on the left side of the mouse and keyboard connectors, the NAS must be upgraded.

Performance

The IBM Nways BroadBand Switch Control Program Version 2 and the more powerful NAS result in improved performance of the Nways Switch:

- Increased number of connections per node: from 2000 up to 6000.
- Shorter IML time. It has been reduced by 30%.
- Shorter delay to control all the resources. It has been reduced by 30%.
- Shorter response time. It has been reduced by 30%.

2220–500 Logic Subrack (Front)

The front of the logic subrack, shown in Figure 36 on page 97 contains the following parts:

Control panel
Contains the manual power ON/STANDBY switch, the alarm and power control (APC) reset switch, and six status LEDs.

Fan units
Two fan units with two fans in each.

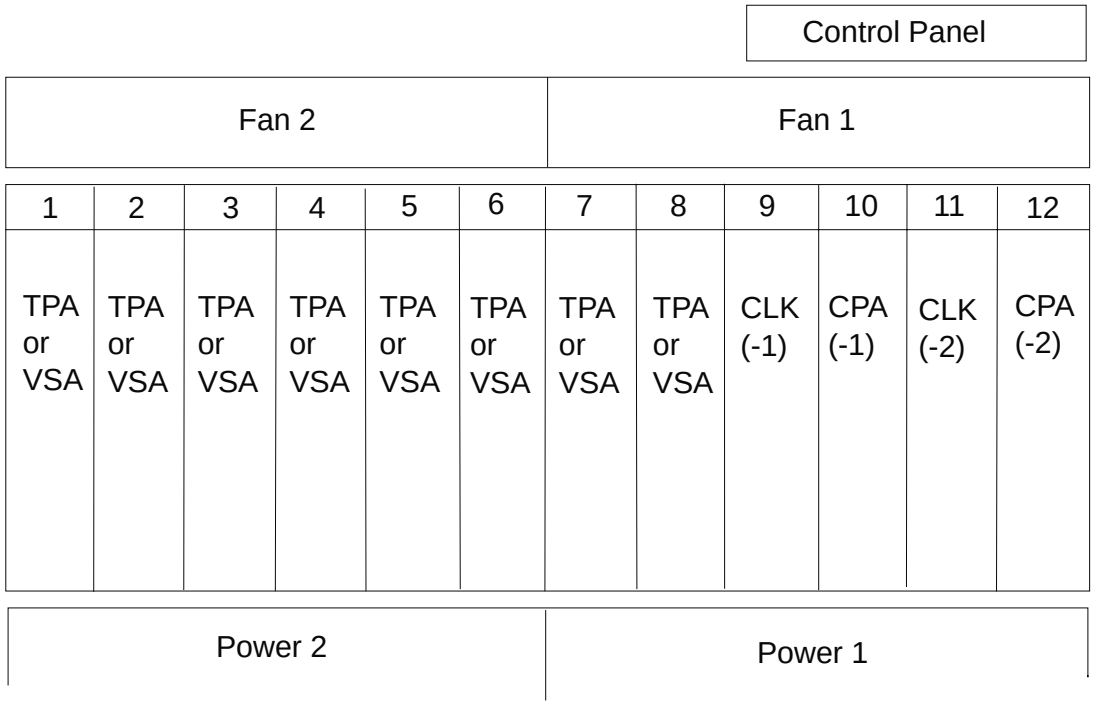
Slots 1 to 8
Can be used to plug:

- Up to eight trunk or port adapters (TPAs)
- Up to four voice server adapters (VSAs).

Control point adapter (CPA)
Can be used alone as a dedicated control point adapter module in slot 10. Can have a backup CPA module in slot 12.

Trunk and control point adapter (TCPA)
A trunk adapter module where control point and trunk adapter functions coexist. It can be plugged in slots 1 to 8 and can have a backup module (also in slots 1 to 8).

Clock module (CLK)
Optional module (in slot 9). It can have a backup module (in slot 11).



Legend

CLK clock

CPA control point adapter

TPA trunk or port adapter

VSA voice server adapter

Figure 36. 2220-500 Logic Subrack (Front)

2220–500 Logic Subrack (Rear)

The rear of the logic subrack, shown in Figure 37 on page 98, contains the following parts:

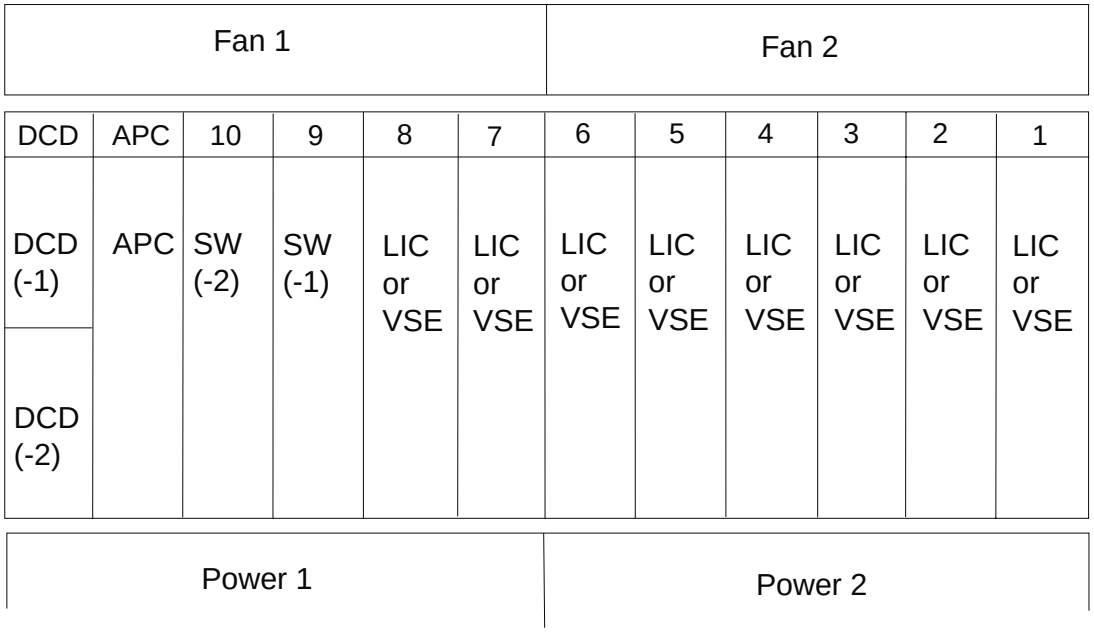
Slots 1 to 8
Can be used to plug:

- Line interface couplers (LICs), each attached to its appropriate adapter.
- Voice server extensions (VSEs), each attached to its VSA.

Switch module (SW)
An ATM cell switch (in slot 9). It can have a backup module (in slot 10).

Alarm and power control (APC) module
Connects the NAS, reports alarms, and controls the power supplies.

DC power distribution (DCD)
Two half-modules, one for each power module.



Legend

APC alarm and power control

DCD dc distribution

LIC line interface coupler

SW switch module

VSE voice server extension

Figure 37. 2220-500 Logic Subrack (Rear)

2220-500 Power Subrack

The power subrack contains the ac or dc power module feature. In a machine that has a backup power module, both modules can be the same or different types.

The ac power supply can be from 208 to 240 V ac (single phase, 50 or 60 Hz). It has an internal backup battery (providing up to five minutes of power supply). The dc power supply can be from -36 to -60 V dc.

2220-500 Redundant Mode

The Model 500 is normally configured to operate in redundant mode. The following key components are duplicated:

- Switch module
- Control point adapter
- Clock module, if present.

2220 Model 501 Configuration

This is an expansion unit used with the 2220 Nways Switch Model 500 to increase the number of attachments. It is attached to either side of the Model 500. It does not have a NAS nor a modem, but does contain logic and power subracks.

Line connection boxes (refer to page 85) can be housed in the rear of the machine for use with the active remote connectors.

2220-501 Logic Subrack (Front)

Control panel
As for the Model 500. Refer to “2220 Model 500 Configuration” on page 95.

Fan units
Two fan units with two fans in each.

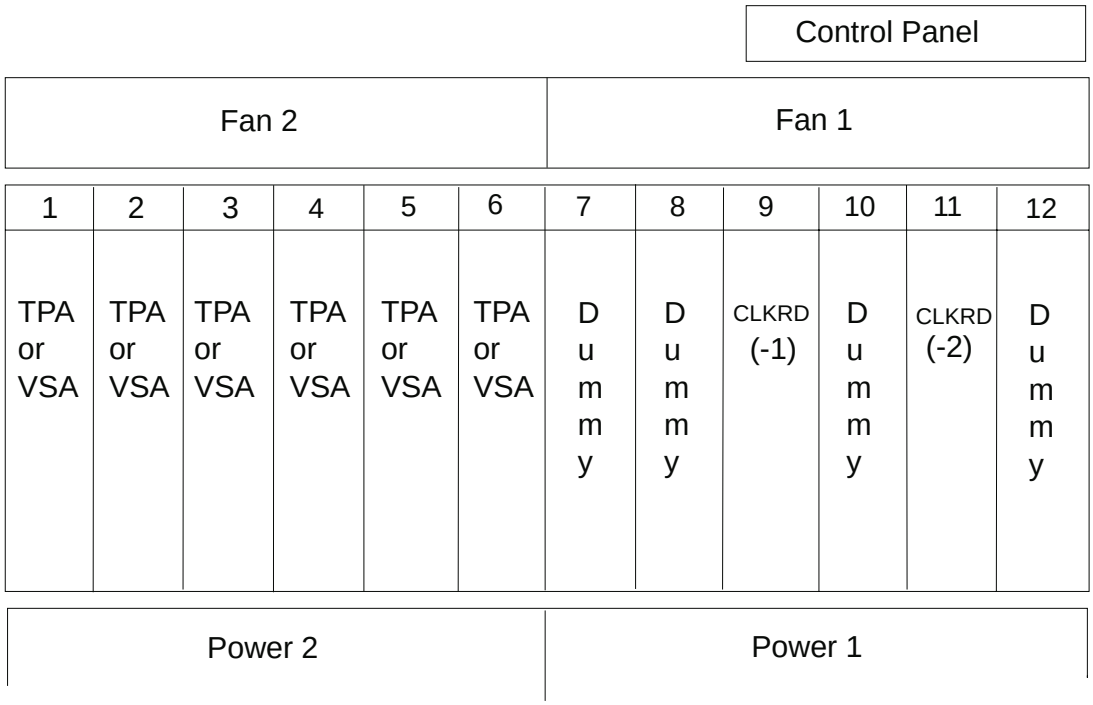
Slots 1 to 6
Can be used to plug:

- Up to six trunk or port adapters (TPAs)
- Up to six voice server adapters (VSAs).

A mixture of the two types is allowed up to a total of six adapters.

Clock redrive (CLKRD)
For a clock module in the Model 500, there is a clock redrive module in the Model 501 (in slot 9). The clock redrive module is linked to the Model 500 clock module and has a similar function.

Dummy modules
Used to fill in the empty slots of the logic subrack in order to ensure correct air cooling.



Legend

CLKRD
clock redrive

TPA trunk or port adapter

VSA voice server adapter

Figure 38. 2220-501 Logic Subrack (Front)

2220-501 Logic Subrack (Rear)

The rear of the logic subrack, shown in Figure 39 on page 101, contains the following parts:

Slots 1 to 6
Can be used to plug:

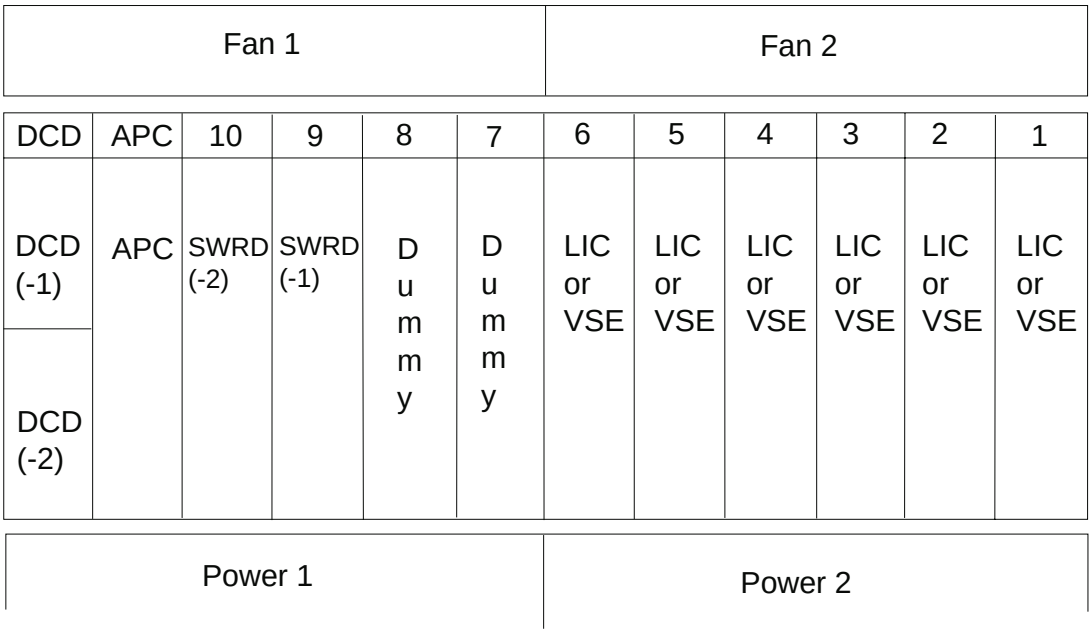
- Line interface couplers (LICs), each attached to its appropriate adapter.
- Voice server extensions (VSEs), each attached to its VSA.

Switch module redrive (SWRD)
For a switch module in the Model 500, there is a switch redrive module in the Model 501. The switch redrive module is linked to the Model 500 switch module and has a similar function.

Alarm and power control (APC) module
Connects the NAS, reports alarms, and controls the power supplies.

DC power distribution (DCD)
Two half-modules, one for each power module.

Dummy modules
Same as for the front of the Model 501 logic subrack.



Legend

APC alarm and power control

DCD dc distribution

LIC line interface coupler

SW switch module

VSE voice server extension

Figure 39. 2220-501 Logic Subrack (Rear)

2220-501 Power Subrack

The power subrack contains the ac or dc power module feature, which can be duplicated to provide backup. The Model 501 power modules must match the Model 500 power modules. Refer to “2220-500 Power Subrack” on page 98 for more information.

2220-501 Redundant Mode

If the clock is duplicated in the Model 500, the clock redrive module is duplicated in the Model 501 (front side, slot 11).

If the switch module is duplicated in the Model 500, the switch redrive is duplicated in the Model 501 (rear side, slot 10). There is no control point in the Model 501 and no duplication of the control point.

2220 Model 300 Configuration

The Model 300 has less capacity than the Model 500. Physically, it is the same size as the Model 500 and can be field-upgraded to a Model 500.

In the Model 300, from top to bottom, there are three main areas:

- Nways Switch administration station (NAS)
- Logic subrack
- Power subrack.

2220-300 Nways Switch Administration Station

The Nways Switch administration station for Model 300 is the same as the one in the Model 500 (refer to page 95).

2220-300 Logic Subrack (Front)

The front of the logic subrack, Figure 40 on page 103, contains the following elements:

Control panel
Same as for the Model 500. Refer to “2220 Model 500 Configuration” on page 95

Fan units
Two fan units with two fans in each.

Slots 1 to 6
Can be used to plug:

- Up to four trunk or port adapters (TPAs)
- Up to two voice server adapters (VSAs).

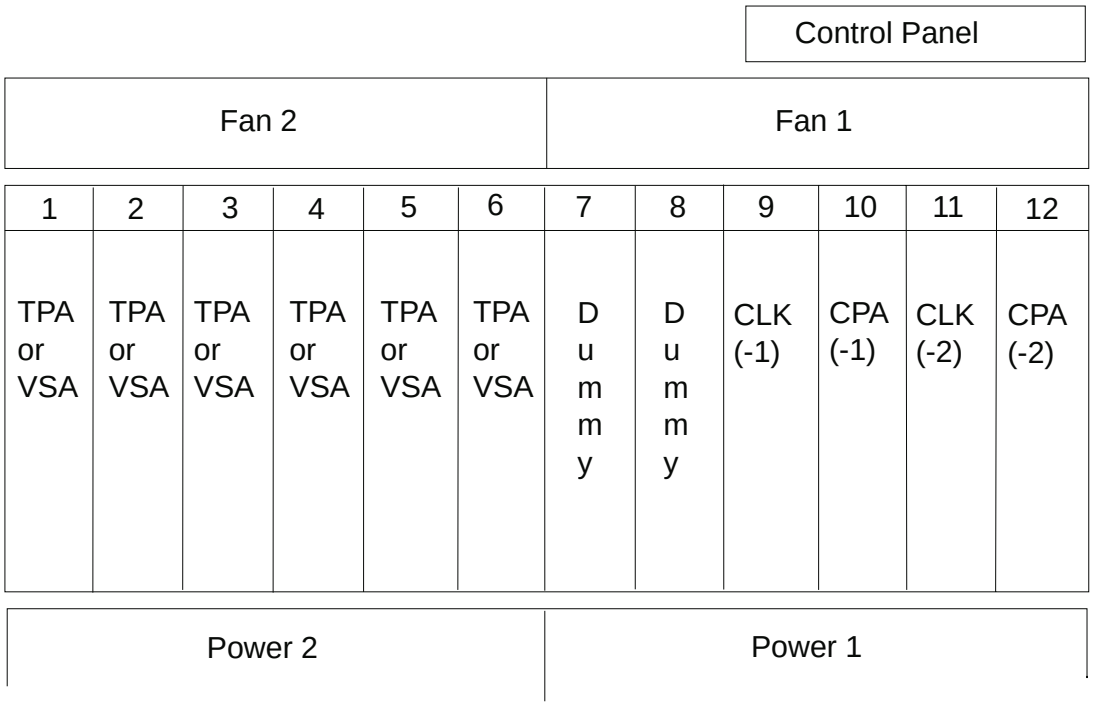
A mixture of the two types is allowed, up to a total of six adapters.

Control point adapter (CPA)
Can be used alone as a dedicated adapter module in slot 10. Can have a backup module in slot 12.

Trunk and control point adapter (TCPA)
Is a trunk adapter module where control point and trunk adapter functions coexist (can be plugged in slots 1 to 6). Can have a backup module (also in slots 1 to 6).

Clock module (CLK)
Optional in slot 9 and can have a backup module in slot 11.

Dummy modules
Used to fill in the empty slots of the logic subrack in order to ensure correct air cooling.



Legend

CLK clock

CPA control point adapter

TPA trunk or port adapter

VSA voice server adapter

Figure 40. 2220-300 Logic Subrack (Front)

2220-300 Logic Subrack (Rear)

The rear of the logic subrack Figure 41 on page 104, contains the following parts:

Slots 1 to 6
Can be used to plug:

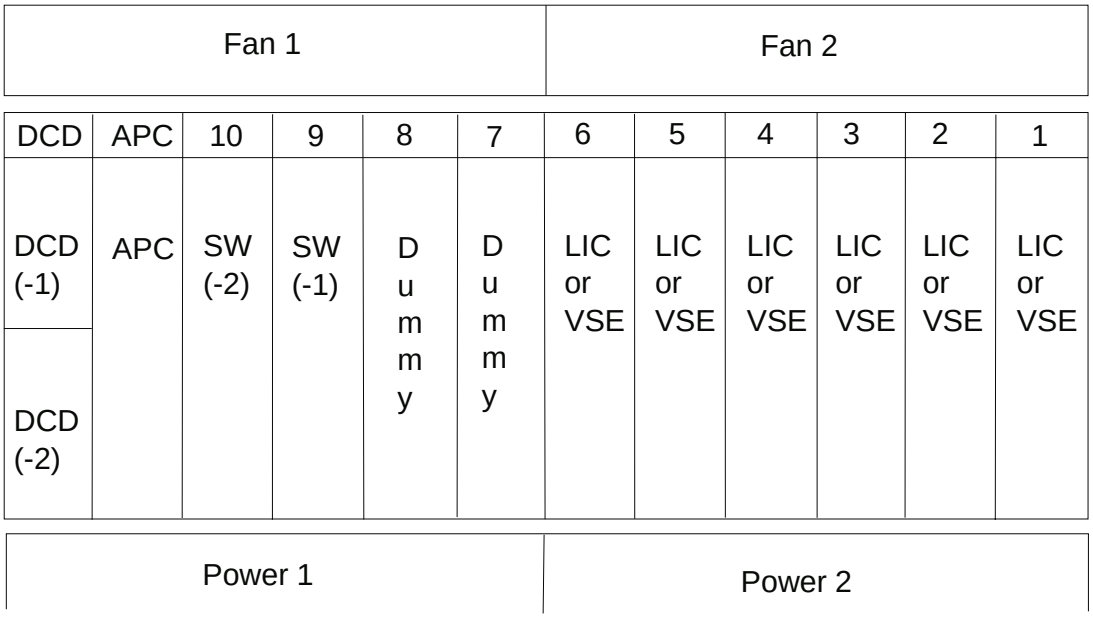
- Line interface couplers (LICs), each attached to its appropriate adapter.
- Voice server extensions (VSEs), each attached to its VSA.

Switch module (SW)
An ATM cell switch (in slot 9), which can have a backup module (in slot 10). It has a smaller capacity that the Model 500 switch module.

Alarm and power control (APC) module
Connects the NAS, reports alarms, and controls the power supplies.

DC power distribution (DCD)
Two half-modules, one for each power module.

Dummy modules
Same as for the front of the Model 300 logic subrack.



Legend

APC alarm and power control

DCD dc distribution

LIC line interface coupler

SW switch module

VSE voice server extension

Figure 41. 2220-300 Logic Subrack (Rear)

2220-300 Power Subrack

The Model 300 power subrack is the same as the Model 500 power subrack. Refer to “2220-500 Power Subrack” on page 98 for more information.

2220-300 Redundant Mode

The Model 300 can be configured to operate in redundant mode. The following key components are duplicated:

- Switch module
- Control point module
- Clock module, if present.

Chapter 8. Physical Line Attachment (Layer 1) Specifications

This chapter summarizes the specifications at the physical level (layer 1) of the attachments to the various types of lines supported by the Nways Switch LICs. It gives information on:

- Type and number of line connectors
- Standards supported:
  - At the electrical or optical level between the line and the LIC
  - For alarms
  - For framing, when applicable.
- Types of coding supported
- Available operating speeds and the corresponding access rate or payload when applicable.

This chapter is divided into several sections, each of them relating to one or more types of lines.

T1, E1, and J1 Line Attachments

Table 13 summarizes the line attachment physical characteristics according to the type of line.

Table 13. T1, E1, and J1 Line Attachment Physical Characteristics and Supported Standards

Characteristics	**T1**	**E1**	**J1**
Fractional Support	FT1	FE1	FJ1
LIC Types	514 and 544	515, 516, 545, 546, 563, and 567	514
Line Speeds	1544 kbps	2048 kbps	1544 kbps
Payloads	• T1: From one channel at 1.536 Mbps to 24 channels at 64 kbps • QSIG: primary rate access 23B+D (23 channels at 64 kbps plus D channel)	• E1: from one channel at 1.984 Mbps to 31 channels at 64 kbps • ISDN/QSIG: primary rate access 30B+D (30 channels at 64 kbps plus D channel)	• J1: From one channel at 1.536 Mbps to 24 channels at 64 kbps • ISDN: primary rate access 23B+D (23 channels at 64 kbps plus D channel)
Clock Extraction	Yes	Yes	No
Connector Types	RJ48C/CA48C DB15/CA31A	**LIC515 and 545** 75-ohm line impedance, BNC type connector **LIC516, 546, 563, and 567** Open wires 120-ohm line impedance, RJ48 type connector	ISO IO173

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Table 13. T1, E1, and J1 Line Attachment Physical Characteristics and Supported Standards (continued)

Characteristics	T1	E1	J1
Number of Line Attachments	**LIC514** 4 line attachments **LIC544** 8 line attachments	**LIC515, 516, 563, and 567** 4 line attachments **LIC545 and 546** 8 line attachments	**LIC514** 4 line attachments **LIC544** 8 line attachments
Physical Interfaces	• **Interface type:** – DS1 for LIC514 – DS1 for LIC544 with external CSU – DSX1 for LIC544 (Maximum length of cable to DSU-end is 36 m or 110 ft) • **Standards:** AT&T 62411 ANSI T1.403 EIA IA.547	**LIC515, 516, 545, and 546** ITU-T G.703 **LIC563 and 567** ITU-T I.431 ETS 300 011	• **Interface type:** – NTT interface – DS1 – DSX1 (maximum length of cable to DSU-end is 36 m or 110 ft). • **Standards:** – JT-I411a – JT-I431a – ANSI T1.403 – NTT HSDLCS
Line Codes	• B8ZS • AMI	• HDB3	• B8ZS • AMI
Frame Formats	D4 (SF), D5 (ESF) for: • T1.403 • T1.407 • AT&T 62411	• ITU-T G.703 unstructured • ITU-T G.704 with or without CRC • ITU-T G.706 support for frame alignment/CRC procedure	NTT-I interface format
Alarm	• T1.M1 • AT&T 62411	ITU-T G.732	ITU-T G.732
Compatibilities	• DACS (transparent) from AT&T • DDS/M24 (transparent) from AT&T • G.704/702 compatibility for inter-PBX signaling.	G.704/702 compatibility for inter-PBX signaling	NTT interface multiple access service
Signaling Types	• None • PBX CAS • PBX CCS Transparent	• None • PBX CAS • PBX CCS Transparent • PBX Q signaling (QSIG)	• None • PBX CAS • PBX CCS Transparent

T3, E3, E2, or J2 Line Attachments

Table 14 summarizes the line attachment physical characteristics according to the type of line.

Table 14. T3, E3, E2, and J2, Physical Characteristics and Supported Standards

Characteristics	T3	E3	E2	J2
Fractional Support	No fractional T3	No fractional E3	No fractional E2	**LIC523**:No**LIC562**:Yes (J2 MA/SR)
LIC Type	513	523	523	523, 562
Speed	44 736 kbps	34 368 kbps	8448 kbps	**LIC523**:6312 kbps **LIC562**:1,536 Mbps
Payload	Clear channel: 1 x 42 209.7 kbps	Clear channel: **G.751** 1 x 34 099.5 kbps **G.753** 1 x 34 176 kbps	Clear channel: **G.742** 1 x 8328.45 kbps **G.745** 1 x 8368.30 kbps	Clear channel: **LIC523**:1 x 6144 kbps
Clock Extraction	Yes	Yes	Yes	Yes
Connector Type	BNC	BNC	BNC	BNC
Number of Line Attachments	1 line attachment	1 line attachment	1 line attachment	1 line attachment
Physical Interfaces	• DS3 • T1.107/107a	ITU-T G.703	ITU-T G.703	• JT-G703-a • T-1411a • NTT I interface
Line Codes	B3ZS	HDB3	HDB3	B8ZS
Frame Formats	M-framed, non subrated: • ANSI T1.107/107a • C-bit parity: – Clear channel – Multiplex	• G.751 • G.753 See note	• G.742 • G.745 See note	• G.704 • NTT I interface
Alarm	T1 or M1			
Note: The use of tributary and payload justification is not supported on clear channel lines.				

SONET STS-3c and SDH STM-1 Line Attachments

Table 15 on page 108 summarizes the line attachment physical characteristics according to the type of line.

Table 15. SONET STS-3c and SDH STM-1 Line Attachments

Characteristics	Optical Single Mode Fiber	Optical Multi Mode Fiber	Electrical
LIC Type	**554** Range up to 20 or 40 km or 12.42 to 24.84 mi (8µ fiber) **555** Range up to 10 or 20 km or 12.42 mi (8µ fiber)	**556** Range up to 2 km or 1.24 in (8µ fiber)	**553** Range up to 150 m (450 ft)
Line Speed	155.520 Mbps		
Payload	149.760 Mbps		
Clock Extraction	Yes		
Connector Type	**LIC554** SC (SC to FC/PC adapter supplied) **LIC555** SC	SC	**LIC553** BNC 75 ohms.
Number of Line Attachments	1 line attachment		
Physical Interfaces	Not Applicable	Not Applicable	ITU-T G.703
Line Code	Not Applicable	Not Applicable	CMI
Laser	1310 nm, class 1 (ITU-T G.957)	The LIC556 uses a diode, not a laser	Not applicable
Minimum Transmitted Power	**LIC554** -8 dBm **LIC555** -15 dBm	-19 dBm	Not applicable
Maximum Receiver Sensitivity	**LIC554** -34 dBm **LIC555** -28 dBm	-30 dBm	Not applicable
Optical Power Budget	**LIC554** 26 dBm **LIC555** 13 dBm	11 dBm	Not applicable
Frame Formats	SONET STS-3c (T1-105) SDH STM-1 (ITU-T G.708/G.709) ATM cells in VC-4		
Cell Delineation	I.432		
Rate decoupling	I.432, I.361, and ATM Forum 3.0/3.1		
Idle Cell Character	Not supported		
Cell Discard Policies	ANSI, ANSI unassigned ATM Forum, ATM Forum unassigned CCITT, CCITT unassigned		

ATM DS3 and E3 Line Attachments

Table 16 summarizes the line attachment physical characteristics according to the type of line.

Table 16. ATM DS3 and E3 Line Attachment Physical Characteristics and Supported Standards

Characteristics	DS3	E3
Fractional Support	No fractional DS3	No fractional E3
LIC Type	551	552
Line Speed	44.736 Mbps	34.368 Mbps
Payload	1 × 42.209 Mbps	1 × 33.920 Mbps
Clock Role	DTE or DCE	DTE or DCE
Connector Type	75–ohm line impedance, BNC type connector	75–ohm unbalanced line impedance, BNC type connector
Number of Line Attachments	2 line attachments	2 line attachments
Physical Interfaces	DS3	ITU-T G.703
Line Codes	B8ZS	HDB3
Frame Formats	C-bit parity multiplex	ITU-T G.832
Transmission Convergence Layer	• PLCP • HEC	Not applicable
Cell Payload Scrambling	• PLCP: No • HEC: Yes	Not applicable
Cell Discard Policies	ANSI, ANSI unassigned ATM Forum, ATM Forum unassigned CCITT, CCITT unassigned	
Idle Cell Character	Not supported	

X.21, V.35, V.36, and V.24 (RS-232) Line Attachments

The line interface characteristics are as follows according to the type of line:

- Interface role: DTE or DCE.
- Clock role (internal or external) and speed. Available speeds are given in Table 17.
- NRZ-I: can be yes or no.

Note: Each interface supports only leased lines, full-duplex mode.

Table 17. X.21, V.35, V.36, and V.24 (RS-232) Line Interface Characteristics

	X.21	V.35	V.36	V.24 (RS-232)
LIC Types	511 or 522	511 or 522	522	511

Table 17. X.21, V.35, V.36, and V.24 (RS-232) Line Interface Characteristics (continued)

	X.21	V.35	V.36	V.24 (RS-232)
Internal Clock Speeds	For LIC511 only: 2400 bps 4800 bps 9600 bps 19 200 bps 38 400 bps 56 000 bps 64 000 bps 256 000 bps For LIC522 only: 512 kbps 1024 kbps 1536 kbps 2048 kbps (default)			2400 bps 4800 bps 9600 bps 19 200 bps
External Clock Speeds	From 56 to 2048 kbps (default is 2048 kbps)			From 56 to 256 kbps (default is 256 kbps)
Clock Role	DTE or DCE is determined by the cable type, not by the configuration parameter			
Clock Extraction	LIC522 only (only from the first line attached to the LIC)		No	No
Physical Interface Standards	ITU-T X.21	ITU-T V.35	ITU-T V.36	ITU-T V.24
Connector Types and Number	**LIC511** Two DB15 connectors for connection of two LCBs (See note)			
	LIC512 Four RJ45 connectors **LIC522** Four RJ45 connectors			

Note:

The interface standards are defined for the end of the active remote connector (ARC) cables connected to the line connection boxes (LCBs) or line connection box expansions (LCBEs):

- Every LCB supports the attachment of one LCBE.
- The maximum number of lines on one LIC511 is 60 (15 per LCB or LCBE).
- The actual maximum number of lines depends on their speed (number of lines × line speed ≤ 2.048kbps).

JJ-20 TTC Line Attachment

Table 18 summarizes the line attachment physical characteristics of the JJ-20 TTC line attachment to Japanese private branch exchange (PBX).

Table 18. JJ-20 TTC Line Attachment Physical Characteristics and Supported Standards

Characteristics	JJ-20 TTC
LIC Type	517
Line Speed	2048 kbps
Payload	• Clear channel: 2048 kbps (unframed) • Channelized: 30 × 64 kbps (framed)
Clock Extraction	No (The extracted RCV clock is only used for receive data sampling, not for reference clock)
Clock Role	DTE (internal)
Connector Type	ISO 4903 (DB15 Female)
Number of Line Attachments	4 line attachments
Physical Interface	JJ-20.11 electrical and physical conditions
Code	CMI
Frame Format	JJ-20.11
Alarm	JJ-20.10
Compatibility	JJ-20.12 compatibility for inter-PBX signaling
signaling Type	• Framed: PBX CAS • Unframed: none

HSSI Line Attachments

The HSSI line interface is supported by the LIC530. This interface can be either DTE or DCE.

Internal Clock Speeds Available

The following clock speeds are available in the internal clocking mode:

Table 19. HSSI Clock Speeds (LIC530)

Clock Speed	Corresponding T1 Speed	Corresponding E1 Speed
6.144 Mbps	4xT1	3xE1
12.288 Mbps	8xT1	6xE1
18.432 Mbps	12xT1	9xE1
24.576 Mbps	16xT1	12xE1
30.720 Mbps	20xT1	15xE1
36.864 Mbps	24xT1	18xE1
43.006 Mbps	28xT1	21xE1
49.152 Mbps	32xT1	24xE1

External Clock Speeds Available

The HSSI line interface is able to accommodate any external clock speed up to 49.152 Mbps.

Note: Clock extraction is available only at 49.152 Mbps.

Appendix. Notices

Notices

References in this publication to IBM products, programs, or services do not imply that IBM intends to make these available in all countries in which IBM operates. Any reference to an IBM product, program, or service is not intended to state or imply that only IBM's product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any of IBM's intellectual property rights may be used instead of the IBM product, program, or service. Evaluation and verification of operation in conjunction with other products, except those expressly designated by IBM, is the user's responsibility.

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This product is in conformity with the protection requirements of EU Council Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM can not accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the fitting of non-IBM option cards.

Electronic Emission Notices

Federal Communications Commission (FCC) Statement

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to the Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Industry Canada Compliance Statement

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This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Avis de conformité aux normes d'Industrie Canada

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Japanese Voluntary Control Council For Interference (VCCI) Statement

This equipment is in the 1st Class category (information equipment to be used in commercial and/or industrial areas) and conforms to the standards set by the Voluntary Control Council for Interference by Information Technology Equipment aimed at preventing radio interference in commercial and industrial areas.

Consequently, when used in a residential area or in an adjacent area thereto, radio interference may be caused to radios and TV receivers, and so on.

Read the instructions for correct handling.

Power Line Harmonics (JEIDA) Statement

The guidelines of power line harmonics required by JEIDA are satisfied.

Korean Communications Statement

Please note that this device has been approved for business purpose with regard to electromagnetic interference. If you find this is not suitable for your use, you may exchange it for a non-business one.

New Zealand Radiocommunications (Radio) Regulations

Attention: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Taiwanese Class A Warning Statement

This a Class A product. In a domestic environment this product may cause radio interference in which case the user will be required to take adequate measures.

警告使用者:
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

Safety Notices for United Kingdom

1. The IBM 2220 Nways BroadBand Switch is manufactured according to the International Safety Standard EN 60950 and as such is approved in the UK under the General Approval Number NS/G/1234/J/100003 for indirect connection to the public telecommunication network.
2. The network adapter interfaces housed within the IBM 2220 Nways BroadBand Switch are approved separately, each one having its own independent approval number. These interface adapters, supplied by IBM, do not use or contain excessive voltages. An excessive voltage is one that exceeds 42.4 V peak ac or 60 V dc. They interface with the IBM 2220 Nways BroadBand Switch using Safety Extra Low Voltages (SELV) only. In order to maintain the separate (independent) approval of the IBM adapters, it is essential that other optional cards, not supplied by IBM, do not use mains voltages or any other excessive voltages. Seek advice from a competent engineer before installing other adapters not supplied by IBM.

Safety Notice for Australia

In Australia, the LIC545 and LIC546 must be connected only to Safety Extra Low Voltage (SELV) networks.

If an attachment to a Telephone Network Voltage (TNV) network is required, you must use a LIC515 instead of a LIC545, and a LIC516 instead of a LIC546.

Telecommunication Connectivity Notices

Notice to Users of Machines Installed in the U.S.

This equipment complies with Part 68 of the FCC rules. On the LIC module of this equipment is a label that contain, among other information, the FCC registration number. If requested, this information must be provided to the telephone company.

If this equipment causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of the service may be required. If advance notice is not practical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you feel it is necessary.

The telephone company may make changes in its facilities, equipment, operations, or procedures, that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications to maintain uninterrupted service.

If you experience trouble with this equipment, please contact (800) IBM-SERV for repair and warranty information. If the trouble is causing harm to the telephone network, the telephone company may request you to remove the equipment from the network until the problem is resolved.

No repair can be done by you, customer. Please contact (800) IBM-SERV.

This equipment cannot be used on telephone company-provided coin service. Connection to Party Line Service is subject to state tariffs.

Equipment Ordering Information for U.S. Machines

This section provides information about Facility Interface Codes and Service Order Codes that are needed to order the corresponding services to the carrier company. Please refer to “Notice to Users of Machines Installed in the U.S.” on page 115 for the legal information related to the connection of this equipment to the telephone network.

LIC514:

Facility Interface Code	Service Order Code	Module type
04DU9-BN	6.0F	LIC514
04DU9-DN	6.0F	LIC514
04DU9-1KN	6.0F	LIC514
04DU9-1SN	6.0F	LIC514

The standard connecting arrangement code for this equipment is:

Connector type
8-position miniature

Connector model
RJ48C

Cable length
30 m (98 ft) maximum

R.E.N Not applicable.

LIC544:

Facility Interface Code	Service Order Code	Module type
04DU9-BN	6.0P	LIC544
04DU9-DN	6.0P	LIC544
04DU9-1KN	6.0P	LIC544
04DU9-1SN	6.0P	LIC544

The standard connecting arrangement code for this equipment are:

Connector type
8-position miniature

Connector model
Not Applicable

Cable length
30 m (98 ft) maximum

R.E.N Not applicable

or,

Connector type
15-position

Connector model
DB15F

Cable length
30 m (98 ft) maximum

R.E.N Not applicable

Notice to Users of Machines Installed in Canada

The Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements document(s). The Department does not guarantee the equipement will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be coordinated by a representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Caution: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

Equipment Ordering Information for Canadian Machines

LIC514: The standard connecting arrangement code for this equipment is:

Connector type
15-position or 8-position miniature

Connector model
CA81A or CA48C

Cable length
30 m (98 ft) maximum

Load number
Not applicable

Please refer to "Notice to Users of Machines Installed in Canada" for the legal information related to the connection of this equipment to the telephone network.

LIC544: The standard connecting arrangement code for this equipment is:

Connector type
15-position or 8-position miniature

Connector model
CA81A or CA48C

Cable length
30 m (98 ft) maximum

Load number
Not applicable

Please refer to “Notice to Users of Machines Installed in Canada” on page 117 for the legal information related to the connection of this equipment to the telephone network.

Notice to Users of Machines Installed in UK

The Nways BroadBand Switch is manufactured to the International Safety Standard IEC950 and as such is approved in the UK under the General Approval number NS/G/1234/J/100003.

The Line Interface Adapters (LICs), installed in the Nways Switch are approved separately and each have their own independent approval number.

The LICs, supplied by IBM, do not contain excessive voltages. An excessive voltage is one which exceeds 42.4v peak ac or 60v dc. They interface with the Nways Switch host using Safe Extra Low Voltages only.

EU Directives

LIC 516 complies with the following EU directives:

EMC 89/336/EEC

LVD 73/23/EEC

Telecommunications
91/263/EEC

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Glossary

The following are the abbreviations and technical terms used in the 2220 Nways Switch library.

2220. The IBM 2220 Nways BroadBand Switch (also called Nways Switch) is a fast packet switch enabling high-speed communications over a broadband network. It implements the functions of the IBM Networking BroadBand Services (NBBS) architecture.

2220-300. 2220 Nways Switch Model 300.

2220-500. 2220 Nways Switch Model 500.

2220-501. 2220 Nways Switch Model 501.

2220 NSM. 2220 Nways Switch Manager

AAL. ATM adaptation layer.

ABR. Availability bit rate. A best effort service with a minimum bit rate and a maximum cell loss value.

ac. Alternating current.

access services. Functions that are performed by a port adapter of the IBM 2220 Nways BroadBand Switch to:

- Support the attachment of external user devices through port lines
- Prepare user data packets
- Control the input traffic on port lines
- Manage line protocols.

active remote connector (ARC). A connector that supplies the electrical and physical interfaces between a line interface coupler type 511 (LIC511) in an Nways Switch subrack and data circuit-terminating equipment (DCE) or data terminal equipment (DTE). ARCs are housed in line connection boxes (LCBs).

adapter. An Nways Switch module that can be used, depending on its hardware type and the code that it runs, as:

Control point adapter

Port adapter

Trunk adapter

Voice server adapter.

A trunk or port adapter is associated with a line interface coupler (LIC). A voice server adapter can be associated with a voice server extension (VSE).

ADPCM. Adaptive differential pulse code modulation.

AIS. Alarm indicator signal.

AIX. Advanced Interactive Executive.

alarm and power control (APC). In an Nways Switch, a module that connects the NAS, reports alarms, and controls the power supplies.

Alert Manager. An application that processes the SNA alerts received from IBM 3746s operating in IP mode.

AMI. Alternate mark inversion.

ANSI. American National Standards Institute.

APC. Alarm and power control (module).

AR. Access rate.

ARC. Active remote connector.

asynchronous transfer mode (ATM). A high-speed, connection-oriented switching and multiplexing protocol that transmits different types of traffic (voice, video, and data) simultaneously.

ATM. Asynchronous transfer mode.

ATMAn. ATM adapter type n (module).

ATM adaptation layer (AAL). In ATM devices, a set of protocols that adapt non-ATM devices to an ATM network. There are several classes of ATM adaptation layers which represent the main traffic types (for example, data, voice, and video).

ATM network interface. A logical resource generated by the Nways Switch Control Program to provide access services to a physical ATM port or trunk line. An ATM network interface sets up and maintains predefined ATM virtual connections.

AT&T. American Telephone & Telegraph (Company).

B8ZS. Bipolar eight-zero substitution.

Bc. Burst committed.

Be. Burst in excess.

bearer service profile (BSP). A set of parameters that defines a type of ISDN traffic (speech, audio, data, or video). One BSP is associated with each ISDN numbering plan table.

BECN. Backward explicit congestion notification.

B-ICI. Broadband inter-carrier interface.

BMI. Byte multiplexer interface.

BNC. Bayonet Niell-Concelman.

bps. Bit per second.

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bridge. A functional unit that interconnects two local area networks. A bridge works at the data link level (layer 2) of the OSI reference model.

broadband network. A network that uses a large frequency band to transport different kinds of traffic (such as coded voice, video, and data) at the same time.

BS. Bearer services.

BSC. Binary synchronous communication.

BSP. Bearer service profile.

BT. Burst tolerance.

bursty. Refers to transmission at variable bit rate where the time between data transmissions is not always the same.

CAC. Connection admission control.

CAS. Channel associated signaling.

CBR. Constant bit rate.

CCS. (1) Common channel signaling (2) Change control server (also called CC server).

CDB. Configuration database.

CDV. Cell delay variation.

CDVT. Cell delay variation tolerance.

cell loss priority (CLP). A priority bit in the ATM cell header. When set, it indicates that the cell can be discarded during traffic congestion.

centralized configuration database. A database prepared with the Nways Switch Configuration Tool Version 2 (NCT2) on a configuration station. It stores the parameters of a 2220 network.

CES. Circuit emulation services.

change control server (CCS or CC server). A station that runs the IBM NetView Distribution Manager for AIX to store the Nways Switch Control Program and to manage code changes.

CIR. Committed information rate.

circuit emulation services (CES). An access service that emulates a leased line. It transports information with a constant bit rate at the source and destination. The traffic can be PCM voice, video, fax, multimedia, or real-time synchronous data (such as BSC).

CLIP. Calling line identification presentation.

CLIR. Calling line identification restriction.

CLK. Clock (module).

CLKRD. Clock redrive (module).

clock module (CLK). A module of the 2220 Model 300 or 500 that transmits clock signals to the line interface couplers (LICs). It is optional and can have a backup.

clock redrive (CLKRD). A module of the 2220 Model 501 that drives the signals from the Model 500 clock module to the adapters of the Model 501. The clock redrive is optional and can have a backup.

clock references. In an Nways Switch, the software function that controls the transmission of clock signals to the LICs where they are used for bit synchronization.

CLP. Cell loss priority.

CMIP. Common management information protocol.

CMIS. Common management information services.

CMOT. CMIP over TCP/IP.

CNM. Communication network management.

code file. A named set of records stored as a unit in a change control server. An Nways Switch code file can include data or internal code.

COLP. Connected line identification presentation.

COLR. Connected line identification restriction.

configuration station. See Nways Switch configuration station.

control point (CP). In an Nways Switch, a logical resource that provides network control functions. It can have a backup.

CP. Control point.

CPA. Control point adapter (module).

CPE. Customer premises equipment.

CP spanning tree. In a 2220 network, a distribution tree that connects the Nways Switch control points through trunk lines. The CP spanning tree supplies a very fast and efficient way to multicast control messages such as network topology data.

CRC. Cyclic redundancy check.

CSU. Channel access unit.

CTD. Cell transfer delay.

data circuit-terminating equipment (DCE). An equipment installed on a user premises that provides all the functions required to establish, maintain, and terminate a connection, and to do the signal conversion

and coding between a data terminal equipment (DTE) and a line. A DCE can be separate piece of equipment or part of other equipment.

data terminal equipment (DTE). That part of a data station that serves as data source, data sink, or both, and provides the data communication control function depending on the type of protocol used.

dB. Decibel.

dBm. Decibel based on 1 milliwatt.

DC48. Dc power input type -48V

dc. Direct current.

DCD. Dc distribution (module).

DCE. Data circuit-terminating equipment.

DDI. Direct dialing-in.

DE. Discard eligibility.

decibel (dB). (1) One tenth of a bel. (2) A unit that expresses the ratio of two power levels on a logarithmic scale. (3) A unit for measuring relative power. The number of decibels is 10 times the logarithm (base 10) of the ratio of the measured power levels; if the measured levels are voltages (across the same or equal resistance), the number of decibels is 20 times the log of the ratio.

decibel based on 1 milliwatt (dBm). A unit of absolute power measurement that is scaled such that 0 dBm equals 1 milliwatt.

dialog box. On the screen of a station, an area with entry fields and push buttons. (Also called dialog.)

DLCI. Data link connection identifier.

DNPT. Destination numbering plan table.

DSP. Digital service processor.

DSU. Data service unit.

DTE. Data terminal equipment.

DTMF. Dual-tone modulation frequency.

DTR. Data terminal ready.

dummy module. In an Nways Switch, a cover inserted in the place of a module to ensure correct air cooling inside a logic subrack. During normal operation, the dummy modules must not be removed.

E1 standard. A European standard for TDM digital transmission service at 2.048 Mbps.

E3 standard. A European standard for TDM digital transmission service at 34.368 Mbps. An E3 line can transport up to 16 E1 circuits.

E&M. Earth & mark.

ECMA. European Computers Manufacturers Association.

EIA. Electronics Industries Association.

equivalent capacity. The minimum amount of bandwidth needed by a connection to ensure that the packet loss ratio is below a specified threshold.

ESF. Extended status flags.

ETS. European telecommunication standard.

FANB. Fan box.

FAT. File allocation table.

fax. Document received from a facsimile machine. Synonym for telecopy.

FCS. Frame check sequence.

FDDI. Fiber Distributed Data Interface.

FE1. Fractional E1.

FECN. Forward explicit congestion notification.

FEP. Front-end processor.

fiber. Synonym for optical fiber.

fiber budget. The optical power loss as result of the number of connections in the optical fiber link subtracted from the working budget. The loss as a result of connections includes connector loss and splice loss. The fiber budget is expressed in decibels.

Fiber Distributed Data Interface (FDDI). A U.S. standard for 100 Mbps token-ring LANs using optical fiber cables over distances of several kilometers.

fiber optic cable. Synonym for optical fiber.

FR. Frame relay.

FRAD. Frame-relay access device.

frame relay (FR). A connection-oriented protocol to transport data frames over a fast packet-network with guaranteed end-to-end quality of service.

FRFH. Frame-relay frame handler.

front-end processor (FEP). A processor, such as the IBM 3745, 3746 Model 900 or 950, or 3174, that relieves a main frame from communication control tasks.

FRTE. Frame-relay terminal equipment.

FRU. Field replaceable unit.

FT1. Fractional T1.

FTP. File transfer protocol.

Gbps. Gigabit per second (10 to the power of 9 bits per second).

GCRA. Generic cell rate algorithm.

GFP. Generic function protocol.

GFT. Generic function transport.

GSM. Group special mobile.

GUI. Graphical user interface.

HDB3. High-density bipolar 3.

HDLC. High-level data link control.

high-level data link control (HDLC). A data network protocol.

hot pluggable. Refers to a hardware component that can be installed or removed without disturbing the operation of any other resource that is not connected to, or dependent, on this component.

HPFS. High-performance file system.

HPRI. High priority.

HSAn. High-speed adapter type n (module).

HSDS. High-speed digital services.

HSSI. High-speed serial interface.

hub (intelligent). A wiring concentrator, such as the IBM 8260, that supplies bridging and routing functions for LANs with different cables and protocols.

hunt group. See X.25 hunt group.

IDNX. Integrated Digital Network Exchange.

IE. Information element.

ILMI. Interim local management interface.

IMU. Inverse multiplexing unit

Integrated Digital Network Exchange (IDNX). A processor integrating voice, data, and image applications. It also manages transmission resources and connects to multiplexers and network management support systems. It permits integration of equipment from different vendors.

integrated services digital network (ISDN). A digital end-to-end public or private network that supports multiple services including, but not limited to, voice and data.

IP. Internet Protocol.

IP gateway adapter. In an Nways Switch, a port adapter that routes the IP control between the NAS and the network management station.

ISDN. Integrated services digital network.

ISDN network interface. A logical resource generated by the Nways Switch Control Program to provide access services to a physical ISDN or QSIG port line. An ISDN network interface sets up and maintains connections between calling ISDN terminal equipments and called terminal equipments attached through other Nways Switches.

ISO. International Organization for Standardization.

isochronous. Refers to transmission at a constant bit rate where there is a clock relationship between source and destination. The bit rates are the same on the destination and source.

ITU-T. International Telecommunication Union - Telecommunication (replaces CCITT).

jitter. Undesirable variations in the transmission delay of a digital signal. Also called cell delay variation (CDV).

KB. Kilobyte (storage capacity, 1024 bytes).

kbps. Kilobit per second (1000 bits per second).

LAN. Local area network.

LAPB. Link access procedure for B-channel.

LAPD. Link access procedure for D-channel.

LCB. Line connection box.

LCBB. Line connection box, base (LCEB and LCPB).

LCBE. Line connection box, expansion (LCEE and LCPE).

LCEB. Line connection enclosure, base.

LCEE. Line connection enclosure, expansion.

LCPB. Line connection power, base.

LCPE. Line connection power, expansion.

LCR. Least cost routing.

LED. Light-emitting diode.

LICn. Line interface coupler type n (module).

line. In a 2220 network, any physical medium, such as a telephone wire, microwave beam, or optical fiber, that transmits information. A line can be a trunk line or a port line.

line connection box (LCB). A metallic box that:

- Multiplexes up to 15 low-speed lines. There can be up to four LCBs per LIC type 511 for a total of 60 lines (two LCBs and 30 lines per LIC connector).
- Reduces cable lengths between Nways Switch and DCE or DTE locations.

An LCB fits in a standard 19-inch rack. Each one houses up to 15 active remote connectors (ARCs).

line interface coupler (LIC). In an Nways Switch, a module that physically attaches trunk or port lines. Each line interface coupler is associated with a trunk or port adapter, and supports specific line interfaces.

LIV. Link integrity verification.

LMI. Local management interface.

local area network (LAN). A computer network located on a user premises in a limited geographical area.

logical port. (Also called NBBS port.) A logical resource generated by the Nways Switch Control Program to provide access services to a physical port line (or channel of a TDM port line) using HDLC, FR, or CES protocol. A logical port sets up and maintains its predefined connections.

logical trunk. (Also called NBBS trunk.) A logical resource generated by the Nways Switch Control Program to provide transport services to a physical trunk line (or channel of a TDM trunk line). A logical trunk is mainly responsible for optimizing bandwidth and maintaining the CP spanning tree.

LSAn. Low-speed adapter type n (module).

MA/SR. Multi-access/sub-rate.

management access. Refers to an Nways Switch that connects a network management station or a change control server to a 2220 network through its service bus, which is a dedicated Ethernet LAN.

MB. Megabyte (storage capacity, 1 048 576 bytes).

Mbps. Megabit per second (10 to the power of 6 bits per second).

MBS. Maximum burst size.

MLT. Multiple logical trunks.

module. In an Nways Switch, a hardware unit plugged in a slot of the logic subrack. It houses, for example, an adapter, a line interface coupler, or a voice server extension. All modules are hot pluggable.

ms. Millisecond (1/1000 second).

NAS. Nways Switch administration station.

NBBS. Networking BroadBand Services (architecture).

NBBS architecture. See Networking BroadBand Services.

NBBS connection. See potential connection and virtual connection.

NBBS network. A network built with IBM 2220 Nways BroadBand Switches and conforming to the IBM Networking BroadBand Services (NBBS) architecture.

NBBS port. See logical port.

NBBS trunk. See logical trunk.

NCT2. Nways Switch Configuration Tool Version 2.

NDPS. Non-disruptive path switching.

NEM. Nways Enterprise Manager (see 2220 Nways Switch Manager).

network control. Functions that are performed by an Nways Switch control point to:

- Allocate and control the Nways Switch resources
- Provide topology and directory services
- Select routes
- Control congestion.

network management station (NMS). A station that runs IBM NetView for AIX and the 2220 Nways Switch Manager. It is used to manage network topology, accounting, performance, configuration, and error reporting.

network node interface (NNI). An interface between nodes in a communication network.

Network Support Center (NSC). A location from which IBM remotely supports 2220 networks.

Networking BroadBand Services (NBBS). An IBM architecture for high-speed networking that complements ATM standards and provides access services, transport services, and network control to user traffic.

NIC. Network Information Center.

NMS. Network management station.

NNI. Network node interface.

NPT. Numbering plan table.

NR. Non-reserved.

NRT. Non-real-time.

NRZI. Non-return-to-zero inverted recording.

NRZ-1. Non-return-to-zero change-on-ones recording.

NSAP. Network service address point.

NSC. Network Support Center.

NSM. (See 2220 Nways Switch Manager)

NVDM. NetView Distribution Manager for AIX.

NTT. Nippon Telegraph & Telephone (Corporation).

numbering plan table (NPT). A set of parameters, organized in origin NPT and destination NPT, that defines a type of called ISDN numbers. A numbering plan table is associated with each ISDN network interface.

Nways 2220 Switch Manager (2220 Switch Manager). An IBM licensed program that runs under NetView for AIX to manage the 2220 Nways Switch operation and configuration from a network management station. It replaces the Nways Enterprise Manager (NEM) which is no longer available.

Nways BroadBand Switch. Synonym for 2220 Nways BroadBand Switch.

Nways Enterprise Manager (NEM). An IBM licensed program that was used under NetView for AIX in a network management station to manage Nways Switches, routers, and bridges in a 2220 network (see 2220 Nways Switch Manager).

Nways Switch. Synonym for 2220 Nways BroadBand Switch.

Nways Switch administration station (NAS). A station attached to each 2220 to run the Control Program, and control and service the Nways Switch locally.

Nways Switch configuration station. A mandatory OS/2 or AIX station that runs a stand-alone version of the Nways Switch Configuration Tool Version 2 (NCT2) and stores the centralized configuration database of the NBBS network. An OS/2 station can be used as a remote user console.

Nways Switch Configuration Tool Version 2 (NCT2). A component of the Nways Switch Control Program that is used to configure physical and logical resources. It is also used in stand-alone version under OS/2 or AIX .

Nways Switch Control Program. The IBM licensed program that runs in the NAS and adapters of the 2220 Nways Switch. It includes a CMIP agent to work with the 2220 Switch Manager.

Nways 2220 Switch Manager for AIX. (See Nways 2220 Switch Manager)

Nways Switch Resource Control. A component of the Nways Switch Control Program. It is used from the NAS of an Nways Switch or from a remote user console to control resources and configuration files.

OAM. Operation, administration, and maintenance.

OC3. Optical carrier level 3.

ONPT. Origin numbering plan table.

operation, administration, and maintenance (OAM). A group of functions coded in specific ATM cells to handle alarms and loopback tests on ATM connections.

optical fiber. In fiber optics technology, a wave guide that propagates optical signals from light-generating transmitters to light-detecting receivers.

OSI. Open systems interconnection.

packet loss ratio. The probability that a packet will not reach its destination or not reach it in a specified time. It is obtained by dividing the number of packets lost in transmission by the total number transmitted.

packet transfer mode (PTM). The native transfer mode of the NBBS architecture. PTM divides the traffic into packets of variable length.

PBX. Private branch exchange.

PCM. Pulse code modulation.

PCR. Peak cell rate.

PDH. Plesiochronous digital hierarchy.

permanent virtual circuit (PVC). A virtual circuit that has a logical channel permanently assigned to it at each item of data terminal equipment. It is activated by a program or by a network operator request.

plesiochronous. Refers to transmission at a nominal bit rate where the source and destination are controlled by different clocks. The bit rates are nearly the same.

PLP. Packet layer protocol.

PNP. Private numbering plan.

port. See logical port.

port adapter. In an Nways Switch, a module that provides access services to one or more port lines. Each port adapter is associated with a line interface coupler (LIC).

port line. A communication line that connects a device on user premises to an Nways Switch and serves as a port to the 2220 network. Port lines have different protocols and interfaces.

position. When configuring an Nways Switch, the position parameter indicates the line attachment number on the LIC module (1 to 8, depending on the LIC type).

potential connection. A predefined connection through a 2220 network between two HDLC, CES, or frame-relay devices.

PPP. Point-to-point protocol.

PRA. Primary Rate Access.

private branch exchange (PBX). A switching system located on a user premises that relays inside lines (extensions) and provides access to the public telephone network.

PRS. Primary reference source.

PSDN. Packet switched data network.

PSN. Public switched network.

PSTN. Public switched telephone network.

PTF. Program temporary fix.

PTM. Packet transfer mode.

PTNX. Private telecommunications network exchange.

pulse code modulation (PCM). A standard adopted for the digitalization of analog voice signals. In PCM, voice is sampled at a rate of 8 kHz and each sample is coded in an 8-bit frame.

PVC. Permanent virtual circuit.

Q signaling (QSIG). An international standard for signaling procedures in private telecommunication networks. It applies to the PBX-to-Nways Switch interface, which is called the Q reference point.

QoS. Quality of service.

QSIG. Q signaling.

quality of service (QoS). In a 2220 network, a set of parameters that guarantees the characteristics of a connection, mainly its end-to-end delay, delay variation, and packet loss tolerance.

RABM. Router and Bridge Manager.

rack. A metallic structure, with a standard 19-inch width, that houses the hardware elements of an Nways Switch, that is, logic subrack with modules, fan boxes, and power units. When configuring an Nways Switch, the rack parameter indicates the 2220 Model (rack A is the Model 300 or 500, and rack B is the Model 501).

RDI. Remote defect indication.

real-time processing. Refers to the manipulations of data that are required, or generated, by certain process while the process is in operation. Usually, the results influence the process and, perhaps, related processes.

remote user console. A station running OS/2, TCP/IP, and Nways Switch Resource Control. It can be connected to the NAS of an Nways Switch to remotely control and service it.

resource. In an Nways Switch, a hardware element or a logical entity created by the Control Program. Adapters, modules, and line attachments are examples of physical resources. Control points, logical trunks, logical ports, and network interfaces are examples of logical resources.

resource profile. A record of the characteristics of an Nways Switch resource. It includes (for example) the part number or module name, the change level, and the name and phone number of the person to contact when a problem occurs.

RETAIN. Remote Technical Assistance Information Network

RIP. Route Information Protocol.

router. An attaching device that connects two LAN segments of the same or different architectures. It can also be connected to a wide area network. A router works at the network level (layer 3) of the OSI reference model by determining the best paths for network traffic flows.

Router And Bridge Manager. An application that provides distributed management for routers such as the IBM 2210 or 2216, bridges such as the IBM 8229, and communication controllers such as the IBM 3746 in IP mode.

RS. Recommended specification.

RSF. Remote support facility.

RSN. Receive sequence number.

RT. Real-time.

RVX. RS/EIA-232, V.24/V.35, X.21.

s. Second.

SCR. Sustainable cell rate.

SDH. Synchronous digital hierarchy.

SDLC. Synchronous data link control.

SDT. Structured data transfer.

serial line internet protocol (SLIP). A TCP/IP protocol used on a point-to-point connection between two IP hosts over a serial line (for example, an RS/EIA-232 connection to a modem over a telephone line).

SLA. Serial link architecture.

SLIP. Serial line internet protocol.

slot. When configuring an Nways Switch, the slot parameter indicates the module location (1 to 12) in the logic subrack.

SNA. Systems Network Architecture.

SNMP. Simple Network Management Protocol.

SONET. Synchronous optical network.

spanning tree. See CP spanning tree.

SRC. System reference code.

SSN. Send sequence number.

station. A microcomputer that is connected to a host or a network and at which a user can run applications.

STM-1. Synchronous transport module type 1.

STS-3c. Synchronous transport signal type 3 concatenated.

SUB. Subaddress.

subrack. A metallic structure installed in an Nways Switch rack. A logic subrack holds modules. A power subrack holds power supply components.

SVC. Switched virtual circuit.

SW. Switch (module).

switch module (SW). A module of the 2220 Model 300 or 500 that interconnects the adapters through an ATM cell switch. It can have a backup.

switch redrive (SWRD). A module of the 2220 Model 501 that drives the signals from the switch module in the Model 500 to the adapters of the Model 501. It can have a backup.

SWRD. switch redrive (module)

switched virtual circuit (SVC). A connection set up from a calling address to a called address following a call establishment protocol. It is released when a clear request signal is received.

synchronous digital hierarchy (SDH). A international recommendation for the internal operation of carrier optical networks.

synchronous optical network (SONET). A U.S. standard for transmitting digital information over optical interfaces. It is closely related to the international recommendation for synchronous digital hierarchy (SDH).

T1 standard. A TDM digital transmission service with a basic rate of 1.544 Mbps. Also called DS-1.

T3 standard. A TDM digital transmission service with a basic rate of 44.736 Mbps. A T3 line can transport up to 28 T1 circuits. Also called DS-3.

TCPA. Trunk and control point adapter.

TCP/IP. Transmission Control Protocol/ Internet Protocol.

TDM. Time division multiplexing.

TE. Terminal equipment.

Telnet. In TCP/IP, an application protocol that allows a user at one site to access a remote system as if the display station were locally attached. Telnet uses the Transmission Control Protocol (TCP) as the underlying protocol.

time division multiplexing (TDM). The process of breaking the bandwidth on a communication line into a number of channels, possibly of different size.

TME. Tivoli Management Environment.

TMN. Telecommunication Management Network.

TPA. Trunk or port adapter.

Transmission Control Protocol/ Internet Protocol (TCP/IP). A set of communication protocols that support peer-to-peer connections over both local and wide area networks.

transport services. Functions that are performed by a trunk adapter of an Nways Switch to:

- Support the attachment of trunk lines
- Maximize bandwidth utilization
- Guarantee the quality of service of a connection
- Transfer packets between Nways Switches
- Manage logical queues and schedule transmission.

trunk. See logical trunk.

trunk adapter. In an Nways Switch, a module that provides transport services to one or more trunk lines. Each trunk adapter is associated with a line interface coupler (LIC).

trunk line. In a 2220 network, a high-speed line connecting two Nways Switches. It can be, for example, a copper cable, optical fiber, or radio wave guide and can be leased from telecommunication companies.

UBR. Unspecified bit rate. A best effort service with no quality commitment.

UNI. User network interface.

UPC. Usage parameter control.

URL. Uniform resource locator.

user network interface (UNI). A standardized interface between a user and a communication network.

UTC. Universal time, coordinated.

UUS. User-user signaling.

VBR. Variable bit rate.

VC. Virtual channel.

VCC. Virtual channel connection.

VCI. Virtual channel identifier.

VCN. Virtual circuit number.

virtual channel (VC). In ATM, a unidirectional route between two ATM devices. Virtual channels always come in pairs, one in each direction. They follow virtual paths.

virtual channel connection (VCC). In ATM, a unidirectional connection established over a virtual channel. Virtual channel connections always come in pairs, one VCC in each direction.

virtual channel identifier (VCI). In ATM, the unique numeric tag that identifies every channel. It is defined by a 16-bit field in the ATM cell header.

virtual connection. In frame relay, the return path of an FR potential connection.

virtual path (VP). In ATM, a group of virtual channels that are switched together as one unit. (Also called VC service.)

virtual path connection (VPC). In ATM, a connection established over a virtual path. Virtual path connections always come in pairs, one VPC in each direction. (Also called VP service.)

virtual path identifier (VPI). In ATM, an 8-bit field in the ATM cell header that indicates the virtual path over which the cell is to be routed.

voice server adapter (VSA). In an Nways Switch, a module that supplies additional voice functions to voice connections operating in pulse code modulation at 64 kbps. It can attach a voice server extension (VSE).

voice server extension (VSE). In an Nways Switch, a module associated with a voice server adapter (VSA) to supply voice functions to an extended number of PCM voice connections.

VP. Virtual path.

VPC. Virtual path connection.

VPD. Vital product data.

VPI. Virtual path identifier.

VPN. Virtual private network.

VSA. Voice server adapter (module).

VSEn. Voice server extension type n (module).

WAN. Wide area network.

wide area network (WAN). A network that provides communication services to a large geographic area. It can use or provide public communication facilities.

window. On the screen of a station, an area with a title bar, a menu bar, and scroll bars.

X.25 hunt group. A group of X.25 network interfaces associated with one common subscriber address. If an interface is busy, the connection searches (hunts) for the other interfaces of the group until a free one is found.

X.25 network interface. A logical resource generated by the Nways Switch Control Program to provide access services to a physical X.25 port line. An X.25 network interface sets up and maintains connections between calling X.25 subscribers and called subscribers attached to other Nways Switches.

X.25 Recommendation. An international standard for the interface between data terminal equipments and packet-switched networks.

X.25 subscriber. An X.25 end-user connected to an X.25 network interface through a DTE. A subscriber is defined by an address and a logical name.

Bibliography

This section lists prerequisite and related publications.

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- *2220 Nways BroadBand Switch Planning Guide*, GA33-0293
- *2220 Nways BroadBand Switch Configuration Guide*, GA33-0474
- *2220 Nways BroadBand Switch Physical Lines Interface Specifications, External Cable References*, GA33-0379
- *2220 Nways BroadBand Switch Frame Relay Interface Specifications*, GA33-0374
- *2220 Nways BroadBand Switch HDLC Interface Specifications*, GA33-0375
- *2220 Nways BroadBand Switch CES Interface Specifications*, GA33-0376
- *2220 Nways BroadBand Switch ATM Interface Specifications*, GA33-0378
- *2220 Nways BroadBand Switch X.25 Interface Specifications*, GA33-0413
- *2220 Nways BroadBand Switch ISDN Interface Specifications*, GA33-0447
- *How to use the NAS*, online tutorial[2]

Nways 2220 Switch Manager Publications

- *IBM Nways 2220 Switch Manager for AIX Installation Guide*, SH11-3088
- *IBM Nways 2220 Switch Manager for AIX: Managing the Accounting and Performance Monitoring*, GA33-0366
- *IBM Nways 2220 Switch Manager User's Guide*, online manual[3]

TME 10 NetView for AIX Version 5 Publications

- *NetView for AIX Installation and Configuration* , SC31-8163
- *NetView for AIX V4R1 User's Guide* , SC31-8158

TMN 2.2 Publications

- *TMN 2.2 General Information* , GT01-0458
- *TMN 2.2 Agent User's Guide* SC31-8157

TME 10 Software Distribution Publications

- *Software Distribution for AIX Concepts* , GH19-4161
- *Software Distribution for AIX Getting Started* , GH19-4162
- *Software Distribution for AIX User's Guide* , GH19-4163
- *Software Distribution for AIX Installation and Customization* , GH19-4164
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OSI System Management Standards for CMIP

OSI stands for Open Systems Interconnection

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CMIP/CMIS

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- *Part 3: Attributes for Representing Relationships* ISO 10164-3
- *Part 4: Alarm Reporting Function* , ISO 10164-4
- *Part 5: Event Report Management Function* , ISO 10164-5

2. Online documentation delivered with the 2220 Nways Switch Control Program.
3. Online documentation delivered with the Nways 2220 Switch Manager product.

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- *Part 9: Objects and Attributes for Access Control* ISO 10164-9
- *Accounting Management* , SC 21 N 4971
- *OSI Software Management* , SC 21 N 6040
- *General Relationship Model* , SC 21 N 6041
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Management Information Model

- *Part 1: Management Information Model* , ISO 10165-1
- *Part 2: Definition of Management Information* , ISO 10165-2
- *Part 5: Generic Managed Information* , ISO 10165-5

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Models 300, 500, and 501
At a Glance, an Overview

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