MQSeries® Integrator

# Programming Guide

*Version 2.0.1*

SC34-5603-01

MQSeries® Integrator

# Programming Guide

*Version 2.0.1*

SC34-5603-01

**Note!**

Before using this information and the product it supports, be sure to read the general information under Appendix B, “Notices” on page 183.

## Second edition (August 2000)

This edition applies to IBM® MQSeries® Integrator Version 2, and to any subsequent releases and modifications until otherwise indicated in new editions.

# Contents

# Figures

# Tables

# About this book

This book explains how to write application programs that communicate with MQSeries Integrator Version 2, or to write plug-in nodes and parsers that can be installed in this product.

Part 1, “Application programming” on page 1 starts with a brief overview of the concepts and capabilities of MQSeries Integrator Version 2. It then describes how to write application programs using both *point-to-point* and *publish/subscribe* communication models. Full details of the publish/subscribe command messages, and the MQRFH2 message header that is used to send them, are also provided.

Part 2, “Programming a plug-in node or parser” on page 63 describes how to write *plug-in* message processing nodes and parsers to enhance the capabilities of MQSeries Integrator. Full details of the functions you need to write, and the utility functions provided to assist you, are given in this part of the book.

A glossary is also provided.

Changes made to this book after it was included on the MQSeries Integrator Version 2.0.1 CD are marked with the + character.

## Who this book is for

This book is for programmers who need to write application programs that will communicate with MQSeries Integrator Version 2, or to write plug-in nodes and parsers that will be installed in this product.

## What you need to know to understand this book

To understand this book, you need to have some understanding of MQSeries, including the use of the Message Queue Interface (or the Application Messaging Interface).

You are recommended to read the *MQSeries Integrator Introduction and Planning* book before starting to write application programs. It contains information about the design of applications that communicate with MQSeries Integrator.

## Terms used in this book

All references to MQSeries Integrator are to MQSeries Integrator Version 2 unless otherwise stated.

The book uses the following shortened names:

- MQSeries: a general term for IBM MQSeries Messaging products.
- MQSeries Publish/Subscribe: the MQSeries Publish/Subscribe SupportPac™ available on the Internet for several MQSeries server operating systems (the Internet URL is given in “MQSeries information available on the Internet” on page ix).

## Where to find more information

Becoming familiar with the MQSeries Integrator library will help you accomplish MQSeries Integrator tasks quickly. The library covers planning, installation, administration, and client application tasks.

The library also contains references to complementary product libraries, including the MQSeries Family library.

## MQSeries Integrator publications

The following books make up the MQSeries Integrator Version 2 library:

- IBM MQSeries Integrator Version 2 Introduction and Planning, GC34-5599
- IBM MQSeries Integrator for Windows NT Version 2 Installation Guide, GC34-5600
- IBM MQSeries Integrator for Sun Solaris Version 2 Installation Guide, GC34-5842
- IBM MQSeries Integrator for AIX Version 2 Installation Guide, GC34-5841
- IBM MQSeries Integrator Version 2 Messages, GC34-5601
- IBM MQSeries Integrator Version 2 Using the Control Center, SC34-5602
- IBM MQSeries Integrator Version 2 Programming Guide, SC34-5603 (this book)
- IBM MQSeries Integrator Version 2 Administration Guide, SC34-5792

All books in the MQSeries Integrator Version 2 library are available in softcopy, in Portable Document Format (PDF).

You can read these books using the Adobe Acrobat Reader, or in a Web browser (with Acrobat Reader as a plug-in). You can also print your own copies of these books.

You need Version 3 or later of Acrobat Reader. You can download a free copy of it from the Adobe Web site:

`http://www.adobe.com`

The following MQSeries Integrator Version 2.0 books are also available in hardcopy.

- IBM MQSeries Integrator Version 2 Introduction and Planning
- IBM MQSeries Integrator for Windows NT Version 2 Installation Guide
- IBM MQSeries Integrator for Sun Solaris Version 2 Installation Guide
- IBM MQSeries Integrator for AIX Version 2 Installation Guide

## MQSeries publications

This section describes MQSeries publications that are referred to in this book. They are available in hardcopy, HTML, and PDF formats, except where noted.

**MQSeries Application Programming Guide**
The *MQSeries Application Programming Guide*, SC33-0807, provides guidance information for users of the message queue interface (MQI). It describes how to

design, write, and build an MQSeries application. It also includes full descriptions of the sample programs supplied with MQSeries.

**MQSeries Application Programming Reference**
The *MQSeries Application Programming Reference*, SC33-1673, provides comprehensive reference information for users of the MQI. It includes: data-type descriptions; MQI call syntax; attributes of MQSeries objects; return codes; constants; and code-page conversion tables.

**MQSeries Application Messaging Interface**
The *MQSeries Application Messaging Interface* book, SC34-5604, describes the MQSeries Application Messaging Interface SupportPac. This is a simple interface that application programmers can use without needing to understand all the options available in the MQI. The options that are required in a particular installation are defined by a system administrator, using services and policies.

This book is available in PDF format only.

**MQSeries Publish/Subscribe User's Guide**
The *MQSeries Publish/Subscribe User's Guide*, GC34-5269, provides comprehensive information for users of the MQSeries Publish/Subscribe SupportPac. It includes: installation; system design; writing applications; and managing the publish/subscribe broker.

This book is available in PDF format only.

For a complete list of MQSeries product publications, refer to the information on the MQSeries web site.

## MQSeries information available on the Internet

The MQSeries Business Solution, of which MQSeries Integrator is a part, has a Web site at:

```
http://www.ibm.com/software/ts/mqseries
```

By following links from this web site you can:

- Obtain the latest information about all MQSeries family products.
- Access all the books for the MQSeries family products.
- Down-load MQSeries SupportPacs.

  You might be interested in the MQSeries Integrator problem determination Q&A SupportPac (MHI1) that you can access from:

  ```
  http://www.ibm.com/software/mqseries/txppacs/
  ```

# Bibliography

This section describes the documentation available for all current MQSeries products.

## MQSeries cross-platform publications

Most of these publications, which are sometimes referred to as the MQSeries "family" books, apply to all MQSeries Level 2 products. The latest MQSeries Level 2 products are:

- MQSeries for AIX, V5.1
- MQSeries for AS/400, V5.1
- MQSeries for AT&T GIS UNIX V2.2
- MQSeries for Compaq (DIGITAL) OpenVMS, V2.2.1.1
- | MQSeries for Compaq Tru64 UNIX, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for OS/390, V2.2
- MQSeries for SINIX and DC/OSx, V2.2
- MQSeries for Sun Solaris, V5.1
- MQSeries for Tandem NonStop Kernel, V2.2.0.1
- MQSeries for VSE/ESA V2.1
- MQSeries for Windows V2.0
- MQSeries for Windows V2.1
- MQSeries for Windows NT, V5.1

Any exceptions to this general rule are indicated.

**MQSeries Brochure**
The *MQSeries Brochure*, G511-1908, gives a brief introduction to the benefits of MQSeries. It is intended to support the purchasing decision, and describes some authentic customer use of MQSeries.

**MQSeries: An Introduction to Messaging and Queuing**
*MQSeries: An Introduction to Messaging and Queuing*, GC33-0805, describes briefly what MQSeries is, how it works, and how it can solve some classic interoperability problems. This book is intended for a more technical audience than the *MQSeries Brochure*.

**MQSeries Intercommunication**
The *MQSeries Intercommunication* book, SC33-1872, defines the concepts of distributed queuing and explains how to set up a distributed queuing network in a variety of MQSeries environments. In particular, it demonstrates how to (1) configure communications to and from a representative sample of MQSeries products, (2) create required MQSeries objects, and (3) create and configure MQSeries channels. The use of channel exits is also described.

**MQSeries Queue Manager Clusters**
*MQSeries Queue Manager Clusters*, SC34-5349, describes MQSeries clustering. It explains the concepts and terminology and shows how you can benefit by taking advantage of clustering. It details changes to the MQI, and summarizes the syntax of new and changed MQSeries commands. It shows a number of examples of tasks you can perform to set up and maintain clusters of queue managers.

This book applies to the following MQSeries products only:

- MQSeries for AIX V5.1
- MQSeries for AS/400 V5.1
- MQSeries for HP-UX V5.1
- MQSeries for OS/2 Warp V5.1
- MQSeries for OS/390 V2.2
- MQSeries for Sun Solaris V5.1
- MQSeries for Windows NT V5.1

**MQSeries Clients**
The *MQSeries Clients* book, GC33-1632, describes how to install, configure, use, and manage MQSeries client systems.

**MQSeries System Administration**
The *MQSeries System Administration* book, SC33-1873, supports day-to-day management of local and remote MQSeries objects. It includes topics such as security, recovery and restart, transactional support, problem determination, and the dead-letter queue handler. It also includes the syntax of the MQSeries control commands.

This book applies to the following MQSeries products only:

- MQSeries for AIX, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for Sun Solaris, V5.1
- MQSeries for Windows NT, V5.1

**MQSeries MQSC Command Reference**
The *MQSeries MQSC Command Reference*, SC33-1369, contains the syntax of the MQSC commands, which are used by MQSeries system operators and administrators to manage MQSeries objects.

| **MQSeries Event Monitoring**
| *MQSeries Event Monitoring*, SC34-5760, describes how to use MQSeries
| instrumentation events.

| **MQSeries Programmable System Management**
| The *MQSeries Programmable System Management* book, SC33-1482, provides
| both reference and guidance information for users of MQSeries Programmable
| Command Format (PCF) messages and installable services.

**MQSeries Administration Interface Programming Guide and Reference**
The *MQSeries Administration Interface Programming Guide and Reference*, SC34-5390, provides information for users of the MQAI. The MQAI is a programming interface that simplifies the way in which applications manipulate Programmable Command Format (PCF) messages and their associated data structures.

This book applies to the following MQSeries products only:

- MQSeries for AIX V5.1
- MQSeries for AS/400 V5.1
- MQSeries for HP-UX V5.1
- MQSeries for OS/2 Warp V5.1
- MQSeries for Sun Solaris V5.1
- MQSeries for Windows NT V5.1

**MQSeries Messages**
The *MQSeries Messages* book, GC33-1876, which describes “AMQ” messages issued by MQSeries, applies to these MQSeries products only:

- MQSeries for AIX, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for Sun Solaris, V5.1
- MQSeries for Windows NT, V5.1
- MQSeries for Windows V2.0
- MQSeries for Windows V2.1

This book is available in softcopy only.

For other MQSeries platforms, the messages are supplied with the system. They do not appear in softcopy manual form.

**MQSeries Application Programming Guide**
The *MQSeries Application Programming Guide*, SC33-0807, provides guidance information for users of the message queue interface (MQI). It describes how to design, write, and build an MQSeries application. It also includes full descriptions of the sample programs supplied with MQSeries.

**MQSeries Application Programming Reference**
The *MQSeries Application Programming Reference*, SC33-1673, provides comprehensive reference information for users of the MQI. It includes: data-type descriptions; MQI call syntax; attributes of MQSeries objects; return codes; constants; and code-page conversion tables.

| **MQSeries Programming Interfaces Reference Summary**
| The *MQSeries Programming Interfaces Reference Summary*, SX33-6095,
| summarizes programming interfaces information including the application
| programming interface, the application messaging interface, event messages, PCF
| messages, and installable services.

**MQSeries Using C++**
*MQSeries Using C++*, SC33-1877, provides both guidance and reference information for users of the MQSeries C++ programming-language binding to the MQI. MQSeries C++ is supported by these MQSeries products:

- MQSeries for AIX, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for AS/400, V5.1
- MQSeries for OS/390, V2.1
- MQSeries for Sun Solaris, V5.1
- MQSeries for Windows NT, V5.1

MQSeries C++ is also supported by MQSeries clients supplied with these products and installed in the following environments:

- AIX
- HP-UX
- OS/2
- Sun Solaris
- Windows NT
- Windows 3.1
- Windows 95 and Windows 98

**MQSeries Using Java**
*MQSeries Using Java*, SC34-5456, provides both guidance and reference information for users of the MQSeries Bindings for Java and the MQSeries Client for Java. MQSeries classes for Java are supported by these MQSeries products:

- MQSeries for AIX, V5.1
- MQSeries for AS/400, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for MVS/ESA V1.2
- MQSeries for OS/2 Warp, V5.1
- MQSeries for Sun Solaris, V5.1
- MQSeries for Windows NT, V5.1

This book is available in softcopy only.

**MQSeries Application Messaging Interface**
*MQSeries Application Messaging Interface*, SC34-5604, describes how to use the application messaging interface, which is an easy-to-use interface to the MQI.

## MQSeries platform-specific publications

Each MQSeries product is documented in at least one platform-specific publication, in addition to the MQSeries family books.

**MQSeries for AIX**

*MQSeries for AIX Version 5 Release 1 Quick Beginnings*, GC33-1867

**MQSeries for AS/400**

*MQSeries for AS/400 Version 5 Release 1 Quick Beginnings*, GC34-5557

*MQSeries for AS/400 Version 5 Release 1 System Administration*, SC34-5558

*MQSeries for AS/400 Version 5 Release 1 Application Programming Reference (ILE RPG)*, SC34-5559

**MQSeries for AT&T GIS UNIX**

*MQSeries for AT&T GIS UNIX Version 2 Release 2 System Management Guide*, SC33-1642

**MQSeries for Compaq (DIGITAL) OpenVMS**

*MQSeries for Compaq (DIGITAL) OpenVMS Version 2 Release 2.1.1 System Management Guide*, GC33-1791

**MQSeries for Compaq Tru64 UNIX**

*MQSeries for Compaq Tru64 UNIX, Version 5.1 Quick Beginnings*, GC34-5684

**MQSeries for HP-UX**

*MQSeries for HP-UX Version 5 Release 1 Quick Beginnings*, GC33-1869

**MQSeries for OS/2 Warp**

*MQSeries for OS/2 Warp Version 5 Release 1 Quick Beginnings*, GC33-1868

**MQSeries for OS/390**

*MQSeries for OS/390 Version 2 Release 2 Licensed Program Specifications*, GC34-5377

*MQSeries for OS/390 Version 2 Release 2 Program Directory*

*MQSeries for OS/390 Version 2 Release 2 Messages and Codes*, GC34-5375

*MQSeries for OS/390 Version 2 Release 2 Problem Determination Guide*, GC34-5376

*MQSeries for OS/390 Version 2 Release 2 Concepts and Planning Guide*, SC34-5650

*MQSeries for OS/390 Version 2 Release 2 System Setup Guide*, SC34-5651

*MQSeries for OS/390 Version 2 Release 2 System Administration Guide*, SC34-5652

**MQSeries Publish/Subscribe**

*MQSeries Publish Subscribe User's Guide*, GC34-5269

**MQSeries link for R/3**

*MQSeries link for R/3 Version 1 Release 2 User’s Guide*, GC33-1934

**MQSeries for SINIX and DC/OSx**

*MQSeries for SINIX and DC/OSx Version 2 Release 2 System Management Guide*, GC33-1768

**MQSeries for Sun Solaris**

*MQSeries for Sun Solaris Version 5 Release 1 Quick Beginnings*, GC33-1870

**MQSeries for Tandem NonStop Kernel**

*MQSeries for Tandem NonStop Kernel Version 2 Release 2.0.1 System Management Guide*, GC33-1893

**MQSeries for VSE/ESA**

*MQSeries for VSE/ESA Version 2 Release 1 Licensed Program Specifications*, GC34-5365

*MQSeries for VSE/ESA Version 2 Release 1 System Management Guide*, GC34-5364

**MQSeries for Windows**

*MQSeries for Windows Version 2 Release 0 User’s Guide*, GC33-1822

*MQSeries for Windows Version 2 Release 1 User’s Guide*, GC33-1965

**MQSeries for Windows NT**

*MQSeries for Windows NT Version 5 Release 1 Quick Beginnings*, GC34-5389

*MQSeries for Windows NT Using the Component Object Model Interface*, SC34-5387

*MQSeries LotusScript Extension*, SC34-5404

## Softcopy books

Most of the MQSeries books are supplied in both hardcopy and softcopy formats.

## BookManager format

The MQSeries library is supplied in IBM BookManager format on a variety of online library collection kits, including the *Transaction Processing and Data* collection kit, SK2T-0730. You can view the softcopy books in IBM BookManager format using the following IBM licensed programs:

BookManager READ/2
BookManager READ/6000
BookManager READ/DOS
BookManager READ/MVS
BookManager READ/VM
BookManager READ for Windows

## HTML format

Relevant MQSeries documentation is provided in HTML format with these MQSeries products:

- MQSeries for AIX, V5.1
- MQSeries for Compaq Tru64 UNIX, V5.1
- MQSeries for AS/400, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for OS/390, V2.2
- MQSeries for Sun Solaris, V5.1
- MQSeries for Windows NT, V5.1 (compiled HTML)
- MQSeries link for R/3 V1.2

The MQSeries books are also available in HTML format from the MQSeries product family Web site at:

```
http://www.ibm.com/software/mqseries/
```

## Portable Document Format (PDF)

PDF files can be viewed and printed using the Adobe Acrobat Reader.

If you need to obtain the Adobe Acrobat Reader, or would like up-to-date information about the platforms on which the Acrobat Reader is supported, visit the Adobe Systems Inc. Web site at:

```
http://www.adobe.com/
```

PDF versions of relevant MQSeries books are supplied with these MQSeries products:

- MQSeries for AIX, V5.1
- MQSeries for Compaq Tru64 UNIX, V5.1
- MQSeries for AS/400, V5.1
- MQSeries for HP-UX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for OS/390, V2.2
- MQSeries for Sun Solaris, V5.1
- MQSeries for Windows NT, V5.1
- MQSeries link for R/3 V1.2

PDF versions of all current MQSeries books are also available from the MQSeries product family Web site at:

```
http://www.ibm.com/software/mqseries/
```

## PostScript format

The MQSeries library is provided in PostScript (.PS) format with many MQSeries Version 2 products. Books in PostScript format can be printed on a PostScript printer or viewed with a suitable viewer.

## Windows Help format

The *MQSeries for Windows User's Guide* is provided in Windows Help format with MQSeries for Windows Version 2.0 and MQSeries for Windows Version 2.1.

## MQSeries information available on the Internet

The MQSeries product family Web site is at:

```
http://www.ibm.com/software/mqseries/
```

By following links from this Web site you can:

- Obtain latest information about the MQSeries product family.
- Access the MQSeries books in HTML and PDF formats.
- Download MQSeries SupportPacs.

# Summary of changes

This section lists the changes that have been made to this edition of the book. Changes are marked with vertical revision bars in the left-hand margin. The changes are summarized below:

- Updates to reflect the inclusion of support for AIX and Sun Solaris.
- Description of two new utilities provided for conversion between MQSeries Integrator's internal processing code (in UCS-2) and file code such as ASCII. See “Character representation handling functions” on page 172
- Editorial improvements to content and structure of the original Chapter 6, which has now been divided into the following two chapters:
  - Chapter 6, “Implementing a plug-in node or parser” on page 65
  - Chapter 7, “Installing a plug-in node or parser” on page 91

# Part 1. Application programming

This part contains:

# Chapter 1. Introduction

To build a complete MQSeries Integrator Version 2.0.1 application, you need to consider the following activities:

- Define the information space and model.
- Build the business message flows.
- Develop or modify applications that feed messages into the message flows, and consume the messages they produce.

The first two activities are described in the *MQSeries Integrator Introduction and Planning* book and *MQSeries Integrator Using the Control Center* respectively.

This book concentrates on the third activity, how to develop applications that work with MQSeries Integrator Version 2.0.1. To help you understand what can be done with the product, this chapter contains an overview of its functionality.

## Overview of MQSeries Integrator

MQSeries Integrator Version 2.0.1 is IBM's *message broker* product, addressing the needs of business and application integration through management of information flow. It provides services that allow you to:

- Route a message to several destinations, using rules that act on the contents of one or more of the fields in the message or message header.
- Transform a message, so that applications using different formats can exchange messages in their own formats.
- Store and retrieve a message, or part of a message, in a database.
- Modify the contents of a message (for example, by adding data extracted from a database).
- Publish a message to make it available to other applications. Other applications can choose to receive publications that relate to specific topics, or that have specific content, or both.
- Extend the function of MQSeries Integrator Version 1.

These services are based on the messaging transport layer provided by the MQSeries products.

### Message brokers

A message broker, usually referred to simply as a broker, is a set of execution environments hosting services you create to handle your message traffic.

You can install and configure any number of brokers. Together, these make up a *broker domain*. The broker domain is the set of brokers you can administer as a single entity, using the MQSeries Integrator Version 2.0.1 Control Center.

Brokers are connected together to provide communication throughout your broker domain, as required. This is needed for publish/subscribe applications (see "Applications" on page 5). Communications in the broker domain are provided by MQSeries.

## Message flows

When you design your broker domain, you decide what processing must be done on the messages flowing through the brokers. You define this work as a set of actions executed between receipt of the message by the broker, and delivery of the message to the target applications.

Each action, or subset of actions, is implemented as a *message processing node*, and these are grouped together in a sequence to form a *message flow*. You create message flows using the MQSeries Integrator Control Center (see “The Control Center” on page 5).

Message flows can range from the very simple, performing just one action on a message, to the complex, providing a number of actions on the message to transform its format and content. A message flow can process one message in several ways to deliver a number of output messages, perhaps with different format and content, to a number of target applications.

The message flows you create receive messages at **MQInput** nodes. Every input node represents an MQSeries queue, and every message flow must have at least one input node.

Message flows usually complete their activity by sending one or more messages to one or more recipients from **MQOutput** nodes that represent MQSeries queues, or from **Publication** nodes that redistribute the message to interested subscribers using MQSeries queues.

Other message flows might simply store the message in a database for later processing, and not use an output node at all.

The other nodes between input and output provide the actions you want taken against the messages. MQSeries Integrator supplies a number of predefined message processing nodes. In addition to the input and output nodes already mentioned, their functions include filter (on message data content) and compute (for example, add data from a database).

You can create new nodes, using a system programming interface supplied by MQSeries Integrator, to provide other options for message processing. This is described in Part 2, “Programming a plug-in node or parser” on page 63.

## Messages

Each message flowing through your system has a specific content and structure, referred to as a *message template*.

Message template information identifies the structure of the data it contains. Messages sent to MQSeries Integrator can be of the following types:

- MQSeries messages, with an MQSeries message descriptor (MQMD) and data; this type of message does not have to be predefined but if the data is not one of the defined types, MQSeries Integrator will not be able to distinguish individual fields
- Message repository manager (MRM) messages (defined in the MQSeries Integrator Control Center)

- MQSeries Integrator Version 1 messages (defined in the MQSeries Integrator Version 1 user interface)
- XML (Extensible Markup Language) messages (which are self-defining)
- User-defined messages

Message template information for predefined messages is usually included in the message header, so the message flows recognize the messages when they receive them. Other messages might not use the expected header, but you can set up your message flow input nodes to indicate how the messages will be processed.

The message bit-stream is decoded by *message parsers*. MQSeries Integrator supplies several message parsers ready for use on known message templates and message headers.

You can create new parsers, using a system programming interface supplied by MQSeries Integrator, if you need to process other types of message. This is described in Part 2, “Programming a plug-in node or parser” on page 63.

## The Control Center

The functions and facilities of MQSeries Integrator are controlled using a graphical interface known as the Control Center. The Control Center comes with comprehensive on-line help, and is described in *MQSeries Integrator Using the Control Center*.

You can use the Control Center to:

- Define your broker domain
- Work with message flows
- Organize your MRM messages
- Control your publish/subscribe network
- Manage your broker domain

The Control Center allows you to restrict access and authority to the functions it provides, so you can control who can do what within the broker domain.

## Applications

Applications using messages to send or receive data can communicate in several ways. Applications written to the *point-to-point* model transfer information from one sender to one receiver. *Publish/subscribe* applications, on the other hand, transfer information from one or more sender to one or more receivers, with a third party acting as the intermediary so that the information requirements of the receiver are matched against the information that the sender provides.

Today, most MQSeries applications are using *point-to-point* communications. These applications might be using a one-way *send-and-forget* (or *datagram*) model, or a *request/reply* (client/server) model. Such messages can be sent to a message flow you have established in the broker, to carry out the required processing on the message before sending it on to the receiving application.

Brokers support a second type of communication model known as *publish/subscribe*. In this model, some applications (*publishers*) provide information, and others (*subscribers*) consume that information. You can also have applications that are both publishers and subscribers.

Publishers create messages and send them to one or more message flows at a local broker that support publish/subscribe. Each message has an associated *topic* that categorizes the information in the message. Subscribers register subscriptions with their local broker, specifying the types of publication they are interested in (determined, for example, by the topic and the contents of the message). When a broker receives a publication that matches a subscription that has been registered, it sends that publication to the subscriber. Brokers exchange subscriptions and publications with each other, so that subscribers can receive information published at any broker in the domain.

New and existing applications can take advantage of the broker functions through the MQSeries *Message Queue Interface* (MQI), or the MQSeries *Application Messaging Interface* (AMI). Both interfaces support point-to-point and publish/subscribe programming models. You can use the MQI to send messages that access broker functions. The AMI provides higher levels of function that are designed to simplify the messaging process, particularly for the publish/subscribe model.

If you have existing applications written to these interfaces, it should be possible, in many cases, to configure your message broker environment in such a way that the applications will run unchanged.

You can find information about the design of new applications, and the reuse of existing applications in the *MQSeries Integrator Introduction and Planning* book.

The remaining chapters in Part 1 of this book tell you how to write application programs that communicate with MQSeries Integrator Version 2.0.1.

# Chapter 2. Writing application programs

Applications communicate with MQSeries Integrator by sending messages to the broker, or receiving messages from the broker, using MQSeries message queues. Before writing your application program, you need to decide on the following:

- The structure and format of the messages
- | The message header (MQRFH2, MQRFH, or no header)
- The queues used for sending and receiving messages
- The communication model (point-to-point, publish/subscribe, or both)
- The programming interface (Message Queue Interface or Application Messaging Interface)
- Other features (transactional processing, message ordering, message persistence)

All these aspects of the application design are covered in detail in the *MQSeries Integrator Introduction and Planning* book.

Some of the information in that book is summarized in this chapter, together with the information you need when writing programs to implement your design.

See “Sending and receiving messages” for information relevant to all applications.

See “Point-to-point messaging” on page 9 for specific information about point-to-point applications.

Go to Chapter 3, “Writing publish/subscribe applications” on page 13 for more information about publish/subscribe applications.

## Sending and receiving messages

In both communication models (point-to-point and publish/subscribe) messages are sent to, and received from, an MQSeries Integrator broker using normal MQSeries message queues. Information needed by the broker is (optionally) encoded in an MQRFH2 rules and formatting header. This header is usually placed after the normal MQSeries message descriptor (MQMD), and before the body of the message.

You need to construct a message according to your chosen message template, including the header (if used), and send it to an input queue at the broker. This queue has to be set up by a system administrator, as an attribute of the input node of the message flow that will process your message (see *MQSeries Integrator Using the Control Center*).

If you are writing an application to receive a message from the broker, the queue that it arrives on is also set up by the system administrator (as an attribute of the output node of the message flow). In the case of publish/subscribe applications, you specify in the application which queue you want publications to be sent to.

You can use the MQSeries Message Queue Interface (MQI) or the MQSeries Application Messaging Interface (AMI) to send and receive these messages.

## Message headers

MQSeries Integrator messages can contain headers of the following types:

- MQRFH2
- MQRFH

or they can be sent without an MQRFH2 or MQRFH header.

### MQRFH2

The MQRFH2 header is based on the MQRFH header, but it allows Unicode strings to be transported without translation, and it can carry numeric datatypes. New applications should use the MQRFH2 header so that they have access to all the functionality in MQSeries Integrator Version 2.0.1.

Following the fixed portion of the MQRFH2 header is a number of *NameValueLength* and *NameValueData* pairs. Each one of these contains one *folder*, which holds a sequence of *properties* encoded as name/value *elements* in XML (Extensible Markup Language: see *MQSeries Integrator Introduction and Planning* for more details). A `<psc>` folder contains publish/subscribe commands. An `<mcd>` folder contains a description of the message contents. This is used by MQSeries Integrator to decide which message parser to invoke if content-based operations are carried out in the message flow.

Full details of the MQRFH2 header and its contents are given in Chapter 4, “The MQRFH2 rules and formatting header” on page 31.

### MQRFH or no header

Existing MQSeries Integrator Version 1 and MQSeries Publish/Subscribe applications using the MQRFH header are supported by MQSeries Integrator Version 2.0.1. For full details refer to *MQSeries Integrator Introduction and Planning*.

MQSeries messages that have no MQRFH2 or MQRFH header are also supported. The default message properties on a message flow can provide defaults for values normally carried in a header. This allows messages without headers to be handled by message flows that need to parse the contents of the message. Similarly, if a message without a header is sent to a message flow that contains a **Publication** node, the message will be published.

The output message is unchanged if this facility is used. See the information on the **MQInput** node in *MQSeries Integrator Using the Control Center*.

## Using the Message Queue Interface

The MQSeries Message Queue Interface (MQI) that is used to put (MQPUT) and get (MQGET) messages to and from queues is described in the *MQSeries Application Programming Guide* and the *MQSeries Application Programming Reference* book.

If you are using the MQI in your application programs, Chapter 4, “The MQRFH2 rules and formatting header” on page 31 describes the MQRFH2 header in detail, and the structure of the folders that are contained within it. Chapter 5, “Publish/subscribe command messages” on page 41 details the command messages that are sent to the broker, using the MQRFH2 header, in publish/subscribe applications.

## Using the Application Messaging Interface

For many applications it is not necessary to understand the details of the MQRFH2 header or the MQI. The MQSeries Application Messaging Interface (AMI) has been developed to hide their complexities from an application programmer by containing them in policies and services that are set up by a systems administrator. MQSeries and MQSeries Integrator functionality, including publish/subscribe, can be accessed through the AMI from applications written in the C, Cobol, C++, or Java™ programming languages.

**Availability**

The MQSeries Application Messaging Interface can be downloaded free of charge from the Internet, complete with sample applications that demonstrate how to use its functions. See

`http://www.ibm.com/software/mqseries/txppacs/`

If you are using the AMI, read the remainder of this chapter and then refer to the *MQSeries Application Messaging Interface* book. You will need to check with your system administrator to find out what policies and services have been defined for your application. (For instance, the service point used to send or receive messages must have its Service Type attribute set to ‘MQSeries Integrator V2’ if you want to use the MQRFH2 header in your messages).

If you are using the publish/subscribe capability of MQSeries Integrator, you should also read Chapter 3, “Writing publish/subscribe applications” on page 13.

## Point-to-point messaging

MQSeries Integrator point-to-point applications involve these components:

| | |
|---|---|
| **Sender** | An application that sends a message |
| **Broker** | The message broker that processes the message |
| **Receiver** | An application that receives the message |

There can be more than one sender or receiver in any system.

## Send and forget

With send and forget (datagram) messages, no response is expected from the receiver. The sender puts a message to a queue at the broker. This should be the input queue defined for the required message flow as an attribute of the **MQInput** node. The queue manager is the one used by the broker. The sender needs to have authority to put to this queue.

If the sender and receiver applications already exist, you can use queue aliasing to route the sender’s message to the broker, instead of sending it to the receiver. This means that you do not have to change the sending application.

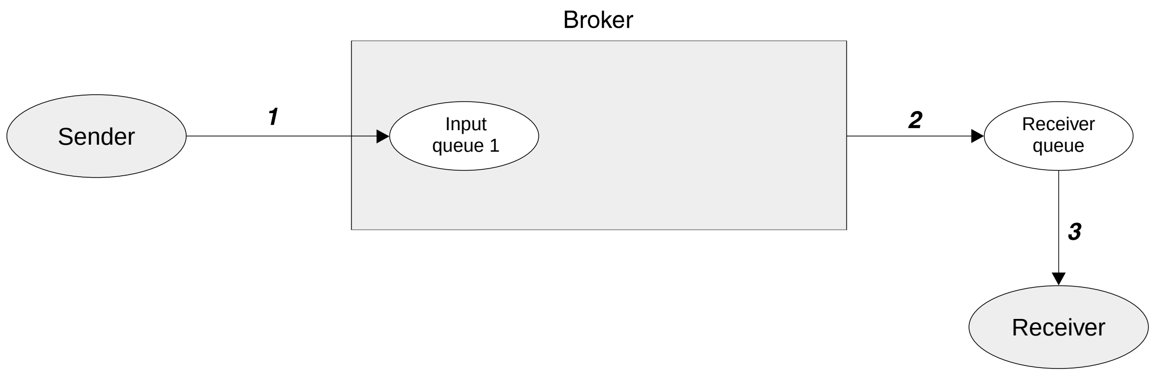
The broker processes the message according to the message flow. If content-based filtering, routing, or message transformation is to be applied, the broker parses the message according to the structure of the message as defined in an `<mcd>` folder in the *`NameValueData`* field of the MQRFH2 header. If this header or

| the <mcd> folder does not exist, the default message properties of the message flow
| are used.

Having processed the message, the broker puts the output message onto the receiver's input queue. This queue, and its queue manager, are defined as attributes of the **MQOutput** node. Alternatively, the output node can specify that the output message is sent to the *ReplyToQ* defined in the message descriptor (MQMD).

If the message flow contains more than one input or output, each is treated in the same way as described above.

| Send and forget messaging is illustrated in Figure 1.



| *Figure 1. Send and forget messaging. The sender puts a message on the input queue of a message flow at the*
| *broker (1). The output from the message flow is put on the receiver's queue (2), from where the receiver can get it (3).*

## Request/reply

With request/reply messaging, after the receiver receives a request message it sends a reply back to the sender. The request message is handled as described for send and forget messages. There are two possibilities for the reply:

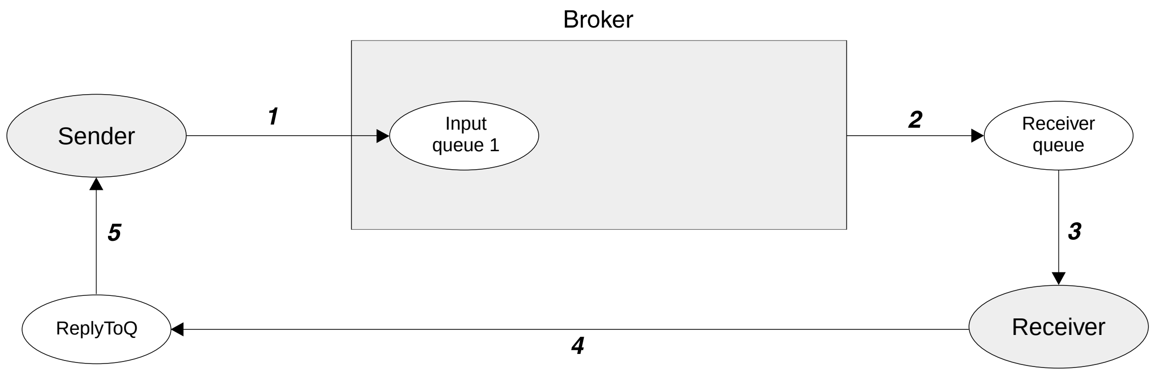
1. The receiver sends the reply message directly back to the sender, without involving the broker. The message is sent to the *ReplyToQ* in the message descriptor (MQMD) of the request message, which is passed unchanged by the broker.
2. The receiver sends the reply message to a reply message flow in the broker, so that it can be processed before reaching the sender. In this case the broker must replace the sender's *ReplyToQ* in the MQMD of the request message with the input queue name of the reply message flow.

   The output of this reply message flow must go to the sender's *ReplyToQ*. If the name is fixed, there is no problem; otherwise, some means of associating this queue with the reply message is needed.

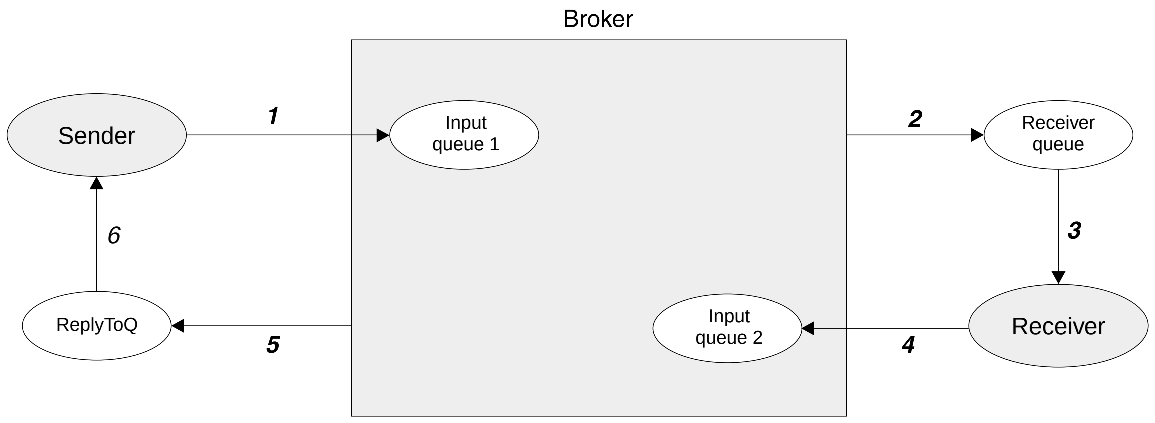
   This can be done by setting up a message flow that stores the message descriptor of the original request message using a database node, and then retrieving it from the database in order to send the reply message to the correct destination.

   Alternatively, the relevant details in the message descriptor can be copied into a folder in the MQRFH2 header, and carried with the message.

| Request/reply messaging is illustrated in Figure 2 on page 11 and Figure 3 on
| page 11.



| *Figure 2. Request/reply with direct reply. The sender puts a message on the input queue of a message flow at the*
| *broker (1). The output from the message flow is put on the receiver's queue (2), from where the receiver gets it (3).*
| *The receiver sends the reply directly to the ReplyToQ of the sender (4), from where the sender can get it (5).*



| *Figure 3. Request/reply with reply processed by the broker. The sender puts a message on the input queue of the*
| *first message flow at the broker (1). The output from the message flow is put on the receiver's queue (2), from where*
| *the receiver gets it (3). The receiver sends the reply to the input queue of the second message flow at the broker (4).*
| *After processing the reply, the broker sends it to the ReplyToQ of the sender (5), from where the sender can get it (6).*
| *(In this case, the output node of the second message flow needs to know the ReplyToQ of the sender.)*

## The message descriptor

Fields in the MQSeries message descriptor (MQMD) of an input message are usually passed unchanged to the output node.

However, if the message flow contains a transformation (such as a compute node), any of the MQMD fields might be changed according to how the message flow has been set up by the administrator.

## Error handling

The handling of errors by an application program depends on how the message flow in the broker has been set up by the administrator.

Error events can be produced by any node in a message flow that has a failure output terminal. The failure output might be connected to an output node, in which case it can be directed to the sender of the message that caused the error. Otherwise, the error is passed to the input node of the message flow. From here it is returned to the backout-retry queue associated with the input queue.

If the broker is unable to put a message to the receiver’s queue, the input node rolls back the transaction (if any) and puts the message to the backout-retry queue.

# Chapter 3. Writing publish/subscribe applications

This chapter describes how to write applications that use the publish/subscribe model. If you are writing applications that use only the point-to-point model, you don’t need to read this chapter.

Before writing your application program, you need to decide on the following:

- The topic trees used by publishers (including the use of wildcards by subscribers)
- The options used by publishers (retained, local, other subscribers only)
- If message ordering techniques are needed (sequence number, publication timestamp)
- The options used by subscribers (subscription point, filter, local, new publications only, publish on request only)
- The subscriber queues used to receive publications (with optional correlation identifiers)
- The persistence of published messages

All these aspects of the application design are covered in more detail the *MQSeries Integrator Introduction and Planning Guide*.

Some of the information in that book is summarized in this chapter, together with the information you need when writing programs to implement your design.

The following information is presented in this chapter:

## Publish/subscribe messaging

MQSeries Integrator publish/subscribe applications involve these components:

| | |
|---|---|
| **Publisher** | An application that generates publications |
| **Broker** | The message broker that distributes the publications |
| **Subscriber** | An application that subscribes to and receives publications |

There are usually multiple publishers and subscribers in a publish/subscribe system, and there can be multiple brokers as well. Publishers can also be subscribers.

The following sections describe in detail the roles of the publisher, subscriber and broker. They communicate with each other by sending messages as shown in Figure 4.

If you are using the Message Queue Interface (MQI) to write applications, you need to understand the MQRFH2 header (see Chapter 4, “The MQRFH2 rules and formatting header” on page 31) that is used to send the command messages. These messages are described in Chapter 5, “Publish/subscribe command messages” on page 41, together with details of the message descriptor (MQMD) used when sending the messages.

If you are using the Application Messaging Interface (AMI) to write applications, you don’t need to understand the details of the MQMD and MQRFH2 header. After you have read this chapter, you might find it useful to look at Chapter 5, “Publish/subscribe command messages” on page 41 to see what options are available for each command. Then turn to the *MQSeries Application Messaging Interface* book.

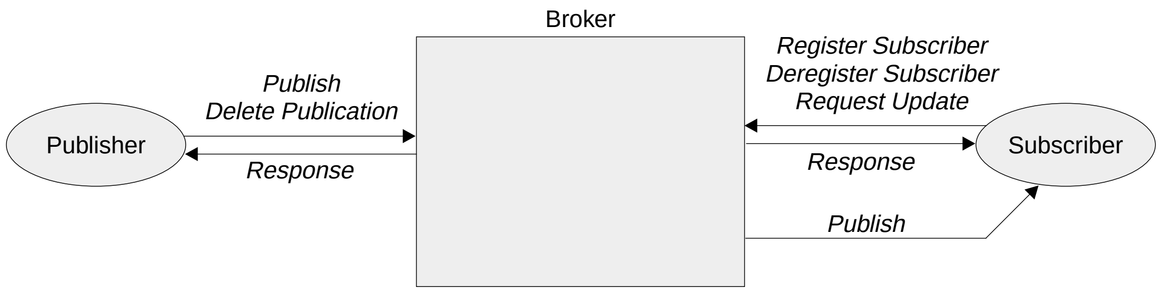


*Figure 4. Communication between publisher, subscriber, and broker. The publisher can send Publish or Delete Publication messages to the broker. The broker forwards the Publish message to subscribers that have a matching subscription. The subscriber can send Register Subscriber, Deregister Subscriber, or Request Update messages to the broker. Optional Response messages from the broker are sent to the publisher and subscriber.*

## The publisher

The publishing application sends a **Publish** command message (see page 47) to the input queue of a message flow that contains a **Publication** node. The input queue is defined as an attribute of the **MQInput** node of the message flow. The publisher must have authority (set by MQSeries) to put a message to this queue. It must also have access authority (set by the MQSeries Integrator system administrator) for the topic or topics that are specified for this publication.

The command is contained within a `<psc>` folder in the *NameValueData* field of the MQRFH2 header. The publication data is in the body of the message, following the MQRFH2 header. The contents of the publication data are (optionally) described in an `<mcd>` folder in the *NameValueData* field of the header, so that content-based filtering can be applied to this publication.

## Topics

The topic that describes the publication is specified in the **Publish** message. Topics can be defined statically by the system administrator (see *MQSeries Integrator Using the Control Center*). In addition, if permitted by the system administrator, they can be defined dynamically in a **Publish** message. Subscriber access to publications is controlled by the system administrator on a topic basis.

Topic names are case sensitive. A topic name can contain any of the characters in the Unicode character set, including the space character, but it is recommended that topic names do not use the null character. Three characters have special meanings: the separator (/), the multi-level wildcard (#) and the single-level wildcard (+).

The separator (/) is used to denote levels within a topic name, for example `employee/hire/development`. This enables a hierarchy of topics to be used.

Note that publishers must specify a complete topic name, without wildcards.

It is permissible to specify more than one topic for a publication.

The topic string is not limited in length. However, topic strings become less efficient as they become longer or have more levels.

## Retained publications

Publishers can specify that a publication is retained by the broker. Normally, a publication is discarded as soon as the broker has sent it to all of its current subscribers. If `RetainPub` is specified as a publication option in the **Publish** message, the publication is retained by the broker. It will replace any previously retained publication for that topic.

### State and event information

Retained publications are useful for information about the current *state* of something, such as the price of stock or the score in a soccer match. When the stock price (or the score) changes, the previous state information is no longer needed. In contrast, publications about individual *events* contain information such as the sale of some stock, or the scoring of a particular goal. Each of these events is independent of other events.

### When to use retained publications

Retained publications do not have to be used for state information. If all the subscriptions for a topic are in place before any publications are made, it is not necessary to retain the publication. Another reason is if state information is published at frequent intervals (for example, every few seconds). On the other hand, if publications *are* retained, a subscribing application that fails can request the current retained publication using the **Request Update** command message (see page 53) after a restart. (Otherwise, it might need to store a local copy of messages received.) See "Sample application" on page 27.

Because a retained publication is stored by each broker that has a subscription for its topic, there are performance and storage implications to be considered, especially if the publications are large.

### Mixed publications

Mixing retained and non-retained publications on the same topic is not recommended but, if applications do this and publish a non-retained publication, any existing retained publication for that topic is still retained.

It is not recommended for two or more applications to publish retained publications to the same topic. If they do and the timing is close to simultaneous, it is indeterminate which publication is retained. If these publishers use two different brokers, it is possible that different retained publications for the same topic could be held at each broker.

### Expiry of retained publications

Use the *`Expiry`* field of the message descriptor (MQMD) to set an expiry interval for a retained publication.

### Deleting a retained publication

Retained publications can be deleted by sending a **Delete Publication** command message (see page 42) to the broker. It must be sent to the same input queue as the corresponding publication to be deleted. Authority to issue this command message is the same as the authority needed to publish messages for the specified topics.

Note that if different publishers publish information on the same topics, the information that is deleted might have originated from a different publisher. In fact a retained publication can be deleted by any user, subject to appropriate authority.

## Local publications

Publishers can publish locally (by specifying the `Local` option) or globally (the default case). Local publications are not forwarded to other brokers, and are received only by subscribers registered at the same broker (whether those subscriptions specified `Local` or not). Local retained publications are retained only at this broker. It is acceptable for applications to publish and subscribe locally and globally (including retained publications) to the same topic at different brokers; each broker will deal with them in isolation from the other brokers where necessary.

### Deleting a local publication

Note that a message published locally can be deleted by a global **Delete Publication** command (that is, without the `Local` option). Similarly, a message published globally can be deleted at the local broker by a local **Delete Publication** command, in which case the message will be absent from that one broker. Therefore, care should be taken if using local and global publications on the same topic.

## Conference-type applications

The `OtherSubsOnly` (other subscribers only) option allows simpler processing of conference-type applications, where a number of individual applications all publish `and` subscribe to the same topic (such as 'Conference'). Normally this means that each application will receive its own publications, since it has a matching subscription.

If this option is specified, it tells the broker not to send the publication to the subscriber queue associated with that application, so that an application can publish information into the conference without receiving that information itself.

## Message ordering

Messages can be published by brokers in the same order as they are received from publishers, depending on the setting of the "order mode" attribute of the **MQInput** node (provided, of course, that the publisher sends all its publications on a given topic to the same input queue). This normally means that each subscriber receives messages from a particular broker, on a particular topic, from a particular publisher, in the order that they are published by that publisher.

However, as with all MQSeries messages, it is possible for messages to be delivered out of order. This could happen:

- If additional instances of the message flow are running.
- If a link in the network goes down and subsequent messages are rerouted along another link.
- If a queue becomes temporarily full, or put-inhibited. In this case a message is put to a dead-letter queue and therefore delayed, while subsequent messages might pass straight through.

If you need to ensure that your messages are delivered in the correct order in all circumstances, you can use one of the following strategies:

- A *sequence number* parameter (`SeqNum`). A publisher can include this with each message in the `<psc>` folder, increasing the value by one for each successive message that it publishes for the same topic. The broker does not check or set this parameter; the responsibility for it lies with the publisher. The number can be checked by the subscriber, which needs to remember the last sequence number it received for that topic.
- A *publish timestamp* parameter (`PubTime`). A publisher can include this with each message `<psc>` folder (with or without the sequence number parameter). This is particularly useful if subscribers are only interested in the latest information; they can check whether the timestamp is greater than that of the last **Publish** message that they processed.

The publisher and subscriber might need to remember the sequence number or publish timestamp atomically with issuing or receiving a publication. This can be accomplished by saving the information on a queue, using the same unit-of-work as the one in which the publication is put or retrieved (see “Persistence and units of work” on page 25).

## Publishing messages without an MQRFH2 header

Messages that do not originate from an MQSeries Integrator Version 2 publisher can also be sent to subscribers even though the messages do not have the usual information needed to make a routing decision. This is done by setting the `Topic` property on the **MQInput** node. If a message arrives at the MQInput node’s queue and does not have an MQRFH2 header that contains a `<psc>` folder, the message is treated as if it was a **Publish** command with this default topic. The message will be sent to subscribers who have registered for the default topic. If a subscriber has included a filter as part of the registration, this will also be applied to a message of this type.

**Notes:**

1. The default topic will not be added to the message; the message is processed as if it contained the topic. The subscriber will receive the original message with no MQRFH2 `<psc>` folder.
2. This type of message is handled as if it were declared with the ‘local’ publish option. The message will not be forwarded to neighboring brokers, even if they subscribed to the default topic.
3. Response messages will not be sent to publishing applications that produce messages in this way, even if the MQMD is set to imply that responses should be sent.
4. Existing MQSeries Publish/Subscribe applications that use MQRFH format subscriptions will not receive these messages.

## The subscriber

The subscribing application sends a **Register Subscriber** command message (see “Register Subscriber” on page 50) to the broker, to specify what publications it wants to receive (defined by topic, filter, and subscription point) and the queue for receiving the publications (the subscriber queue). The command is contained within a `<psc>` folder in the *NameValueData* field of the MQRFH2 header.

The command message is sent to the control queue at the broker. This is the SYSTEM.BROKER.CONTROL.QUEUE (which is compatible with MQSeries Publish/Subscribe applications). The subscriber must have authority (set by MQSeries) to put a message to this queue and to the subscriber queue. It must also have access authority (set by the MQSeries Integrator system administrator) for the topic or topics that are registered in this subscription.

## Subscriptions

A subscription consists of the following:

- One or more topics. Wildcards can be used.
- An optional subscription point.
- An optional filter on the contents of the publication message.
- A subscriber queue, queue manager, and optional `CorrelId`.

When the broker receives a publication that matches the topic, subscription point, and filter, it forwards the publication to the subscriber queue (unless the subscriber registered with the ‘publish on request only’ option, as explained in “Retained publications” on page 22).

### Topics and wildcards

Topics associated with publications are described in “Topics” on page 15. Multiple topics can be specified in subscriptions, and wildcards can be used.

The multi-level wildcard (#) matches any number of levels (including zero). It can be used only at the beginning or end of a topic name string.

The single-level wildcard (+) matches exactly one level. It can be used anywhere in a topic name string. However, MQSeries Integrator is optimized for wildcards at the end of the topic name. It is therefore recommended that applications structure their topics into subject trees, so that subscribers can subscribe to sub-trees by placing the multi-level wildcard at the end.

An additional level of selection can be achieved using a filter on the topic name. See “Filters” on page 20.

| **Note:** It is recommended that subscriptions to ‘#’ are avoided where possible,
| because, in a multi-broker environment, they will cause a greater proportion
| of publications to be sent between brokers.

### Subscription points

A subscription point is the name by which subscribers access publications at one or more **Publication** nodes.

Each Publication node has one subscription point name, and different Publication nodes can share the same name. A subscriber registering a subscription to a particular subscription point will receive publications from all of the Publication nodes that have the specified subscription point name. This applies to all message flows running in the broker, and to all brokers connected in the network (except for local publications).

By default, Publication nodes have a null subscription point name, and subscribers that do not specify a subscription point when they register will receive publications from all such nodes.

It is recommended that you use the default subscription point where possible. The use of non-default subscription point names requires extra processing and might, therefore, impact the performance of your broker network.

The subscription point name must not be more than 64 characters in length.

## Filters

You can specify a content-based filter to select publications according to their contents, in addition to specifying a topic and subscription point. MQSeries Integrator needs to know the structure of the message in order to parse its contents correctly. (The structure is defined by the domain, set, type and format, as described in "Message service folders" on page 38). This can be achieved in a number of ways:

- The message is a self-defining XML message.
- The message is defined by an `<mcd>` folder in the MQRFH2 header (see page 38).
- Otherwise, the message is assumed to be as defined in the attributes of the **MQInput** node.

The filter itself is entered as an expression with SQL syntax, for example:

```
Body.Name LIKE 'C%'
```

This means that the contents of a field called "Name" in the body of the input message (that is, the publication data that follows the MQRFH2 header) will be extracted and matched against the string given in the expression. % is a wildcard, meaning zero or more characters. If the name in the message starts with 'C', the expression evaluates to TRUE and so the publication will be sent to the subscriber.

For more details about filters, see Appendix A, "Using filters in content-based routing" on page 177.

## Subscriber queues

A publication is delivered to the queue and queue manager specified by the subscriber either by specifying the `<QName>` and `<QMgrName>` properties in the **Register Subscriber** command message, or by using values taken from the MQMD (which is the default). This is the *subscriber queue*.

If required, the subscriber queue can be a temporary dynamic queue. In this case, the broker will deregister the subscription automatically if the queue is deleted (for example, when the subscriber disconnects from the queue manager). For optimal broker performance, it is recommended that subscribing applications deregister their subscriptions before terminating. If the application fails to deregister, the broker will automatically remove the subscriptions when it sees that the queue has been deleted. Note that automatic deregistration will not work if:

- The dynamic temporary queue is not local (that is, it is not on the same queue manager on which the broker is running)
- The subscriber has named a queue that is an alias of a local temporary dynamic queue

A correlation identifier can be included if required. This allows several applications to share a queue, which might be desirable if there are many clients. It also allows a single application to distinguish between publications arising from different subscriptions.

In general, if a subscribing application has more than one subscription that matches a publication, only one copy of the publication is sent to it. However, if it registered with different subscriber identifiers (a combination of the MQSeries queue, queue manager, and optional correlation identifier), more than one copy might be sent to the application.

The subscriber queue should not in general be the same as any defined in a message flow, because this would cause the published message to be republished. However, such a restriction is not imposed by the broker, and it is possible to use this behavior to chain message flows together dynamically.

## Registration

A subscriber can register multiple times with the same or different brokers as necessary. An application can be both a subscriber and a publisher.

An existing subscriber can re-register in order to increase the range of topics, subscription points, or filters for which it wants to receive information. Similarly it can change its registration options or expiry time for a given combination of topic, subscription point and filter for which it is already registered. Only the application that originally registered a subscription can update it.

**Note:** When registering again, unspecified options are assumed to take their default values; they do **not** remain unchanged.

### Local subscriptions

A subscriber can specify the `Local` option when registering a subscription. In this case the broker does not forward the subscription to other brokers in the network. The subscriber will not receive publications that are published to other brokers, only those published to the broker at which it registers its subscription.

### Subscription expiry

The *Expiry* interval in the message descriptor (MQMD) of the **Register Subscriber** command message determines when the subscription expires. If this is set to MQEI_UNLIMITED, the subscription does not expire. If a subscription is re-registered, the subscription's expiry time is updated to the value of *Expiry* in the MQMD of the re-registration message.

### Deregistration

One or more subscriptions for a particular subscriber can be deregistered using the **Deregister Subscriber** command message (see page 44). This is sent to the broker control queue, SYSTEM.BROKER.CONTROL.QUEUE. The message must be sent by the subscriber that registered the subscription in the first place.

There are other ways in which a subscription can be deregistered:

- The subscription expires, as explained above.
- A system administrator deregisters the subscription (see *MQSeries Integrator Using the Control Center*).
- If the subscriber queue is a temporary dynamic queue, and the queue is deleted (for example, when the subscriber disconnects from the queue manager), the broker will deregister the subscription automatically. However, see the restrictions listed in "Subscriber queues" on page 20.

When a subscriber application sends a message to deregister a subscription, and receives a response message to say that this was processed successfully, it is possible that some publications will subsequently reach the subscriber queue if they were being processed by the broker at the same time as the deregistration. This might result in a buildup of unprocessed messages on the subscriber queue. If the application does a loop that includes an MQGET call with the appropriate `CorrelId` after sleeping for a while, any such messages will be cleared off the queue.

Similarly, if the subscriber uses a permanent dynamic queue and, when completing, it deregisters and closes the queue with the `PurgeandDelete` option, it is possible that the queue will not be empty. This is because publications from the broker might not yet be committed at the time that the queue was deleted. In this case, a Q_NOT_EMPTY return code will be issued by the MQCLOSE call. The application can avoid this problem by sleeping and reissuing the MQCLOSE call from time to time.

## Retained publications

Retained publications are normally sent directly to subscribers that have matching subscriptions. A new subscriber will be sent the current retained publication immediately after registering, unless it specified the `NewPubsOnly` option when it registered the subscription (in which case only new publications are sent to it).

If a subscriber registers with the `PubOnReqOnly` option (publish on request only) the subscriber will not receive the current retained publication until it sends a **Request Update** command message to the broker control queue SYSTEM.BROKER.CONTROL.QUEUE (see page 53). Note that with this option the subscriber will not receive any non-retained publications.

A subscriber that did not register with `PubOnReqOnly` can also use **Request Update** at any time. This might be necessary if the subscriber had already received the publication in the normal way, but had failed without saving it, and on restart wants to receive it again.

A subscriber can request to be informed if the subscriber is being told that the publication was sent to it as a result of a subscriber request update operation. Normal publications (even retained ones) will not have `IsRetainedPub` set. This is done by specifying the `InformIfRet` option in the **Register Subscriber** message. The broker will then set the `IsRetainedPub` publication option in the **Publish** message when it forwards a retained publication to the subscriber.

## Flow of publish/subscribe messages

Figure 5 on page 23 shows the flow of messages in a simple publish/subscribe system with no retained publications. It is assumed that a message flow consisting of at least one **MQInput** node and a **Publication** node has been set up in the broker. The input queue in the diagram relates to this **MQInput** node. It is also assumed that the subscriber registers its subscription to the same topic that the publisher is using. Note that the subscriber does not receive publications that were published before it registered its subscription.

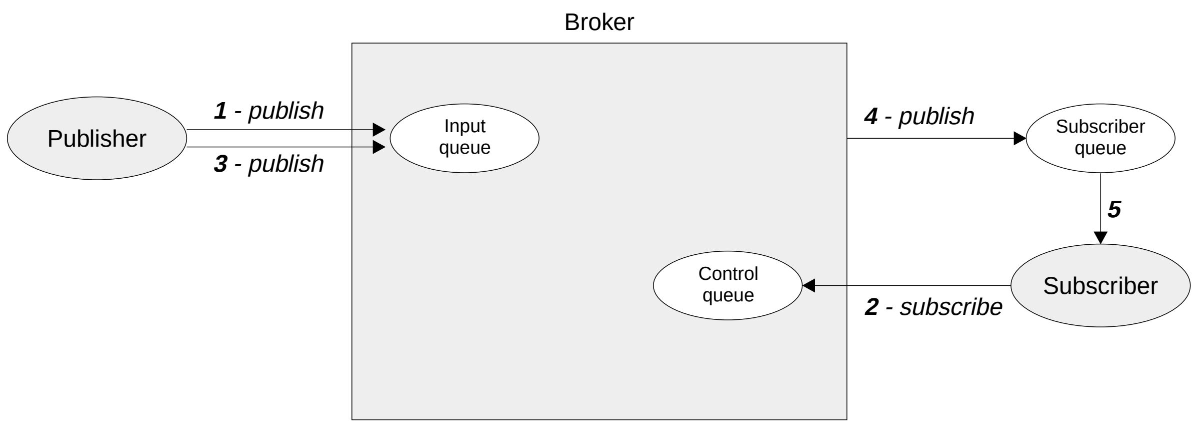


*Figure 5. Publish/subscribe without retained publications. The publisher sends a publication to the input queue (1). The subscriber does not receive this publication because it has not yet registered a subscription. After it subscribes (2), the next publication (3) is sent to the subscriber queue (4), from where the subscriber can get it (5).*

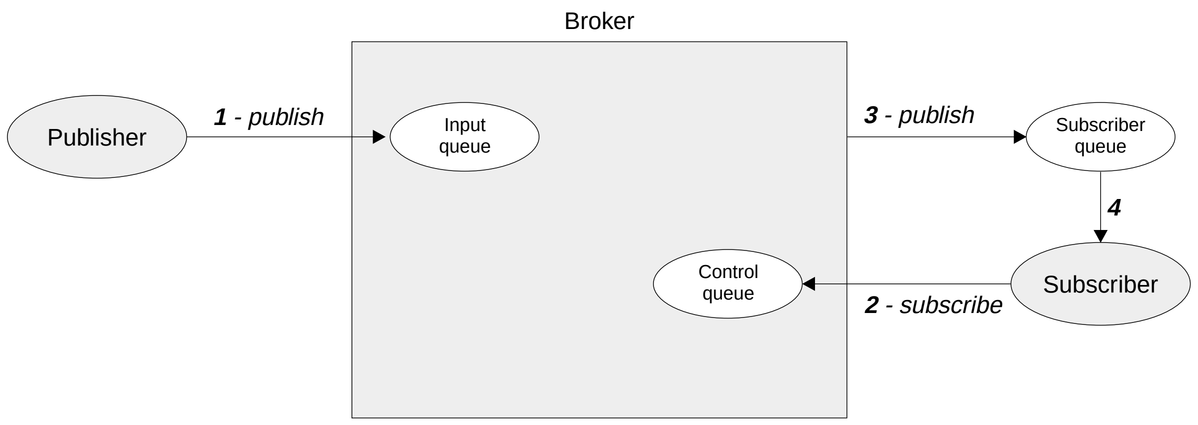


*Figure 6. Using retained publications. The publisher sends a retained publication to the broker (1). When the subscriber registers (2), the current retained publication is sent to the subscriber queue (3), from where the subscriber can get it (4). Subsequent publications will be sent to the subscriber straightaway.*

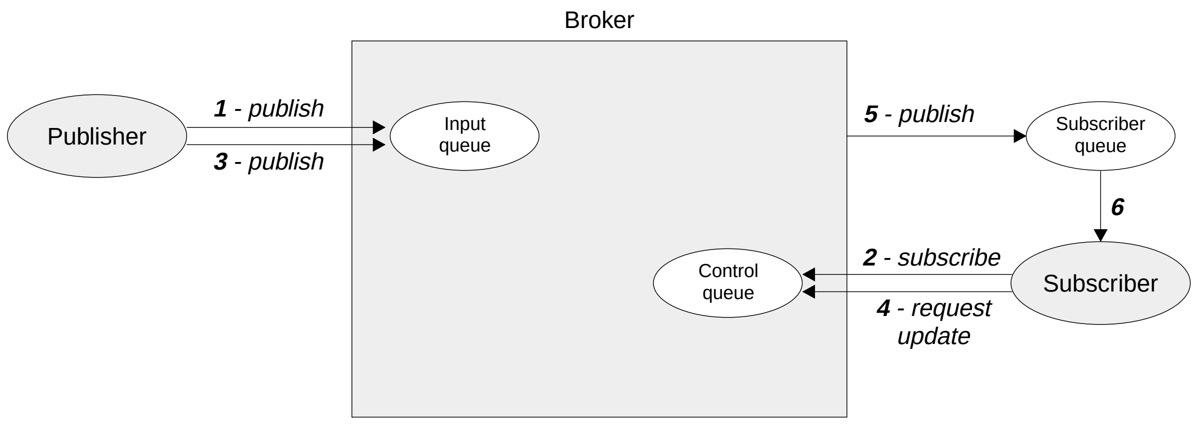


*Figure 7. Publish on request only. The subscriber registers a subscription with "publish on request only" (2). Although there is a current retained publication (1), it is not sent to the subscriber until it uses "request update" (4). By this time, the retained publication has been replaced by a new publication (3) which is sent to the subscriber queue (5), from where the subscriber can get it (6).*

Figure 6 shows the use of retained publications. In this case the subscriber receives a retained publication that was published *before* the subscriber registered its subscription.

In Figure 7 on page 23, the subscriber registers its subscription with the `PubOnReqOnly` option, so it does not receive the retained publication until it sends a **Request Update** message to the broker (by which time the earlier retained publication has been replaced by a later one).

**Note:** The figures assume that the publishers and subscribers have not requested responses from the broker.

## The broker

The broker forwards **Publish** messages to subscribers, for publications that match each subscription (defined by topic, filter, and subscription point). The publications are sent to the subscriber queue as defined in the **Register Subscriber** command message.

Unless the `Local` option is specified, a broker sends subscription registrations to other brokers in the network. Matching publications will then be forwarded to that broker for distribution to its subscribers.

Only one copy of a publication is sent to each subscriber, regardless of how many matching subscriptions that subscriber has (unless it registered with different subscriber queues or correlation identifiers).

Publications sent from brokers have their message descriptor changed. Refer to “MQMD for publications forwarded by a broker” on page 58.

### Broker response messages

The broker can send a message to a publisher or subscriber in response to a command message. A response message has a similar format to a command message, but it is contained in a `<pscr>` folder in the *NameValueData* field of the MQRFH2 header.

The response message is sent to the queue identified by the *ReplyToQ* and *ReplyToQMgr* fields in the message descriptor (MQMD) of the command message. The persistence of the response message is set to the same value as for the command message. If the *ReplyToQ* is a temporary dynamic queue, the command message must be non-persistent. The *MsgType* and *Report* fields in the MQMD, together with the success or failure of the command, determine whether the response message is sent.

The broker can generate three types of response:

|  |  |
|---|---|
| **ok** | The command completed successfully |
| **warning** | The command was only partially successful |
| **error** | The command failed |

For further details, see “Broker Response” on page 55.

Brokers do not request publishers or subscribers to generate responses to messages from the broker.

## Broker restarts

Subscription registrations and retained publications are maintained across broker restarts. After a restart, any subsequent publications for the specified topics will be forwarded to the application. In addition, if the broker has any retained publications for these topics, the application can request to receive them after the restart using **Request Update**.

## Persistence and units of work

Subscriber registration messages should normally be sent as persistent messages.

Brokers maintain the persistence and priority of publications as set by the publisher, unless changed by options in the **Register Subscriber** command (see page 50), or by the Access Control List (see MQSeries Integrator Using the Control Center). Publications will be delivered as non-persistent messages if the ‘Persistent’ flag in the Access Control List is set to False (the default), regardless of the persistence set by the publisher or the subscriber.

If a publication matches more than one subscription for an application, the persistence of the publication delivered to the subscriber queue is determined according to the following rules:

| **Subscription persistence** | **Resulting publication persistence** |
|---|---|
| All subscriptions are non-persistent (regardless of the publication persistence), or persistent as publisher and the publication is non-persistent | Non-persistent |
| At least one subscription is set to persistence as queue, all others are as above | Persistence as queue |
| At least one subscription is persistent (regardless of the publication persistence), or persistent as publisher and the publication is persistent | Persistent |

Note that this table applies to the persistence options for a specific subscriber having more than one subscription that matches the publication. The persistence options for different subscribers are **not** merged, so it is possible for them to receive the same publication with different persistence.

When reading messages from input queues, brokers always read persistent messages within a unit-of-work, so that they are not lost if the broker or system crashes. Non-persistent messages might or might not be read within a unit-of-work, depending on the setting of the attributes of the **MQInput** node.

Publication messages are treated so that publication to subscribers is once and once only for persistent messages. For non-persistent messages, delivery to subscribers is also once only unless *SyncPointIfPersistent* was specified in the queue manager configuration file and the broker or queue manager stops abruptly. In this case, the message might be lost for one or more subscribers. Regardless of its persistence, however, a **Publish** message is never sent more than once to a subscriber, for a given subscription (unless it is explicitly requested using the **Request Update** command).

If the subscriber queue is a temporary dynamic queue, the subscription request must specify non-persistent delivery of publications or else it will be rejected by the broker.

Publishers and subscribers can choose whether to use a unit-of-work when publishing or receiving messages. However, if the *SequenceNumber* technique described previously is used for maintaining ordering, both publisher and subscriber must retain sequencing information atomically with putting or getting a message if the application is to be restartable.

## Sample application

One of the sample applications provided with MQSeries Integrator Version 2.0.1 uses publish/subscribe to simulate a results gathering service that reports the latest score in a sports event such as a soccer match. It receives information from one or more instances of a soccer match simulator that scores goals at random for the two teams. This is illustrated in Figure 8.

Refer to the *MQSeries Integrator Installation Guide* for details of where to find this sample application.

The match simulator does not keep track of the score. It merely indicates when a match starts or finishes, and when a goal is scored. These events are published to three different topics on the MQSI_SOCCER_PUBLICATION_QUEUE queue.

- When a match starts, the names of the teams are published on the `Sport/Soccer/Event/MatchStarted`topic.
- When a goal is scored, the name of the team scoring the goal is published on the `Sport/Soccer/Event/ScoreUpdate` topic.
- When a match ends, the names of the teams are published on the `Sport/Soccer/Event/MatchEnded` topic.

The publications on these topics are *not* retained, as they contain event information and not state information.

The results service subscribes to the topic `Sport/Soccer/Event/#` to receive publications from any matches that are in progress. It keeps track of the current score in each match, and whenever there is a change it publishes the score as a *retained* publication on the following topic:

```
Sport/Soccer/State/LatestScore/Team1 Team2,
```

where Team1 and Team2 are the names of the teams in the match.

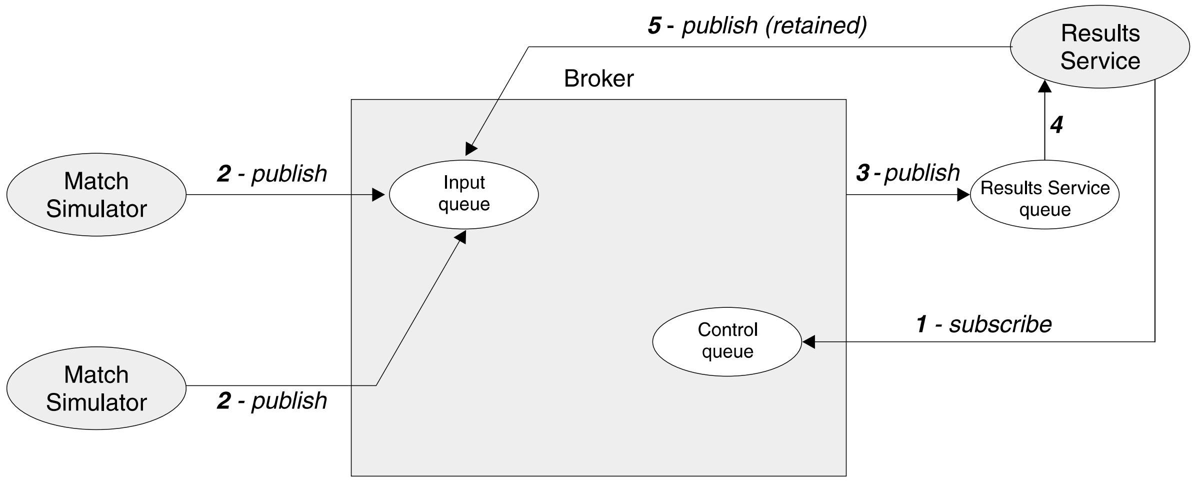


*Figure 8. The results service application. The results service subscribes to the topics "match started", "score update" and "match ended" (1). When the match simulators publish event information on these topics (2), the publications are forwarded to the results service queue (3), from where the results service application gets them (4). The results services then publishes the latest scores (which are state information) as retained publications (5).*

A subscriber wanting to receive all the latest scores could register a wildcard subscription to the following topic:

```
Sport/Soccer/State/LatestScore/#
```

If it was interested in one particular team only, it could register different wildcard subscriptions to the following topics:

```
Sport/Soccer/State/LatestScore/MyTeam/+
Sport/Soccer/State/LatestScore/+/MyTeam
```

Note that the results service must be started before the match simulators, otherwise it might miss some events and hence not be able to ascertain the current state in each match. This is usually the case with event publications, in which subscriptions are static and need to be in place before publications arrive.

If it stops while matches are still in progress the results service can find out the state of play when it restarts. This is done by subscribing to its own retained publications using the the `Sport/Soccer/State/LatestScore/#` topic, with the 'Publish on Request Only' option. A **Request Update** command is then issued to receive any retained publications which contain latest scores.

These publications enable the results service to reconstruct its state as it was when it stopped. It can then process all events that occurred while it was stopped by processing the subscription queue for the `Sport/Soccer/Events/#` topic. Because the subscription will still be registered (no **Deregister Subscriber** message has been sent) it will include any event publications that arrived while the results service was inactive.

This sample program illustrates the following aspects of a publish/subscribe application:

- Event information (not retained).
- State information (retained publication).
- Wildcard matching of topic strings.
- Multiple publishers on the same topics (non-retained publications only).
- The need to subscribe to a topic *before* it is published on (non-retained publications).
- A subscriber continuing to be sent publications when that subscriber (not its subscription) is interrupted.
- The use of retained publications to recover state after a subscriber failure.

## Using the AMI in publish/subscribe applications

The MQSeries Application Messaging Interface (AMI) has functions to generate a number of publish/subscribe command messages, and to receive a publication from the broker. The name of the function (or method) depends on the programming language being used (C, Cobol, C++, or Java). In the case of C and Cobol there are two sets of functions: the high-level interface and the object interface.

The AMI can be downloaded free from the Internet, complete with sample applications that demonstrate how to use its publish/subscribe function. See

`http://www.ibm.com/software/mqseries/txppacs/`

## AMI publish/subscribe functions

### Publish command

| | |
|---|---|
| **C high-level / object** | amPublish / amPubPublish |
| **Cobol high-level / object** | AMHPB / AMPBPB |
| **C++** | AmPublisher->publish |
| **Java** | AmPublisher.publish |

### Register Subscriber command

| | |
|---|---|
| **C high-level / object** | amSubscribe / amSubSubscribe |
| **Cobol high-level / object** | AMHSB / AMSBSB |
| **C++** | AmSubscriber->subscribe |
| **Java** | AmSubscriber.subscribe |

### Deregister Subscriber command

| | |
|---|---|
| **C high-level / object** | amUnsubscribe / amSubUnsubscribe |
| **Cobol high-level / object** | AMHUN / AMSBUN |
| **C++** | AmSubscriber->unsubscribe |
| **Java** | AmSubscriber.unsubscribe |

### Receive a publication

| | |
|---|---|
| **C high-level / object** | amReceivePublication / amSubReceive |
| **Cobol high-level / object** | AMHRCPB / AMSBRC |
| **C++** | AmSubscriber->receive |
| **Java** | AmSubscriber.receive |

These functions have parameters that enable you to specify some of the properties in the command message, such as the *topic*. Other properties in the command message are specified by the AMI *service* and *policy* that you use to send the message. Services and policies are set up by the system administrator. For example, the subscriber service that you use in a publish/subscribe application specifies a sender service point and a receiver service point. These in turn define the queues that are used to send subscription requests to the broker, and to receive publications from the broker (the service points must have a Service Type of ‘MQSeries Integrator V2’). The publish and subscribe attributes of the policy you

| use in a publish/subscribe application specify options such as the use of retained
| publications, and which subscription point to use.

If required, you can modify the properties in the command message by changing the appropriate name/value elements before sending the message. Helper functions are provided for this purpose. Details of these name/value elements and the options that are available for each command are given in Chapter 5, “Publish/subscribe command messages” on page 41.

There are no AMI functions to generate **Delete Publication** or **Request Update** command messages directly. You have to construct a message containing the appropriate name/value elements using the helper functions provided, and then send the message to the broker.

Refer to the *MQSeries Application Messaging Interface* book for details of how to use the functions mentioned above (including the name/value element helper functions).

# Chapter 4. The MQRFH2 rules and formatting header

The MQRFH2 header is used to pass messages to and from the MQSeries Integrator Version 2.0.1 broker. The MQRFH2 header follows the MQSeries message descriptor (MQMD) and precedes the message body (if present). Other headers, such as the IMS or CICS bridge headers, are allowed before or after the MQRFH2 header.

If you are using the Message Queuing Interface (MQI) to write application programs, you need to understand this header. In addition, if your application uses the publish/subscribe model, you should read Chapter 5, “Publish/subscribe command messages” on page 41.

## MQRFH2 Structure

The following table summarizes the fields in the structure.

*Table 1. Fields in MQRFH2*

| Field | Description | Page |
|---|---|---|
| *StrucId* | Structure identifier | 32 |
| *Version* | Structure version number | 32 |
| *StrucLength* | Total length of MQRFH2 including *NameValueData* | 33 |
| *Encoding* | Numeric encoding of data that follows *NameValueData* | 33 |
| *CodedCharSetId* | Character set identifier of data that follows *NameValueData* | 33 |
| *Format* | Format name of data that follows *NameValueData* | 33 |
| *Flags* | Flags | 34 |
| *NameValueCCSID* | Character set identifier of *NameValueData* | 34 |
| | | |
| *NameValueLength* | Length of *NameValueData*. Can be repeated as many times as required. | 34 |
| *NameValueData* | Name/value data. Can be repeated as many times as required. | 34 |

**Purpose**:

The MQRFH2 structure contains information about the structure and intended consumers of a message that allows an MQSeries Integrator broker to process it and to deliver or publish it to those consumers.

**Format name**:

This is the value that should be put in the Format field of the preceding header (usually the MQMD). The value is `MQRFH2ƀƀ`, where ‘ƀ’ is a blank. MQFMT_RF_HEADER_2 is a constant defined to hold this value.

For the C programming language, the constant MQFMT_RF_HEADER_2_ARRAY is also defined; this has the same value as MQFMT_RF_HEADER_2, but is an array of characters instead of a string.

**Character set and encoding**:

The character set and encoding of the fields in the MQRFH2 are as follows:

- Fields other than *NameValueData* are in the character set and encoding given by the *CodedCharSetId* and *Encoding* fields in the header structure that precedes the MQRFH2, or by those fields in the MQMD structure if the MQRFH2 is at the start of the application message data. The character set should be one that has single-byte characters for the characters that are valid in queue names.
- *NameValueData* is in the character set given by the *NameValueCCSID* field. Only certain Unicode character sets are valid for *NameValueCCSID* (see the description of *NameValueCCSID* for details).

  Some character sets have a representation that is dependent on the encoding. If *NameValueCCSID* is one of these character sets, *NameValueData* must be in the same encoding as the other fields in the MQRFH2.
- The user data (if any) that follows *NameValueData* can be in any supported character set (single-byte, double-byte, or multi-byte), and any supported encoding.

**Availability**:

This structure is available in MQSeries V5.1 environments that have CSD 2 applied.

Data conversion of this structure is supported in these environments.

## Fields

*StrucId* (MQCHAR4)
Structure identifier.

The value must be:

MQRFH_STRUC_ID
Identifier for rules and formatting header structure.

For the C programming language, the constant MQRFH_STRUC_ID_ARRAY is also defined; this has the same value as MQRFH_STRUC_ID, but is an array of characters instead of a string.

The initial value of this field is MQRFH_STRUC_ID.

*Version* (MQLONG)
Structure version number.

The value must be:

MQRFH_VERSION_2
Version-2 rules and formatting header structure.

The initial value of this field is MQRFH_VERSION_2.

*StrucLength* (MQLONG)

Total length of MQRFH2 including *NameValueData*.

This is the length in bytes of the MQRFH2 structure, including the *NameValueLength* and *NameValueData* fields at the end of the structure. It is valid for there to be multiple pairs of *NameValueLength* and *NameValueData* fields at the end of the structure, in the sequence: length1, data1, length2, data2, .... *StrucLength* does *not* include any user data that may follow the last *NameValueData* field at the end of the structure.

*StrucLength* must be set to a multiple of four; otherwise, problems with data conversion of the user data might occur in some environments.

The following constant gives the length of the *fixed* part of the structure, that is, the length excluding the *NameValueLength* and *NameValueData* fields:

MQRFH_STRUC_LENGTH_FIXED_2
Length of fixed part of MQRFH2 structure.

The initial value of this field is MQRFH_STRUC_LENGTH_FIXED_2.

*Encoding* (MQLONG)

Numeric encoding of data that follows *NameValueData*.

This specifies the representation used for numeric values in the data (if any) that follows the last *NameValueData* field. This applies to binary integer data, packed-decimal integer data, and floating-point data.

The initial value of this field is MQENC_NATIVE.

*CodedCharSetId* (MQLONG)

Character set identifier of data that follows *NameValueData*.

This specifies the coded character set identifier of character strings in the data (if any) that follows the last *NameValueData* field. The following special value can be specified:

MQCCSI_INHERIT
Inherit character-set identifier of current structure.

Character data in the data that follows the current structure is in the same character set as the current structure.

The initial value of this field is MQCCSI_INHERIT.

*Format* (MQCHAR8)

Format name of data that follows *NameValueData*.

This specifies the format name of the data (if any) that follows the last *NameValueData* field.

The name should be padded with blanks to the length of the field. Do not use a null character to terminate the name before the end of the field, because the queue manager does not change the null and subsequent characters to blanks in the MQRFH2 structure. Do not specify a name with leading or embedded blanks.

The initial value of this field is MQFMT_NONE.

*Flags* (MQLONG)
Flags.

The following value must be specified:

MQRFH_NONE
No flags.

The initial value of this field is MQRFH_NONE.

*NameValueCCSID* (MQLONG)
Character set identifier of *NameValueData*.

This specifies the coded character set identifier of the data in the *NameValueData* field. This is different from the character set of the other strings in the MQRFH2 structure, and can be different from the character set of the data (if any) that follows the last *NameValueData* field at the end of the structure.

*NameValueCCSID* must have one of the following values:

| **CCSID** | **Description** |
|---|---|
| 1200 | UCS-2 open-ended |
| 13488 | UCS-2 2.0 subset |
| 17584 | UCS-2 2.1 subset (includes the euro symbol) |
| 1208 | UTF-8 |

For the UCS-2 character sets, the encoding (byte order) of the *NameValueData* must be the same as the encoding of the other fields in the MQRFH2 structure. Surrogate characters (`X'D800'` through `X'DFFF'`) are not supported.

The initial value of this field is 1208.

The following two fields are optional, but if present they must occur as a pair. They can be repeated as a pair as many times as required, that is, if they occur multiple times they must occur in the sequence: length1, data1, length2, data2, ....

**Note:** Because these fields are optional, they are omitted from the declarations of the structure that are provided for the various programming languages supported.

*NameValueLength* (MQLONG)
Length of *NameValueData*.

This specifies the length in bytes of the data in the *NameValueData* field. To avoid problems with data conversion of the data (if any) that follows the *NameValueData* field, *NameValueLength* should be a multiple of four.

*NameValueData* (MQCHARn)
Name/value data.

This is a variable-length character string containing data encoded using an XML-like syntax. The length in bytes of this string is given by the *NameValueLength* field that precedes the *NameValueData* field. This length should be a multiple of four.

**Note:** Because the length of *NameValueData* is not fixed, the field is omitted from the declarations of the structure that are provided for the various programming languages supported.

The string consists of a single “folder” that contains zero or more properties. The folder is delimited by XML start and end tags whose name is the name of the folder:

```
<folder> property1 property2 ... </folder>
```

Characters following the folder end tag, up to the length defined by *NameValueLength*, must be blank. Within the folder, each property is composed of a name and a value, and optionally a data type:

```
<name>value</name>
```

In these examples:

- The delimiter characters (<, =, ", /, and >) must be specified exactly as shown.
- `name` is the user-specified name of the property; see below for more information about names.
- `value` is the user-specified value of the property; see below for more information about values.
- Blanks are significant between the > character which precedes a value, and the < character which follows the value. Elsewhere, blanks can be coded freely between tags, or preceding or following tags (for example, in order to improve readability); these blanks are not significant.
- You must not use null as a pad character.

If properties are related to each other, they can be grouped together by enclosing them within XML start and end tags whose name is the name of the group:

```
<folder> <group> property1 property2 ... </group> </folder>
```

Groups can be nested within other groups, without limit, and a given group can occur more than once within a folder. It is also valid for a folder to contain some properties in groups and other properties not in groups.

**Names of properties, groups, and folders**: Names of properties, groups, and folders must be valid XML tag names, with the exception of the colon character, which is not permitted in a property, group, or folder name. In particular:

- Names must start with a letter or an underscore. Valid letters are defined in the W3C XML specification, and consist essentially of Unicode categories Ll, Lu, Lo, Lt, and Nl.
- The remaining characters in a name can be letters, decimal digits, underscores, hyphens, or dots. These correspond to Unicode categories Ll, Lu, Lo, Lt, Nl, Mc, Mn, Lm, and Nd.
- The Unicode compatibility characters (X'F900' and above) are not permitted in any part of a name.
- Names must not start with the string `XML` in any mixture of upper or lower case.

In addition:

- Names are case-sensitive. For example, `ABC`, `abc`, and `Abc` are three different names.

- Each folder has a separate name space. As a result, a group or property in one folder does not conflict with a group or property of the same name in another folder.
- Groups and properties occupy a single name space within a folder. As a result, property cannot have the same name as a group within the folder containing that property.

Generally, programs that analyze the *NameValueData* field should ignore properties or groups that have names that the program does not recognize, provided that those properties or groups are correctly formed.

**Values of properties**: The value of a property can consist of any characters, except as detailed below:

- If the value contains any of the following characters, each occurrence of the character must be replaced by the corresponding escape sequence:

| Character | Escape sequence |
|---|---|
| `&` | `&amp;` |
| `<` | `&lt;` |

- The following escape sequences are also defined, but their use is optional:

| Character | Escape sequence |
|---|---|
| `>` | `&gt;` |
| `"` | `&quot;` |
| `'` | `&apos;` |

**Note:** The `&` character at the start of an escape sequence must *not* be replaced by `&amp;`. For example:

```
<Filter>&quot;Body.Field1"&lt;> '&amp;hello&apos;</Filter>
```

which translates as:

```
<Filter>"Body.Field1"<> '&hello'</Filter>
```

## Initial values

*Table 2 (Page 1 of 2). Initial values of fields in MQRFH2*

| Field name | Name of constant | Value of constant |
|---|---|---|
| *StrucId* | MQRFH_STRUC_ID | `'RFHb'` (See note 1) |
| *Version* | MQRFH_VERSION_2 | `2` |
| *StrucLength* | MQRFH_STRUC_LENGTH_FIXED_2 | `36` |
| *Encoding* | MQENC_NATIVE | See note 2 |
| *CodedCharSetId* | MQCCSI_INHERIT | `-2` |
| *Format* | MQFMT_NONE | `'bbbbbbbb'` |
| *Flags* | MQRFH_NONE | `0x00000000` |

*Table 2 (Page 2 of 2). Initial values of fields in MQRFH2*

| Field name | Name of constant | Value of constant |
|---|---|---|
| *NameValueCCSID* | None | 1208 |

**Notes:**

1. The symbol ‘b’ represents a single blank character.
2. The value of this constant is environment-specific.
3. In the C programming language, the macro variable MQRFH2_DEFAULT contains the values listed above. It can be used in the following way to provide initial values for the fields in the structure:

   ```
   MQRFH2 MyRFH2 = {MQRFH2_DEFAULT};
   ```

## Definition for the C programming language

This structure is defined in the cmqc.h header file. The constants that are used within the `NameValueData` field are defined in the BipRfc.h header file.

```
typedef struct tagMQRFH2 {
  MQCHAR4  StrucId;         /*  Structure identifier                       */
  MQLONG   Version;         /*  Structure version number                   */
  MQLONG   StrucLength;     /*  Total length of MQRFH2 including
                                 NameValueData                             */
  MQLONG   Encoding;        /*  Numeric encoding of data that follows
                                 NameValueData                             */
  MQLONG   CodedCharSetId;  /*  Character set identifier of data that
                                 follows NameValueData                     */
  MQCHAR8  Format;          /*  Format name of data that follows
                                 NameValueData                             */
  MQLONG   Flags;           /*  Flags                                      */
  MQLONG   NameValueCCSID;  /*  Character set identifier of NameValueData  */
 } MQRFH2;
```

**Note:** Because *NameValueData* and *NameValueLength* are optional fields, they are omitted from the above definition.

## Message service folders

The following folder names are defined for use by MQSeries products:

| | |
|---|---|
| `<mcd>` | Message content descriptor |
| `<psc>` | Publish/subscribe command |
| `<pscr>` | Publish/subscribe command response |
| `<usr>` | Application (user) defined properties |

Each folder is contained in a separate `NameValueData` field, each with a preceding `NameValueLength` field.

Other names are available for use by independent software vendors. To avoid naming problems, we recommend that vendors prefix their chosen folder name with their internet domain name. For example, a vendor with domain name `ourcompany.com` should name its folders in this way:

```
com.ourcompany.xxx
```

or

```
com.ourcompany.ourData
```

## The mcd folder

The `<mcd>` folder can contain the following elements that describe the structure of the message data in an MQSeries message. They are all character strings.

| | |
|---|---|
| `<Msd>` | Message service domain |
| `<Set>` | Message set |
| `<Type>` | Message type |
| `<Fmt>` | Message format |

The domain element identifies how to handle the message. The syntax of the other elements (set, type, and format) depend on the value assigned to `<Msd>`.

The following values for `<Msd>` have been allocated:

`mrm`
: MQSeries Integrator MRM-managed messages. This domain supports the following values for `<Fmt>`:

  `xml`
  : XML representation

  `pdf`
  : MTI bitstream representation

  *CWF identifier*
  : The custom wire format identifier that you assigned to your message set in the Control Center.

  The `Set` element should contain the identifier of the MRM message set to which the message belongs (this identifier is obtained from the Control Center). The `Type` element value is the identifier of the MRM message definition (within the specified message set) to which this message belongs.

| | |
|---|---|
| `neon` | The message is parsed by the MQSeries Integrator Version 1 message parser. The values for message set, type, and format are mapped to MQSeries Integrator Version 1 equivalents. The `Type` element should contain the name of the MQSeries Integrator Version 1 message format, as defined in the MQSeries Integrator Version 1 user interface. The `Set` element normally contains the name of the MQSeries Integrator Version 1 Application Group; however, for Publication purposes, this is not relevant and can be omitted. The `Fmt` element is not used and is ignored. |
| `none` | The message is treated as an opaque blob, and delivered to the recipient as is. If this domain is chosen, the set and type must not be specified. |
| `xml` | The message is treated as a self-defining XML message. |

An alternative to having an `<mcd>` folder with `<Msd>` set to none or XML is to set the `Format` field of the MQRFH2 header to MQFMT_NONE or “xml”, respectively, omitting the `<mcd>` folder completely from the MQRFH2 header in both cases.

## The psc folder

The `<psc>` folder is used to convey publish/subscribe command messages to the broker. Only one `psc` folder is allowed in the `NameValueData` field.

See Chapter 5, “Publish/subscribe command messages” on page 41 for full details.

## The pscr folder

The `<pscr>` folder is used to contain information from the broker, in response to publish/subscribe command messages. There is only one `pscr` folder in a response message.

See “Broker Response” on page 55 for full details.

The broker ignores this folder in messages that it receives from publishing or subscribing applications.

## The usr folder

The content model of the `<usr>` folder is as follows:

- Any valid XML name can be used as an element name, providing that it doesn't contain a colon
- Only simple elements are permitted (no grouping)
- All elements assume a default type of string, unless modified by a dt="xxx" attribute
- All elements are optional, but should occur at most once in a folder
- An MQRFH2 instance can contain at most one `<usr>` folder

## Multiple MQRFH2 headers

It is possible for a message to have more than one MQRFH2 header: for instance if one application forwards a message, including its header, to another application. In this case, the one added later precedes the original header.

- Attributes that describe the body of the message, such as the domain, set, type, and format, or the CCSID and encoding, are taken from the *last* MQRFH2 header, which must immediately precede the body of the message.
- Anything else, such as the topic for a publish/subscribe message, is taken from the *first* MQRFH2 header.

# Chapter 5. Publish/subscribe command messages

This chapter describes the command messages that are sent to MQSeries Integrator in a publish/subscribe application.

If you are using the Message Queue Interface (MQI) to write applications that use the publish/subscribe model, you need to understand these messages, and the header described in Chapter 4, “The MQRFH2 rules and formatting header” on page 31.

The following information is provided:

The commands are contained in a `<psc>` folder in the *`NameValueData`* field of the MQRFH2 header.

The message that can be sent by a broker in response to a command message is contained in a `<pscr>` folder.

The command descriptions list the properties that can be contained in a folder. Unless otherwise specified, the properties are optional and can occur at most once.

- *Names* of properties are shown thus: `<Command>`
- *Values* must be in string format, for example: `Publish`
- String constants representing property values are shown in parentheses, for example (MQPSC_PUBLISH)

The commands are listed in this chapter in alphabetic order.

| String constants are defined in the header file **BipRfc.h**.

## Delete Publication

The **Delete Publication** command message is sent to a broker from a publisher, or another broker, to tell it to delete any retained publications for the specified topics.

This message is sent to the input queue of a message flow containing a **Publication** node. Authority to put a message to this queue, and to publish on the specified topic or topics, is required.

The input queue should be the same one that the original publication was sent to.

If the user has authority on some (but not all) topics, those that can be deleted will be and a warning response will indicate those that are not deleted.

See page 57 for details of the message descriptor (MQMD) parameters needed when sending a command message to the broker.

If a **Publish** command contained more than one topic, a **Delete Publication** command matching some but not all of those topics deletes only the publications for the topics specified.

### Properties

`<Command>` (MQPSC_COMMAND)
: The value is `DeletePub` (MQPSC_DELETE_PUBLICATION). This property is required, and must be present.

`<Topic>` (MQPSC_TOPIC)
: The value is a string containing a topic for which retained publications are to be deleted. This can include wildcards to cause publications on several topics to be deleted.

  This property is required, and can optionally be repeated for as many topics as needed.

`<DelOpt>` (MQPSC_DELETE_OPTION)
: The delete options property can take the following value:

  `Local` (MQPSC_LOCAL)

  All retained publications for the specified topics are deleted at the local broker (that is, the broker to which this message is sent), whether they were published with the `Local` option or not. Publications at the other brokers are not affected.

  `None` (MQPSC_NONE)

  All options take their default values. This has the same effect as omitting the delete options property. If other options are specified at the same time, `None` is ignored.

  The default if this property is omitted is that all retained publications for the specified topics are deleted at all brokers in the network, whether they were published with the `Local` option or not.

## Example

Here is an example of *NameValueData* for a **Delete Publication** command message. This is used by the sample application to delete, at the local broker, the retained publication that contains the latest score in the match between Team1 and Team2.

```
<psc>
 <Command>DeletePub</Command>
 <Topic>Sport/Soccer/State/LatestScore/Team1 Team2</Topic>
 <DelOpt>Local</DelOpt>
</psc>
```

## Deregister Subscriber

The **Deregister Subscriber** command message is sent to a broker from a subscriber, or another application on a subscriber's behalf, to indicate that it no longer wishes to receive messages matching the given parameters.

This message is sent to SYSTEM.BROKER.CONTROL.QUEUE, the broker's control queue. Authority to put a message to this queue is required.

See page 57 for details of the message descriptor (MQMD) parameters needed when sending a command message to the broker.

An individual subscription can be deregistered by specifying the corresponding topic, subscription point and filter values to the original subscription. If any of the values were not specified (that is, they took the default values) in the original subscription, they should be omitted in the subscription deregistration.

Alternatively, all subscriptions for a subscriber, or a group of subscriptions, can be deregistered using the `DeregAll` option. For example, if `DeregAll` is specified, together with a subscription point (but no topic or filter), then all subscriptions for the subscriber on the specified subscription point are deregistered, regardless of the topic and filter. Any combination of topic, filter and subscription point is allowed (if all three are specified only one subscription can match, so `DeregAll` is ignored).

The message must be sent by the subscriber that registered the subscription in the first place (determined by the subscriber's user ID).

Subscriptions can also be deregistered by a system administrator (see *MQSeries Integrator Using the Control Center*). If the subscriber queue is a temporary dynamic queue and the queue is deleted, or if the subscription expires, the broker will deregister the subscription automatically.

When a subscriber application sends a message to deregister a subscription, and receives a response message to say that this was processed successfully, it is possible that some publications will subsequently reach the subscriber queue if they were being processed by the broker at the same time as the deregistration. If the messages are not removed from the queue, there could be a buildup of unprocessed messages on the subscriber queue. If the application does a loop that includes an MQGET call with the appropriate `CorrelId` after sleeping for a while, any such messages will be cleared off the queue.

Similarly, if the subscriber uses a permanent dynamic queue and, when completing, it deregisters and closes the queue with the MQCO_DELETE_PURGE option on an MQCLOSE call, it is possible that the queue will not be empty. This is because publications from the broker might not yet be committed at the time that queue was deleted. In this case, an MQRC_Q_NOT_EMPTY return code will be issued by the MQCLOSE call. The application can avoid this problem by sleeping and reissuing the MQCLOSE call from time to time.

## Properties

`<Command>` (MQPSC_COMMAND)
: The value is `DeregSub` (MQPSC_DEREGISTER_SUBSCRIBER). This property is required, and must be present.

`<Topic>` (MQPSC_TOPIC)
: The value is a string containing the topic to be deregistered.

  This property can, optionally, be repeated if multiple topics are to be deregistered. It can be omitted if `DeregAll` is specified in `<RegOpt>`.

  The topics specified can be a subset of those registered if the subscriber wishes to retain subscriptions for other topics. Wildcards are allowed, but a topic string containing wildcards must exactly match the corresponding string that was specified in the **Register Subscriber** command message.

`<SubPoint>` (MQPSC_SUBSCRIPTION_POINT)
: The value is a string specifying the subscription point from which the subscription is to be detached.

  This property must not be repeated. It can be omitted if a `<Topic>` is specified, or if `DeregAll` is specified in `<RegOpt>`. If you omit this property, the following happens:

  - If you do **not** specify `DeregAll`, subscriptions matching the `<Topic>` property (and the `<Filter>` property if present) are deregistered from the default subscription point.
  - If you specify `DeregAll`, all subscriptions (matching the `<Topic>` and `<Filter>` properties if present) are deregistered from all subscription points.

  Note that you cannot specify the default subscription point explicitly, so there is no way of deregistering all subscriptions from this subscription point only: you must specify the topics.

`<Filter>` (MQPSC_FILTER)
: The value is a string specifying the filter to be deregistered. It must match exactly (including case and spaces) a subscription filter previously registered.

  This property can, optionally, be repeated if multiple filters are to be deregistered. It can be omitted if a `<Topic>` is specified, or if `DeregAll` is specified in `<RegOpt>`.

  The filters specified can be a subset of those registered if the subscriber wishes to retain subscriptions for other filters.

`<RegOpt>` (MQPSC_REGISTRATION_OPTION)
: The registration options property can take the following values:

  `DeregAll` (MQPSC_DEREGISTER_ALL)
  : All matching subscriptions registered for this subscriber are to be deregistered.

    If you specify `DeregAll`:

    - `<Topic>`, `<SubPoint>`, and `<Filter>` can be omitted
    - `<Topic>` and `<Filter>` can be repeated, if required
    - `<SubPoint>` must not be repeated

    If you do **not** specify `DeregAll`:

- <Topic> must be specified, and can be repeated if required
- <SubPoint> and <Filter> can be omitted
- <SubPoint> must not be repeated
- <Filter> can be repeated, if required

CorrelAsId (MQPSC_CORREL_ID_AS_IDENTITY)

The *CorrelId* in the message descriptor (MQMD), which must not be zero, is used to identify the subscriber. It must match the *CorrelId* used in the original subscription.

None (MQPSC_NONE)

All options take their default values. This has the same effect as omitting the registration options property. If other options are specified at the same time, None is ignored.

The default, if this property is omitted, is that no registration options are set.

<QMgrName> (MQPSC_Q_MGR_NAME)
The value is the queue manager name for the subscriber queue. It must match the *QMgrName* used in the original subscription.

If this property is omitted, the default is the *ReplyToQMgr* name in the message descriptor (MQMD). If the resulting name is blank, it defaults to the broker's queue manager name.

<QName> (MQPSC_Q_NAME)
The value is the queue name for the subscriber queue. It must match the *QName* used in the original subscription.

If this property is omitted, the default is the *ReplyToQ* name in the message descriptor (MQMD), which must not be blank in this case.

## Example

Here is an example of *NameValueData* for a **Deregister Subscriber** command message. In this case the sample application is deregistering its subscription to the topics which contain the latest score for all matches. The subscriber's identity, including the *CorrelId*, is taken from the defaults in the MQMD.

```
<psc>
 <Command>DeregSub</Command>
 <RegOpt>CorrelAsId</RegOpt>
 <Topic>Sport/Soccer/State/LatestScore/#</Topic>
</psc>
```

## Publish

The **Publish** command message is sent:

- From a publisher to a broker, or
- From a broker to a subscriber

to publish information on a specified topic or topics.

This message is sent by a publisher to the input queue of a message flow that contains a **Publication** node. Authority to put a message to this queue, and to publish on the specified topic or topics, is required.

If the user has authority on some (but not all) topics, those that can be published will be and a warning response will indicate those that are not published.

If a subscriber has any matching subscriptions, the broker forwards the **Publish** message to the subscriber queues defined in the corresponding **Register Subscriber** command messages.

See page 57 for details of the message descriptor (MQMD) parameters needed when sending a command message to the broker, and used when a broker forwards a publication to a subscriber.

The broker forwards the **Publish** message to other brokers in the network that have matching subscriptions (unless it is a local publication).

Publication data (if any) is included in the message body. The data may be described in an `<mcd>` folder in the *NameValueData* field of the MQRFH2 header.

## Properties

`<Command>` (MQPSC_COMMAND)
: The value is `Publish` (MQPSC_PUBLISH). This property is required, and must be present.

`<Topic>` (MQPSC_TOPIC)
: The value is a string containing a topic that categorizes this publication. No wildcards are allowed.

: This property is required, and can optionally be repeated for as many topics as needed.

`<SubPoint>` (MQPSC_SUBSCRIPTION_POINT)
: The subscription point on which the publication is published.

: This property should not be included in a publication message sent to the broker but will be added automatically to publication messages by the broker before those messages are sent to any appropriate subscribers. The value of the `<SubPoint>` property will be the value of the Subscription Point attribute of the Publication node that is handling the publishing.

`<PubOpt>` (MQPSC_PUBLICATION_OPTION)
The publication options property can take the following values:

`RetainPub` (MQPSC_RETAIN_PUB)

The broker is to retain a copy of the publication. If this option is not set, the publication is deleted as soon as the broker has sent the publication to all of its current subscribers.

`IsRetainedPub` (MQPSC_IS_RETAINED_PUB)

(Can only be set by a broker.) This publication has been retained by the broker. The broker sets this option to notify a subscriber that this publication was published earlier and has been retained, provided that the subscription has been registered with the `InformIfRetained` option. It is set only in response to a **Register Subscriber** or **Request Update** command message. Retained publications that are sent directly to subscribers do not have this option set.

`Local` (MQPSC_LOCAL)

This option tells the broker that this publication should not be propagated to other brokers. All subscribers that registered at this broker will receive this publication if they have matching subscriptions.

`OtherSubsOnly` (MQPSC_OTHER_SUBS_ONLY)

This option allows simpler processing of conference-type applications, where a publisher is also a subscriber to the same topic. It tells the broker not to send the publication to the publisher's subscriber queue even if it has a matching subscription. (The publisher's subscriber queue consists of its *QMgrName*, *QName*, and optional *CorrelId*, as described below.)

`CorrelAsId` (MQPSC_CORREL_ID_AS_IDENTITY)

The *CorrelId* in the MQMD (which must not be zero) is part of the publisher's subscriber queue, in applications where the publisher is also a subscriber (see `OtherSubsOnly`).

`None` (MQPSC_NONE)

All options take their default values. This has the same effect as omitting the publication options property. If other options are specified at the same time, `None` is ignored.

The default, if this property is omitted, is that no publication options are set.

`<PubTime>` (MQPSC_PUBLISH_TIMESTAMP)
The value is an optional publication timestamp set by the publisher. It is of length 16 characters in the format:

```
YYYYMMDDHHMMSSTH
```

using Universal Time. However, this is not checked by the broker, which merely transmits this information to subscribers if it is present.

`<SeqNum>` (MQPSC_SEQUENCE_NUMBER)
The value is an optional sequence number set by the publisher.

It should increase by 1 with each publication. However, this is not checked by the broker, which merely transmits this information to subscribers if it is present.

If publications on the same topic are published to different interconnected brokers, it is the responsibility of the publishers to ensure that sequence numbers, if used, are meaningful.

`<QMgrName>` (MQPSC_Q_MGR_NAME)
The value is a string containing the queue manager name for the publisher's subscriber queue, in applications where the publisher is also a subscriber (see `OtherSubsOnly`).

If this property is omitted, the default is the *ReplyToQMgr* name in the message descriptor (MQMD). If the resulting name is blank, it defaults to the broker's queue manager name.

`<QName>` (MQPSC_Q_NAME)
The value is a string containing the queue name for the publisher's subscriber queue, in applications where the publisher is also a subscriber (see `OtherSubsOnly`).

If this property is omitted, the default is the *ReplyToQ* name in the message descriptor (MQMD), which (if `OtherSubsOnly` is set) must not be blank.

## Example

Here are some examples of *NameValueData* for a **Publish** command message. The first example is for a publication sent by the match simulator in the sample application to indicate that a match has started.

```
<psc>
 <Command>Publish</Command>
 <Topic>Sport/Soccer/Event/MatchStarted</Topic>
</psc>
```

The second example is for a retained publication. In this case the results service is publishing the latest score in the match between Team1 and Team2.

```
<psc>
 <Command>Publish</Command>
 <PubOpt>RetainPub</PubOpt>
 <Topic>Sport/Soccer/State/LatestScore/Team1 Team2</Topic>
</psc>
```

## Register Subscriber

The **Register Subscriber** command message is sent to a broker by a subscriber, or another application on a subscriber's behalf, to indicate that it wishes to subscribe to one or more topics at a subscription point. A message content filter can also be specified.

This message is sent to SYSTEM.BROKER.CONTROL.QUEUE, the broker's control queue. Authority to put a message to this queue is required, in addition to access authority for the topic or topics in the subscription (set by the broker's system administrator).

If the user has authority on some (but not all) topics, those that can be registered will be and a warning response will indicate those that are not registered.

See page 57 for details of the message descriptor (MQMD) parameters needed when sending a command message to the broker.

If the queue is a temporary dynamic queue, the subscription will be deregistered automatically by the broker when the queue is closed.

## Properties

`<Command>` (MQPSC_COMMAND)
: The value is `RegSub` (MQPSC_REGISTER_SUBSCRIBER). This property is required, and must be present.

`<Topic>` (MQPSC_TOPIC)
: The topic for which the subscriber wants to receive publications. Wildcards are allowed (see "Topics and wildcards" on page 19).

  This property is required, and can optionally be repeated for as many topics as needed.

`<SubPoint>` (MQPSC_SUBSCRIPTION_POINT)
: The value is the subscription point to which the subscription is attached.

  If this property is omitted, the default subscription point is used.

`<Filter>` (MQPSC_FILTER)
: The value is an SQL expression that is used as a filter on the contents of publication messages (see "Filters" on page 20). If a publication on the specified topic matches the filter, it is sent to the subscriber.

  If this property is omitted, no content filtering takes place.

`<RegOpt>` (MQPSC_REGISTRATION_OPTION)
: The registration options property can take the following values:

  `Local` (MQPSC_LOCAL)

  The subscription is local and is not distributed to other brokers in the network. Publications made at other brokers will not be delivered to this subscriber, unless it also has a corresponding global subscription.

  `NewPubsOnly` (MQPSC_NEW_PUBS_ONLY)

  Retained publications that exist at the time the subscription is registered are not sent to the subscriber, only new publications.

If a subscriber re-registers and changes this option so that it is no longer set, it is possible that a publication that has already been sent to it will be sent again.

`PubOnReqOnly` (MQPSC_PUB_ON_REQUEST_ONLY)

The broker does not send publications to the subscriber, except in response to a **Request Update** command message.

`InformIfRet` (MQPSC_INFORM_IF_RETAINED)

The broker will inform the subscriber if a publication is retained when it sends a **Publish** message in response to a **Register Subscriber** or **Request Update** command message. The broker does this by including the `IsRetainedPub` publication option in the message.

`CorrelAsId` (MQPSC_CORREL_ID_AS_IDENTITY)

The *`CorrelId`* in the message descriptor (MQMD), which must not be zero, is used when sending matching publications to the subscriber queue.

`Pers` (MQPSC_PERSISTENT)

Publications matching this subscription are delivered to the subscriber as persistent messages.

`NonPers` (MQPSC_NON_PERSISTENT)

Publications matching this subscription are delivered to the subscriber as non-persistent messages.

`PersAsPub` (MQPSC_PERSISTENT_AS_PUBLISH)

Publications matching this subscription are delivered to the subscriber with the persistence specified by the publisher. This is the default behavior.

`PersAsQueue` (MQPSC_PERSISTENT_AS_Q)

Publications matching this subscription are delivered to the subscriber with the persistence specified on the subscriber queue.

`None` (MQPSC_NONE)

All registration options take their default values.

If the subscriber is already registered, its options are reset to their default values (this is *not* the same effect as omitting the registration options property), and the subscription expiry is updated from the MQMD of the **Register Subscriber** message.

If other registration options are specified at the same time, `None` is ignored.

If the registration options property is omitted and the subscriber is already registered, its registration options are unchanged and the subscription expiry is updated from the MQMD of the **Register Subscriber** message.

If the subscriber is not already registered, a new subscription is created with all registration options taking their default values.

The default values are `PersAsPub` and no other options set.

`<QMgrName>` (MQPSC_Q_MGR_NAME)
: The value is the queue manager name for the subscriber queue, to which matching publications are sent by the broker.

  If this property is omitted, the default is the *ReplyToQMgr* name in the message descriptor (MQMD). If the resulting name is blank, it defaults to the broker's *QMgrName*.

`<QName>` (MQPSC_Q_NAME)
: The value is the queue name for the subscriber queue, to which matching publications are sent by the broker.

  If this property is omitted, the default is the *ReplyToQ* name in the message descriptor (MQMD), which must not be blank in this case.

  If the queue is a temporary dynamic queue, non-persistent delivery of publications (`NonPers`) must be specified in the `<RegOpt>` property.

  If the queue is a temporary dynamic queue, the subscription will be deregistered automatically by the broker when the queue is closed.

## Example

Here is an example of *NameValueData* for a **Register Subscriber** command message. In the sample application, the results service uses this message to register a subscription to the topics containing the latest scores in all matches, with the 'Publish on Request Only' option set. The subscriber's identity, including the *CorrelId*, is taken from the defaults in the MQMD.

```
<psc>
 <Command>RegSub</Command>
 <RegOpt>PubOnReqOnly</RegOpt>
 <RegOpt>CorrelAsId</RegOpt>
 <Topic>Sport/Soccer/State/LatestScore/#</Topic>
</psc>
```

## Request Update

The **Request Update** command message is sent from a subscriber to a broker, to request the current retained publications for the specified topic and subscription point that match the given (optional) filter.

This message is sent to SYSTEM.BROKER.CONTROL.QUEUE, the broker's control queue. Authority to put a message to this queue is required, in addition to access authority for the topic in the request update (set by the broker's system administrator).

See page 57 for details of the message descriptor (MQMD) parameters needed when sending a command message to the broker.

This command is normally used if the subscriber specified the option `PubOnReqOnly` (publish on request only) when it registered. If the broker has matching retained publications, they are sent to the subscriber. If not, the request fails (with an MQRCCF_NO_RETAINED_MSG). The requester must have previously registered a subscription with the same Topic, SubPoint, and Filter values.

## Properties

`<Command>` (MQPSC_COMMAND)
: The value is `ReqUpdate` (MQPSC_REQUEST_UPDATE). This property is required, and must be present.

`<Topic>` (MQPSC_TOPIC)
: The value is the topic the subscriber is requesting. Wildcards are allowed (see "Topics and wildcards" on page 19).

  This property is required, but only one occurrence is allowed in this message.

`<SubPoint>` (MQPSC_SUBSCRIPTION_POINT)
: The value is the subscription point to which the subscription is attached.

  If this property is omitted, the default subscription point is used.

`<Filter>` (MQPSC_FILTER)
: The value is an SQL expression that is used as a filter on the contents of publication messages (see "Filters" on page 20). If a publication on the specified topic matches the filter, it is sent to the subscriber.

  The `<Filter>` property should have the same value as that specified on the original subscription for which you are now requesting an update.

  If this property is omitted, no content filtering takes place.

`<RegOpt>` (MQPSC_REGISTRATION_OPTION)
: The registration options property can take the following value:

  `CorrelAsId` (MQPSC_CORREL_ID_AS_IDENTITY)

  The *`CorrelId`* in the message descriptor (MQMD), which must not be zero, is used when sending matching publications to the subscriber queue.

`None` (MQPSC_NONE)

All options take their default values. This has the same effect as omitting the registration options property. If other options are specified at the same time, `None` is ignored.

The default, if this property is omitted, is that no registration options are set.

`<QMgrName>` (MQPSC_Q_MGR_NAME)
The value is the queue manager name for the subscriber queue, to which the matching retained publication is sent by the broker.

If this property is omitted, the default is the *ReplyToQMgr* name in the message descriptor (MQMD). If the resulting name is blank, it defaults to the broker's *QMgrName*.

`<QName>` (MQPSC_Q_NAME)
The value is the queue name for the subscriber queue, to which the matching retained publication is sent by the broker.

If this property is omitted, the default is the *ReplyToQ* name in the message descriptor (MQMD), which must not be blank in this case.

## Example

Here is an example of *NameValueData* for a **Request Update** command message. In the sample application, the results service uses this message to request retained publications containing the latest scores for all teams. The subscriber's identity, including the *CorrelId*, is taken from the defaults in the MQMD.

```
<psc>
 <Command>ReqUpdate</Command>
 <RegOpt>CorrelAsId</RegOpt>
 <Topic>Sport/Soccer/State/LatestScore/#</Topic>
</psc>
```

## Broker Response

A **Broker Response** message is sent from a broker to the *ReplyToQ* of a publisher or a subscriber, to indicate the success or failure of a command message received by the broker if the command message descriptor specified that a response is required.

See “MQMD for broker response messages” on page 59 for details of the message descriptor (MQMD) parameters used when a broker sends a response to a publisher or a subscriber.

The broker response message is contained within the *NameValueData* field of the MQRFH2 header, in a <pscr> folder.

In the case of a warning or error, the response message contains the <psc> folder from the command message in addition to the <pscr> folder. The message data (if any) is not contained in the broker response message. None of the message that caused an error will be processed but a warning indicates that some of the message may have been processed successfully.

If there is a failure while attempting to send a response:

| • For publication messages, the broker tries to send the response to the MQSeries dead-letter queue if the MQPUT fails. This allows the publication to be sent to subscribers even if the response cannot be sent back to the publisher.

| • For other messages, or if the publication response cannot be sent to the dead-letter queue, an error is logged and the command message is normally rolled back. This depends on how the **MQInput** node has been configured.

### Properties

<Completion> (MQPSCR_COMPLETION)
The completion code, which can take one of three values:

| | |
|---|---|
| ok | Command completed successfully |
| warning | Command completed with warning |
| error | Command failed |

<Response> (MQPSCR_RESPONSE)
The response to a command message, if that command produced a completion code of warning or error. It contains a <Reason> property, and might contain other properties indicating the cause of the warning or error.

In the case of one or more errors, there will be a single response folder, indicating the cause of the first error only. In the case of one or more warnings, there will be a Response folder for each warning.

<Reason> (MQPSCR_REASON)
The reason code qualifying the completion code, if the completion code is warning or error. It is set to one of the error codes listed on page 60. The <Reason> property is contained within a <Response> folder. The reason code may be followed by any valid property from the <psc> folder (for example, a topic name), indicating the cause of the error or warning.

## Examples

Here are some examples of *NameValueData* in a **Broker Response** message. A successful response will be as follows:

```
<pscr>
  <Completion>ok</Completion>
</pscr>
```

Here is an example of a failure response (due to a filter error). The first NameValueData string contains the response; the second contains the original command.

```
<pscr>
  <Completion>error</Completion>
  <Response>
    <Reason>3150</Reason>
  </Reponse>
</pscr>

<psc>
 ...
 command message (to which
 the broker is responding)
 ...
</psc>
```

Here is an example of a warning response (due to unauthorized topics). The first NameValueData string contains the response; the second contains the original command.

```
<pscr>
  <Completion>warning</Completion>
  <Response>
    <Reason>3081</Reason>
    <Topic>topic1</Topic>
  </Reponse>
  <Response>
    <Reason>3081</Reason>
    <Topic>topic2</Topic>
  </Reponse>
</pscr>

<psc>
 ...
 command message (to which
 the broker is responding)
 ...
</psc>
```

## Message descriptor

The MQSeries message descriptor (MQMD) is fully documented in the *MQSeries Application Programming Reference* book. This section summarizes the fields used by MQRFH2 publish/subscribe command and response messages.

## MQMD for command messages

This section describes the message descriptor as set by applications that send command messages to the broker.

Fields that are left as the default value, or can be set to any valid value in the usual way, are not listed here.

*Report*
: See *MsgType* and *CorrelId* (below).

*MsgType*
: Can be set to MQMT_REQUEST for a command message if a response is always required. The MQRO_PAN and MQRO_NAN flags in the *Report* field are not significant in this case.

  Can be set to MQMT_DATAGRAM, in which case responses depend on the setting of the MQRO_PAN and MQRO_NAN flags in the *Report* field:

  - MQRO_PAN alone means that the broker is to send a response only if the command succeeds.
  - MQRO_NAN alone means that the broker is to send a response only if the command fails.
  - If a command completes with a warning, a response is sent if either MQRO_PAN or MQRO_NAN is set.
  - MQRO_PAN + MQRO_NAN means that the broker is to send a response whether the command succeeds or fails. This has the same effect from the broker's perspective as setting *MsgType* to MQMT_REQUEST.
  - If neither MQRO_PAN nor MQRO_NAN is set, no response will ever be sent.

*Format*
: Set to MQFMT_RF_HEADER_2

*MsgId*
: Normally set to MQMI_NONE, so that the queue manager generates a unique value.

*CorrelId*
: Set to any value. If the sender's identity includes a *CorrelId*, specify this value, together with MQRO_PASS_CORREL_ID in the *Report* field, to ensure that it will be set in all response messages sent by the broker to the sender.

*ReplyToQ*
: This is the queue to which responses, if any, are to be sent. This can be the sender's queue which has the advantage that the *QName* parameter can

be omitted from the message. If, however, responses are to be sent to a different queue, the *QName* parameter will be needed.

*ReplyToQMgr*
: Queue manager for responses. If you leave this field blank (the default value), the local queue manager puts its own name in this field.

## MQMD for publications forwarded by a broker

This section describes the message descriptor for messages sent by the broker to subscribers.

The fields are set to their default values, except for the following:

*Report*
: Will be set to MQRO_NONE.

*MsgType*
: Will be set to MQMT_DATAGRAM.

*Expiry*
: Will be set to the value in the **Publish** message received from the publisher. In the case of a retained message, the time outstanding is reduced by the approximate time the message has been at the broker.

*Format*
: Will be set to MQFMT_RF_HEADER_2

*MsgId*
: Will be set to a unique value.

*CorrelId*
: If *CorrelId* is part of the subscriber's identity, this is the value specified by the subscriber when registering. Otherwise, it is a non-zero value chosen by the broker.

*Priority*
: As set by the publisher (or as resolved if the publisher specified MQPRI_PRIORITY_AS_Q_DEF).

*Persistence*
: As set by the publisher (or as resolved if the publisher specified MQPER_PERSISTENCE_AS_Q_DEF), unless specified otherwise in the **Register Subscriber** message for the subscriber to which this publication is being sent.

*ReplyToQ*
: Will be set to blanks.

*ReplyToQMgr*
: Broker's queue manager name.

*UserIdentifier*
: Subscriber's user identifier (as set when the subscriber registered).

*AccountingToken*
: Subscriber's accounting token (as set when the subscriber first registered).

*ApplIdentityData*
Subscriber’s application identity data (as set when the subscriber first registered).

*PutApplType*
Will be set to MQAT_BROKER.

*PutApplName*
Will be set to the first 28 characters of the broker’s queue manager name.

*PutDate*
Timestamp when the broker puts the message.

*PutTime*
Timestamp when the broker puts the message.

*ApplOriginData*
Will be set to blanks.

## MQMD for broker response messages

This section describes the message descriptor for response messages sent by the broker.

The fields are set to their default values, except for the following:

| | |
|---|---|
| *Report* | Will be set to all zeroes. |
| *MsgType* | Will be set to MQMT_REPLY. |
| *Format* | Will be set to MQFMT_RF_HEADER_2 |
| *MsgId* | Will be set according to the *Report* options in the original command message. By default, this means that it is set to MQMI_NONE, so that the queue manager generates a unique value. |
| *CorrelId* | Will be set according to the *Report* options in the original command message. By default, this means that the *CorrelId* is set to the same value as the *MsgId* of the command message. This can be used to correlate commands with their responses. |
| *Priority* | The same value as in the original command message. |
| *Persistence* | The same value as in the original command message. |
| *Expiry* | The same value as in the original command message received by the broker. |
| *PutApplType* | Will be set to MQAT_BROKER. |
| *PutApplName* | Will be set to the first 28 characters of the queue manager name. |

Other context fields are set as if generated with MQPMO_PASS_IDENTITY_CONTEXT.

## Reason codes

The following reason codes might be returned in the *Reason* field of a publish/subscribe response `<pscr>` folder. Constants that can be used to represent these codes in the C or C++ programming languages are also given. The MQRC_ constants require the MQSeries `cmqc.h` header file. The MQRCCF_ constants require the MQSeries `cmqcfc.h` header file (apart from MQRCCF_FILTER_ERROR and MQRCCF_WRONG_USER, which are specific to MQSeries Integrator Version 2 and require the MQSeries Integrator Version 2 `BipRfh2.h` header file).

| Reason code and text | Explanation | Issued by |
|---|---|---|
| 2336 MQRC_RFH_COMMAND_ERROR | Valid values for the `<Command>` field of a `<psc>` folder are: RegSub, DeregSub, Publish, DeletePub, and ReqUpdate. Any other values result in this error code being issued. | Any command |
| 2337 MQRC_RFH_PARM_ERROR | The `<psc>` and `<mcd>` folders both have a set of valid parameters that can be specified within them. Check the descriptions of these folders and ensure that you have not specified incorrect parameters. | Any command |
| 2338 MQRC_RFH_DUPLICATE_PARM | Some parameters (for example, Topic) within a `<psc>` folder can be repeated, while others (for example, Command) can not. Check that you have not duplicated a non-repeatable parameter. | Any command |
| 2339 MQRC_RFH_PARM_MISSING | Some parameters within `<psc>` or `<mcd>` folders are optional and can be omitted; some are mandatory and must not be omitted. Check that you have included all mandatory parameters within your `<psc>` and `<mcd>` folders. | Any command |
| 3072 MQRCCF_TOPIC_ERROR | One or more of the values you supplied for the Topic parameter are incorrect. Check that your values for Topic conform to the specified restrictions. | Any command |
| 3073 MQRCCF_NOT_REGISTERED | The combination of SubPoint, Topic, and Filter that you specified on your DeregSub or ReqUpdate command was either not a combination with which you had previously registered or, for the DeregSub command if the DeregAll option was specified, one of the SubPoint, Topic, or Filter properties was not used to deregister any subscription. | Deregister Subscriber and Request Update commands |
| 3074 MQRCCF_Q_MGR_NAME_ERROR | The specified queue manager was not valid or the queue manager was not available or did not exist. | Deregister Subscriber, Publish, Register Subscriber, and Request Update commands |

| Reason code and text | Explanation | Issued by |
|---|---|---|
| 3076 MQRCCF_Q_NAME_ERROR | The specified queue name was not valid or the queue did not exist on the specified queue manager. | Deregister Subscriber, Publish, Register Subscriber, and Request Update commands |
| 3077 MQRCCF_NO_RETAINED_MSG | There were no retained messages for the topic you specified. (This may or may not be an error, depending on the design of your application program.) | Request Update command |
| 3079 MQRCCF_INCORRECT_Q | RegSub, DeregSub, and ReqUpdate commands are always sent to the SYSTEM.BROKER.CONTROL.QUEUE queue of the broker for which they are intended. Publish and Delete Publication commands are sent to the input queue for the particular publish/subscribe message flow for which they are intended (determined when the message flow is designed). This error code will be returned if a command is sent to the wrong queue. | Any command |
| 3080 MQRCCF_CORREL_ID_ERROR | You have specified CorrelAsId as one of your RegOpt parameters. However, the CorrelId field of the MQMD does not contain a valid correlation identifier (that is, it is set to MQCI_NONE). | Deregister Subscriber and Register Subscriber commands |
| 3081 MQRCCF_NOT_AUTHORIZED | You are not authorized to perform the requested action. Authorization settings for the broker are handled from the Control Center. Contact your system administrator. | Publish and Register Subscriber commands |
| 3083 MQRCCF_REG_OPTIONS_ERROR | You have specified an unrecognized RegOpt parameter in the `<psc>` folder that contains your DeregSub command. | Deregister Subscriber and Register Subscriber commands |
| 3084 MQRCCF_PUB_OPTIONS_ERROR | You have specified an unrecognized PubOpt parameter in the `<psc>` folder that contains your Publish command. | Publish command |
| 3087 MQRCCF_DEL_OPTIONS_ERROR | You have specified an unrecognized DelOpt parameter in the `<psc>` folder that contains your DeletePub command. | Delete Publication command |
| 3150 MQRCCF_FILTER_ERROR | The value specified for the Filter parameter is not valid. Check the section that describes valid syntax for filter expressions and ensure that your expression conforms. | Deregister Subscriber, Register Subscriber, and Request Update commands |

| Reason code and text | Explanation | Issued by |
|---|---|---|
| 3151<br>MQRCCF_WRONG_USER | A subscription that matches the one specified already exists; however, it was registered by a different user. A subscription can only be changed or deregistered by the same user who originally registered it. | Deregister Subscriber, Register Subscriber, and Request Update commands |

# Part 2. Programming a plug-in node or parser

This part contains:

# Chapter 6. Implementing a plug-in node or parser

The function of the MQSeries Integrator Version 2.0.1 message broker can be enhanced by:

- Providing additional message processing nodes to perform a variety of tasks, either superseding existing function or introducing new function. Plug-in nodes can provide generic function that is of value in a wide range of environments, or highly specialized function tailored and customized to a specific environment.
- Providing alternative and complementary message parsers that are accessible to the broker and its message processing nodes through a standard set of parsing and construction interfaces.

Examples of new nodes might include:

- A node that reads one or more records from a specified data file to provide a mechanism for performing batch processing at predetermined intervals or times of day.
- A node to raise events that get displayed in a system management console.
- A currency converter node to provide transformation outside the supplied primitives.
- A combination of updating a database and updating a message from the database in a single node.

This chapter contains:

## Introduction

This section contains an overview of how to implement a message processing node or parser to enhance the functionality of MQSeries Integrator.

A broker extension, or *plug-in*, is written in C and distributed as:

- A shared object on AIX and Sun Solaris, named with a filetype of '.lil' (loadable implementation library).
- A dynamic link library (DLL) on Windows systems, again with a filetype of '.lil'

A plug-in implements a node or parser factory that can support multiple nodes or parser types.

The plug-in is loaded when the broker is initialized. Registration functions in the plug-in are invoked so that the broker understands what nodes or parsers are supported by the plug-in.

## Programming language

Message processing nodes and parsers must be coded in ANSI standard C, and avoid use of operating system specific functions. This will enable them to work on a variety of platforms with re-compilation only (without any source code changes).

### Use of Java

Plug-ins must be written in C. Writing a plug-in in Java and wrappering it in JNI is not recommended. This is because the broker internally initializes a JVM, which is not available through the plug-in interface.

The JVM is initialized with various parameters that are specific to the broker's requirements. Because there is only one JVM in a process, whoever initializes it first specifies these parameters. If a plug-in uses Java, and the broker is initialized first, these parameters might not be suitable for the plug-in. On the other hand, if the plug-in creates the JVM before the broker is started, the broker might not function correctly.

## Interface to the broker

The C interfaces consist of:

1. A set of *implementation functions* (or *callback functions*), which provide the functionality of the plug-in. These implementation functions must be written by the developer, and are invoked *by the message broker*.
2. A set of *utility functions*, the purpose of which is to create or manipulate resources in the message broker or to request a service of the broker. These utility functions are intended to be invoked *by the plug-in*.

A plug-in that implements a message processing node must also have a *signature* defined as an XML representation in a file. This signature enables the MQSeries Integrator Control Center to display a representation of the plug-in on its palette of message processing nodes, and for these nodes to be wired correctly in the design pane.

## Implementing a message processing node

There are a number of tasks that must be performed when implementing a message processing node. They are described in the following sections:

1. "Determine the configuration attributes"
2. "Develop a plug-in initialization function"
3. "Develop a context creation function" on page 68
4. "Develop the attribute functions" on page 68
5. "Develop the node processing function" on page 69
6. "Build an output message (optional)" on page 70

The implementation functions that have to be written by the developer are listed in "Node implementation function overview" on page 114.

The utility functions that are provided by MQSeries Integrator to aid this process are listed in "Node utility function overview" on page 115.

## Determine the configuration attributes

The first step is to decide what *configuration attributes* the node requires, and what the allowable values are for each attribute.

**Note:** To a user of the MQSeries Integrator Control Center, these attributes are known as *properties*.

There is no limit to the number of configuration attributes that a node can have. However, they must not conflict with the base configuration attributes that are inherited by all message processing nodes. These are:

- label
- userTraceLevel
- traceLevel
- userTraceFilter
- traceFilter

## Develop a plug-in initialization function

The initialization function is invoked when the plug-in is loaded during message broker initialization. The plug-in is responsible for:

- Creating and naming the node factory that is implemented by the plug-in. The node factory is simply a container for related node implementations. Node factory names must be unique within a broker.
- Defining the name of each node, and supplying a pointer to a virtual function table that contains pointers to the plug-in implementation functions. Node names must be unique within a broker (if there are duplicate names then the broker concerned will fail to load).

The plug-in initialization function defines the name of the factory that the plug-in supports and the classes of objects supported by the factory. Each UNIX shared object or Windows DLL (that is, each .lil) that implements a plug-in must export a function called **bipGetMessageflowNodeFactory** as its initialization function.

The initialization function must create the factory object and define the names of all nodes supported by the plug-in. A factory can support any number of object classes (nodes). When a node is defined, a list of pointers to the implementation functions for that node is passed to the broker. If a node of the same name already exists, the request is rejected. The plug-in initialization function is invoked automatically during broker initialization.

The initialization function must create a node factory by invoking **cniCreateNodeFactory**. The node classes supported by the factory are defined by calling **cniDefineNodeClass**. The address of the factory object (returned by **cniCreateNodeFactory**) must be returned to the broker as the return value from the initialization function.

## Develop a context creation function

When an instance of a plug-in node object is created, the context creation implementation function **cniCreateNodeContext** is invoked by the message broker. This allows the plug-in node to allocate instance data associated with the node, such as data areas for attributes. The implementation function **cniDeleteNodeContext** must also be provided.

A message flow node has a number of input terminals and output terminals associated with it. Simple nodes have one input terminal, and either zero or a fixed number of output terminals. The utility functions **cniCreateInputTerminal** and **cniCreateOutputTerminal** are used to add terminals to a node when the node is instantiated. They must be invoked within the **cniCreateNodeContext** implementation function. If a plug-in attempts to create a terminal at any other time, the results will be unpredictable.

Note that, by convention within the broker, the supplied message processing nodes that have a terminal named ‘failure’ behave in a particular way. If the failure terminal is not attached to a connector to another node and a processing failure occurs, an exception is thrown to terminate the message flow. It is recommended that a plug-in node supports a failure terminal where appropriate that respects this convention. To provide similar behavior, you can use **cniIsTerminalAttached** to check if the named terminal is attached to another message processing node before attempting to propagate a message to it.

## Develop the attribute functions

The message flow node must respond to requests to get and set its configuration attributes. This is done by providing the **cniSetAttribute**, **cniGetAttribute**, and **cniGetAttributeName** implementation functions. Retrieved attributes come from the properties specified for the node in the Control Center (see “The XML interface definition file” on page 93).

Functions that assign values should perform appropriate verification. Attribute values are passed between the broker and the plug-in using UCS-2 Unicode character strings. See “String handling” on page 74 for more information on handling character strings.

A request to set a configuration attribute causes **cniSetAttribute** to be invoked. This function receives the attribute name and attribute value as parameters. The broker ensures that no messages are being processed while this function is called. That is, there are no thread issues to deal with between the updating of a configuration attribute and the referencing of the attribute by the evaluate function. **cniGetAttributeName** allows the node to describe its configuration attributes.

Attributes are received in XML configuration messages as character strings, regardless of datatype. If the true datatype of an attribute is not a string, the **cniSetAttribute** function must perform the necessary verification and conversion before it stores the attribute value. Similarly, when an attribute value is retrieved using **cniGetAttribute**, it must be converted to a wide character string before returning the result.

## Develop the node processing function

The main processing of a message flow node is performed inside the **cniEvaluate** implementation function.

### Input and output nodes

You cannot create a plug-in input node: the supplied **MQInput** node must be used as the input node for every message flow. This is because the broker's thread management and allocation mechanisms are not available to a plug-in.

The supplied **MQOutput** node must be used when writing to MQSeries queues, because the broker internally maintains MQSeries connection and open queue handles on a thread-by-thread basis, and these are cached to optimize performance. In addition, the broker handles recovery scenarios when MQSeries events occur, and this would be adversely affected if MQSeries Integrator calls were used in a plug-in.

### The contents of the message

In many cases, the plug-in node will need to access the contents of the message received on its input terminal. The message is represented as a tree of syntax elements, as described in "Accessing the message content" on page 78. Groups of utility functions are provided for message management, message buffer access, syntax element navigation, and syntax element access (see "Node utility function overview" on page 115).

### Database access

The broker uses ODBC as an interface to its own internal database, and to customer enterprise databases accessed in **Filter**, **Compute**, and **Database** processing nodes. The ODBC environment cannot be accessed using the plug-in node interface. Database access must be performed using the implementation functions supplied for that purpose (see "SQL statement handling" on page 116), or by using the supplied processing nodes.

### Output terminals

A message can be passed to other connected nodes by invoking **cniPropagate** on an output terminal of the node. It is essential that any calls to **cniPropagate** are performed on the same thread that **cniEvaluate** was called on.

### Threading considerations

The message broker runs on multiple threads, and it is possible that two threads might be executing **cniEvaluate** on the same node object at the same time to process different messages. Therefore the code contained within this implementation function, and any that it calls, must be thread safe and fully re-entrant.

It is advisable not to use extra threads in the implementation of a node. For more information, see "Threading issues" on page 73.

### Runtime node behavior

A plug-in node must perform its processing in its **cniEvaluate** implementation function and return promptly. You must not design a plug-in node that suspends processing in any way, because this might prevent a message flow that contains such a node from being reconfigured or shutdown.

### Other considerations

Restrictions governing applications using MQSeries or any other external software, such as database programs, also apply to plug-ins.

## Build an output message (optional)

A plug-in message processing node might need to create an output message; for example, to derive a new message based on the content of an input message.

The input message is read-only, so you must first take a copy of it using the **cniCreateMessage** function. See "Accessing the message content" on page 78 for a detailed description of the structure of a message. "Node utility function overview" on page 115 lists the utility functions that are provided for message management, message buffer access, and syntax element navigation and access.

When an output message is created, a root element is created automatically as the root of the (initially empty) syntax element tree. Syntax elements can then be added as required to the element tree, using the root element as the initial insertion point.

Note that the nodes supplied with MQSeries Integrator create a 'Properties' folder (belonging to a property parser) as the first child of root. For details see *MQSeries Integrator Using the Control Center*. It is not mandatory that this folder should be present, but it is recommended, and some broker functionality will not be available without it. The C plug-in interface does not produce this folder automatically; it must be provided by the developer if it is required.

In addition, the second child of root (or the first child if the Properties folder is not present) must be an 'MQMD' folder (belonging to an MQMD parser). This folder, containing the MQSeries Message Descriptor, is mandatory for messages propagated to **MQOutput** nodes.

When an element is created, an *owning parser* can be specified, determined by whether the function that accepts a parser class name is used (for example, **cniCreateElementBeforeUsingParser** instead of **cniCreateElementBefore**). When the message is propagated to an **MQOutput** node, the broker instructs the parsers owning the elements at the first generation (that is, immediate children of the root element) to serialize their part of the element tree to the output message buffer. If the parser is implemented as a plug-in, this causes the broker to invoke the implementation function **cniWriteBuffer**. If an element at the first generation is created so that it is not owned by a parser (using **cniCreateElementBefore**, for example), it is owned by a notional *root parser*. This means that this branch of the element tree will not be serialized to the output message buffer. This feature could be used, for example, to store temporary elements that persist for the duration of the flow of that message through the message flow.

## Further information

Further information is given in:

- "General development considerations" on page 73
- "Accessing the message content" on page 78
- "Errors and exception handling" on page 84

Sample programs are provided to assist you in writing a plug-in node. See "Sample code" on page 88.

When the plug-in code is complete, it must be installed on your brokers. This is described in "Installing a plug-in on a broker system" on page 91. The final step is to make it available to MQSeries Integrator. See "Integrating a plug-in node into the Control Center" on page 92.

## Implementing a message parser

There are a number of tasks that must be performed when implementing a message parser. They are described in the following sections:

1. "Develop a plug-in initialization function"
2. "Develop a context creation function" on page 72
3. "Implement the parser functions" on page 72

The implementation functions that have to be written by the developer are listed in "Parser implementation function overview" on page 144.

The utility functions that are provided by MQSeries Integrator to aid this process are listed in "Parser utility function overview" on page 145.

In practice, the task of writing a parser will vary considerably according to the complexity of the bit-stream to be parsed. Only the basic steps are described here.

### Develop a plug-in initialization function

This is invoked when the plug-in is loaded during message broker initialization. The plug-in is responsible for:

- Creating and naming the message parser factory that is implemented by the plug-in. The parser factory is simply a container for related parser implementations. Parser factory names must be unique within a broker.
- Defining the supported message parser class names, and supplying a pointer to a virtual function table that contains pointers to the plug-in implementation functions. Parser class names must be unique within a broker.

The plug-in initialization function defines the name of the factory that the plug-in supports and the classes of objects or shared object supported by the factory. Each UNIX shared object or Windows DLL (that is, each .lil) that implements a plug-in must export a function called **bipGetParserFactory** as its initialization function.

The initialization function must create the factory object and define the names of all parsers supported by the plug-in. A factory can support any number of object classes (parsers). When a parser is defined, a list of pointers to the implementation functions for that parser is passed to the broker. If a parser of the same name already exists, the request is rejected. The plug-in initialization function is invoked automatically during broker initialization.

The initialization function must create a parser factory by invoking **cpiCreateParserFactory**. The parser classes supported by the factory are defined by calling **cpiDefineParserClass**. The address of the factory object (returned by **cpiCreateParserFactory**) must be returned to the broker as the return value from the initialization function.

## Develop a context creation function

Whenever an instance of a plug-in parser object is created, the context creation implementation function **cpiCreateContext** is invoked by the message broker. This allows the plug-in parser to allocate instance data associated with the parser. A **cpiDeleteContext** function to delete the context of the parser object is also required.

## Implement the parser functions

The implementation functions:

**cpiParseBuffer**
**cpiParseFirstChild**
**cpiParseLastChild**
**cpiParsePreviousSibling**
**cpiParseNextSibling**
**cpiWriteBuffer**

provide the functionality of the plug-in parser. These implementation functions are invoked by the broker when an operation within the broker (such as a filter expression that specifies a message field name) requires a syntax element tree to be built or extended.

See "Accessing the message content" on page 78 for a detailed description of the structure of a message. "Parser utility function overview" on page 145 lists the utility functions that are provided for message buffer access, and syntax element navigation and access.

The implementations for these functions in the samples can be used as given, provided that the bit stream is one that is parsed progressively from beginning to end, producing corresponding syntax elements ordered from left to right. This condition is true for most common bit streams.

It will be seen in the samples that these implementations assume that the real parser code resides in a **parseNextItem** function. This function is expected to build the syntax element tree one element at a time, setting names, values and the complete flags appropriately. The implementation of this function is dependent on the nature of the bit stream to be parsed. The sample is an example of a simple pseudo-XML parser.

### Messages with multiple message formats

Normally, the incoming message data is of a single message format, so one parser is responsible for parsing the entire contents of the message. The class name of the parser that is needed is defined in the *Format* field in the MQMD or the MQRFH2 header of the input message.

However, the message might be comprised of multiple formats, for example where there is a header in one format followed by data in another format. In this case, the first parser has to identify the class name of the parser that is responsible for the next format in the chain, and so on. In a plug-in, the implementation function **cpiNextParserClassName** will be invoked by the broker when it needs to navigate down a chain of parser classes for a message comprising multiple message formats.

If your plug-in parser supports parsing a message format that is part of a multiple message format, then the plug-in *must* implement the **cpiNextParserClassName** function.

## Further information

Further information is given in:

- “General development considerations”
- “Accessing the message content” on page 78
- “Errors and exception handling” on page 84

A sample program is provided to assist you in writing a plug-in parser. See “Sample code” on page 88.

When the plug-in code is complete, it must be installed on your brokers. This is described in “Installing a plug-in on a broker system” on page 91.

## General development considerations

There are a number of general development considerations and guidelines which should be addressed when implementing a plug-in node or parser.

## Threading issues

Message processing nodes and parsers must work in a multi-instance, multithreaded environment. There can be many node objects or parser objects each with many syntax elements, and there can be many threads executing methods on these objects. The message broker design ensures that a message object and any objects it owns are used only by the thread that *receives and processes* the message through the message flow.

An instance of a message flow processing node is shared and used by all the threads that service the message flow in which the node is defined. For parsers, an instance of a parser is used only by a single message flow thread.

A plug-in should adhere to this model, and should avoid the use of global data or resources that require semaphores to serialize access across threads. Such serialization can result in performance bottlenecks.

Plug-in implementation functions must be re-entrant, and any functions they invoke must also be re-entrant. All plug-in utility functions are fully re-entrant.

Although a plug-in can spawn additional threads if required, it is essential that the *same* thread returns control to the broker on completion of an implementation function. Failure to do this will compromise the integrity of the broker and will produce unpredictable results.

## Storage management

All memory allocated by a plug-in must be released by the plug-in. The construction of a node at run-time causes **cniCreateNodeContext** to be invoked, part of the intention of which is to allow the plug-in to allocate node instance specific data areas to store a context. The address of the context is returned to the message broker, and is passed back from the broker when an internal method causes a plug-in function to be invoked; thus, the C plug-in can locate and use the correct context for the function processing.

The message broker will pass addresses of C++ objects to the plug-in. These are simply intended to be used as a handle to be passed back on subsequent function calls. The C plug-in should never attempt to manipulate or use this pointer in any way, for example, attempting to release storage using the **free** function. Such actions will cause unpredictable behavior in the message broker.

The **cniCreateNodeContext** implementation function is invoked whenever the underlying node object has been constructed internally. This occurs when a broker is defined with a message flow that utilizes a plug-in node. It is important to note that this is not necessarily the same activity as creating (or reusing) a thread to execute a message flow instance containing the node. In fact, the **cniCreateNodeContext** function will be called only once, during the configuration of the message flow, regardless of how many threads are executing the message flow.

Similar considerations apply to plug-in parsers, and the corresponding implementation function **cpiCreateContext**.

## String handling

To enable an MQSeries Integrator broker to handle messages in all languages at the same time, text processing within the broker is done in UCS-2 Unicode. UCS-2 Unicode character strings are also used across the plug-in interfaces to pass and return character data. Attributes are received in XML configuration messages as character strings, regardless of datatype. If the true datatype of an attribute is not a string, the **cniSetAttribute** function must perform the necessary verification and conversion prior to storing the attribute value. Similarly, when an attribute value is retrieved using **cniGetAttribute**, conversion must be performed to a UCS-2 Unicode character string prior to returning the result.

`CciChar` defines a 16-bit character with UCS-2 Unicode representation. A `CciChar*` is a string of such characters terminated with a `CciChar` of 0. On Windows and AIX, a `CciChar` is represented by type `wchar_t`. However, other platforms do not have a convenient way of representing UCS-2 constants in source code, typically because of 4-byte `wchar_t` or EBCDIC representation. For example, a source-code constant such as L“ABC” expands to 12 bytes on Sun Solaris.

For this reason, MQSeries Integrator provides the utility functions **cciMbsToUcs** and **cciUcsToMbs**. Use these functions, where appropriate, to ensure portability of your plug-in nodes (see “Character representation handling” on page 168).

For more information about Unicode, see:

```
http://www.unicode.org/
```

## Configuration

Message processing nodes and parsers are required to work in a remotely administered server environment. Plug-in nodes should make provision for any configuration information they require to be passed to them using ‘set’ methods, and should also provide corresponding methods for such attributes to be read back. If they read any information from the file system, registry, environment variables or any other such local system resource, this will inhibit the ease of operation in a remote or distributed environment, because the message broker provides no features to administer such resources.

## Using event logging from a plug-in

Message processing nodes and parsers are unlikely to need to write directly to the local error log, because it is recommended that a plug-in reports errors using exceptions (see “Errors and exception handling” on page 84).

However, you can choose to write significant events, error or otherwise, for problem determination and operational purposes in the same manner as MQSeries Integrator. The plug-in utility function **CciLog** is used to do this. Two of the arguments accepted by this function, `messageSource` and `messageNumber`, define the event source and the actual integer representation of a message within that source, respectively.

For Windows systems, the messages are written to the Windows event log, and your message catalog must be delivered as a Windows DLL.

For Unix systems, these messages are written to the SYSLOG facility, and your message catalog must be delivered as an XPG4 message catalog.

The above covers exceptions raised during normal processing. You must also provide for exceptions raised when deploying and configuring a message flow. Messages resulting from these configuration exceptions are reported back to the Control Center for display to the Control Center user. To facilitate this, you must create an appropriately named java properties file and copy it to each Control Center.

### Building and installing a Windows event source

On Windows, the message catalog is delivered as a Windows NT DLL, which you must create as described below. This contains definitions of your event messages to enable the event viewer to display a readable format, based on the event message written by your application. When you compile a message catalog, a header file is created, which defines symbolic values for each event message number you have created. This header file is included by your application.

To create an event source for the Windows NT Event Log Service:

1. Create a message compiler input (.mc) file with the source for your event messages. Refer to the Windows NT documentation for details on the format of this input file.
2. Compile this message file, to create a resource compiler input file, by issuing the command:

   ```
   MC -v -w -s -h <inputdir> -r <outputdir> <filename>
   ```

   The message compiler produces an output header (.h) file which contains symbolic #defines that map to each message number coded in the input.mc file. This header file must be included when compiling a plug-in source file that uses the **CciLog** utility function to write an event message you have defined. The `messageNumber` argument to **CciLog** must use the appropriate value hash-defined in the output header file.
3. Compile the output file (.rc) from the message compiler to create a resource (.res) file by issuing the command:

   ```
   RC /v <filename>.rc
   ```
4. Create a resource DLL using the .res file by issuing the command:

   ```
   LINK /DLL /NOENTRY <filename>.res
   ```

To install the event source into the Windows NT Event Log Service:

1. Start the Windows NT Registry Editor by issuing the command:

   ```
   regedit
   ```
2. Create a new registry subkey for your plug-in application under the existing structure defined in:

   ```
   HKEY_LOCAL_MACHINE
      SYSTEM
         CurrentControlSet
            Services
               EventLog
                  Application
   ```

   Right-click on *Application* and select *New->Key*. The new key is created immediately under the Application key (not under the MQSeries Integrator key “MQSeriesIntegrator2”). You must give the key the name that you specify on the `messageSource` parameter of the **CciLog** invocation.

   You must then create the following values for this entry:

   - The `EventMessageFile` String value must contain the fully qualified path for the `.dll` you have created to contain your messages. This is the message catalog used by **CciLog**.
   - The `TypesSupported` DWORD value must contain the value “7”.

   See “Adding a Source to the Registry” in the Windows NT documentation for more details about this task.

## Building and installing an XPG4 message catalog

On AIX, the IBM-defined MQSeries Integrator v2 messages are installed into file `MQSIv201.cat` in directory `/usr/opt/mqsi/messages`, and linked into directory `/usr/lib/nls/msg/en_US`. We recommend you follow a similar convention when producing your message catalog (but with a different name of course).

On Sun Solaris, it is usual to build a catalog of US English messages, install it in directory `/usr/lib/locale/C/LC_MESSAGES`, and link it into directory `<mqsi_root>/messages/en_US`.

By creating message catalogs in multiple languages, you can arrange for different brokers on a POSIX system to report messages in different languages, which may be appropriate for a worldwide operation.

To find further information about building a message catalog:

- For AIX, see the information on message facility overview for programming in *AIX Version 4.3 General Programming Concepts: Writing and Debugging Programs*, SC23-4128.
- For Solaris, refer to the *Solaris Internationalization Guide for Developers*.

## Building and installing a Control Center message properties file

The properties file required at the Control Center for displaying exception messages arising during configuration of a message flow is a regular Windows NT text file. The name of the file is of the form `myname.properties`, where `myname` must not conflict with any other installed message catalog, and must be the same as the string passed as `messageSource` in the **cciLog** and **cciThrowException** methods. The message properties file is copied into the `/mqsi/messages` directory of each Control Center.

Following are two example messages extracted from a configuration messages file:

```
1001: SEP1001I: \
The system management event service has started, processId {0}.
\n\nThe system management event service executable
has been started. \n\nThe system management event
service is available.

1002: SEP1002W: \
The system management event service has stopped.
\n\nThe system management event service has been stopped.
\n\nNo user action required.
```

In each message, the number prior to the first colon (1001 and 1002 in the example above) corresponds to the `messageNumber` specified in the **cciLog** and **cciThrowException calls**. The text after the colon is the actual message that will be displayed on the error log. The following may be inserted into the message to facilitate formatting.

```
\   = end of line continuation character
{N} = text insert, where N is 0 for the first insert,
        1 for the second insert, etc.
\n  = new line character
\t  = tab character
```

| If a single quote is required within the message, two consecutive single quotes must be specified.

## Accessing the message content

A message consists of a sequence of bytes. This is known as the *wire format*. However, an application usually puts a special interpretation on that sequence of bytes. For example, the sequence might be the memory holding a C structure. The broker needs to deal with all messages in a general way, so it does not deal with the sequence of bytes directly, but instead treats it as a *logical message*. It does this by referencing *syntax elements* that can be navigated to deduce the structure of a message. A parser is used to convert the wire format into a logical message, and to generate an output message based on the data found within the logical message.

In some cases, parsers rely on external data representations stored in a metadata repository. For example, the IBM supplied MRM parser stores information about the message formats it can recognize in a relational database. In other cases, the message format itself is self-defining and no metadata is required to parse that message.

### Syntax elements

The model of a message presented to a message processing node is that of a parse tree of syntax elements, each of which can be one of three types:

| | |
|---|---|
| **Name elements** | A name element has associated with it a string, which is the name of the element. |
| **Value elements** | A value element has a value associated with it. |
| **Name-value element** | A name-value element is an optimization of the case where a name element contains only a value element and nothing else. The element contains both a name and a value. |

The root element is the unique element in the tree that has no parent. The root element is always a name element. Elements with the same parent element are said to be siblings. Sibling elements have a definite order, and iterating over the set of children of an element will always present the elements in the same order.

The element types that are needed depend on the message structure. Here are some examples of how a message can be modelled:

- If the message to be parsed consists of a series of name/scalar-value pairs, the message can be modelled using a tree with a depth of 1, with all of the elements (apart from the root) being name-value elements.
- Suppose the message has name/set-of-values pairs in addition to scalar values. In this case, the name/set-of-values pair can be modelled with a name element to represent the name, and one value element contained within the name element for each value in the set.
- The message might be the series of bytes holding a C structure, which itself contains nested structures. For example:

```
struct SubMessage {
int field1;
int field2;
};
struct Message {
int field1;
float field2;
SubMessage field3;
};

char *messageBytes;  // points to the actual message byte stream
Message *message = (Message*)messageBytes;
```

This message can be modelled by name-value elements representing each scalar field, and a name element representing each nested structure.

## Syntax element navigation

The broker infrastructure provides functions that enable a message processing node implementation to traverse the tree representation of the message, with functions to allow navigation from the current element to its:

- Parent
- First child
- Last child
- Previous (or left) sibling
- Next (or right) sibling

as shown in Figure 9. Other functions support the manipulation of the elements themselves, with functions to create elements, to set or query their values, to insert new elements into the tree and to remove elements from the tree. See "Node utility function overview" on page 115 and "Parser utility function overview" on page 145.

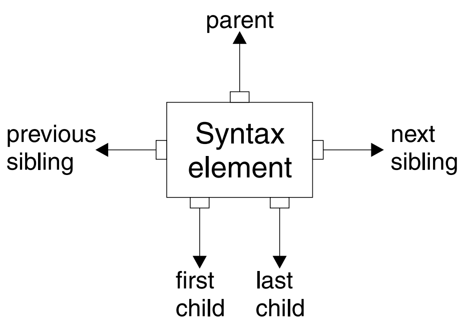


*Figure 9. Showing a syntax element with its connections to other elements*

Figure 10 on page 80 describes a simple syntax element tree that shows a full range of interconnections between the elements.

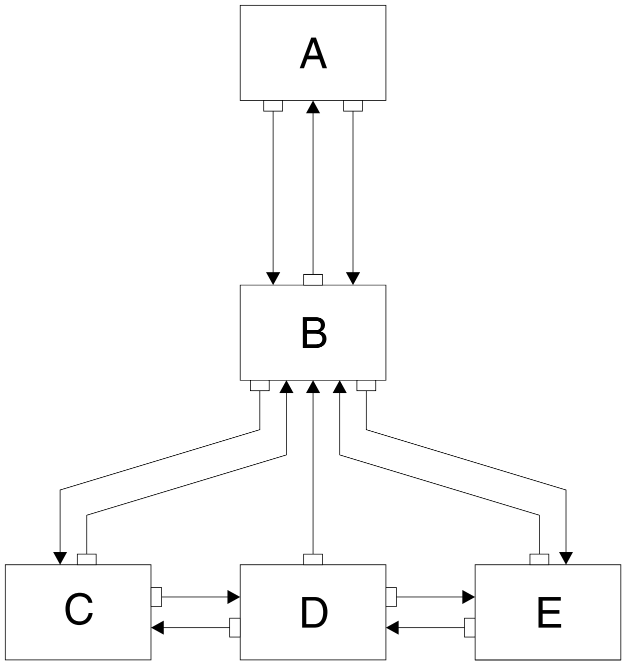


*Figure 10. Syntax element tree*

The element **A** is the *root element* of the tree. It has no parent because it is the root. It has a *first child* of element **B**. Because **A** has no other children, element **B** is also the *last child* of **A**.

Element **B** has three children: elements **C**, **D**, and **E**. Element **C** is the *first child* of **B**; element **E** is the *last child* of **B**.

Element **C** has two siblings: elements **D** and **E**. The *next sibling* of element **C** is element **D**. The *next sibling* of element **D** is element **E**. The *previous sibling* of element **E** is element **D**. The *previous sibling* of element **D** is element **C**.

Figure 11 shows the first generation of syntax elements of a typical message
| received by MQSeries Integrator. (Note that not all messages will have an
| MQRFH2 header.)

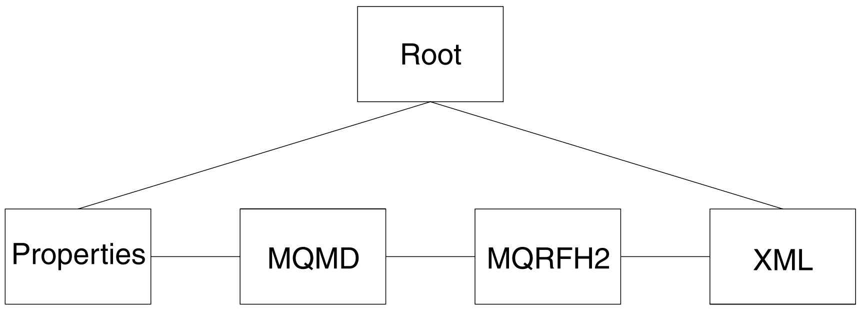


*Figure 11. First generation of syntax elements in a typical message*

These elements at the first generation are often referred to as "folders", in which syntax elements that represent message headers and message content data are stored. In this example, the first child of root is the *Properties* folder. (For more information about standard properties, see *MQSeries Integrator Using the Control Center*.) The next sibling of *Properties* is the folder for the MQMD of the incoming

MQSeries messages. The next sibling is the folder for the MQRFH2 header. Finally, there is the folder that represents the message content, which (in this example) is an XML message.

## Example of an XML message

Suppose we have the following XML message:

```
<Business>
  <Product type='messaging'></Product>
  <Company>
    <Title>IBM</Title>
    <Location>Hursley</Location>
    <Department>MQSeries</Department>
  </Company>
</Business>
```

In this example, the elements are of the following types:

| | |
|---|---|
| **Name** | Business, Product, Company, Title, Location, Department |
| **Value** | IBM, Hursley, MQSeries |
| **Name-value** | type='messaging' |

Figure 12 on page 82 shows the tree that represents the XML shown above.

How can you use the node utility functions (or the similar parser utility functions) to navigate through a message? Taking the XML message shown above, you need to call **cniRootElement** first, with the message received by the node as input to this function.

Figure 11 on page 80 shows that the last child of the root element is the folder containing the XML parse tree. You can navigate to this folder by calling **cniLastChild** (with the output of the previous call as input to this function).

There is one element only (`<Business>`) at the top level of the message, so calling **cniFirstChild** moves to this point in the tree. You can use **cniElementType** to get its type (which is `name`), followed by **cniElementName** to return the name itself (`Business`).

`<Business>` has two children, `<Product>` and `<Company>`, so you can use **cniFirstChild** followed by **cniNextSibling** to navigate to them in turn.

`<Product>` has an attribute (`type='messaging'`), which is a child element. Use **cniFirstChild** again to navigate to this element, and **cniElementType** to return its type (which is `name-value`). Use **cniElementName** as before to get the name. To get the value, call **cniElementValueType** to return the type, followed by the appropriate function in the **cniElementValue** group. In this example it will be **cniElementCharacterValue**.

`<Company>` has three children, each one having a child that is a value element (`IBM`, `Hursley`, and `MQSeries`). You can use the functions already described to navigate to them and access their values.

Other functions are available to copy the element tree (or part of it). The copy can then be modified by adding or removing elements, and changing their names and values, to create an output message.

## Syntax element type definition

The element type is stored as a 32-bit integer. It is set using **cniSetElementType** and **cpiSetElementType** functions, and retrieved using the **cniElementType** and **cpiElementType** functions. As discussed previously, syntax elements are of three basic types: Name, Value, and Name/Value. This basic type is known as the *generic type*, and it is stored in the high-order byte of the element type. The low-order two bytes can be used to save parser-specific type information about the element; this is known as the *specific type*. For example, it can be used to denote an element of a special type, which needs to be handled differently when serialized to an output message by a parser. The remaining byte is reserved and must not be used.

An element's type is set when it is created and it cannot be changed subsequently.

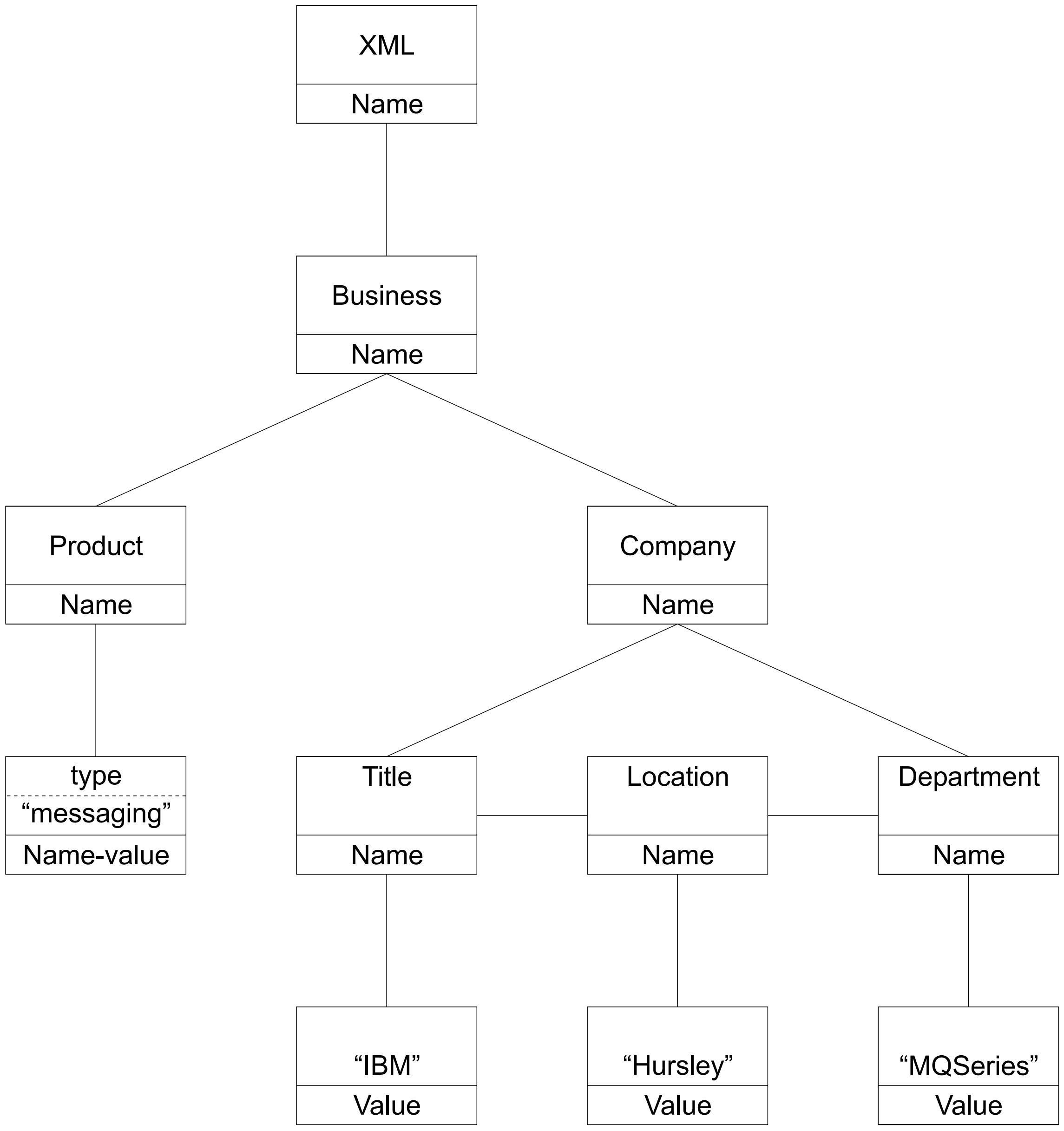


*Figure 12. Tree representation of an XML message*

If a message flow causes part of an element tree to be copied to another location, the specific type information is set to zeroes in the target elements of the copy, if the elements are owned by different parsers. This is because the bit values of the specific type are not meaningful to a different parser.

The **cniSearchElement** group allows a plug-in node to search from a given point in the element tree for an element of a particular type or name. These functions accept a search mode of type `CciCompareMode`; this mode allows the plug-in to search on all combinations of generic type, specific type, and element name.

## Syntax element modification

All messages received on an input terminal of a message processing node are, by implication, *read only*. You must **not** attempt to modify the syntax element tree that belongs to an input message by adding or deleting syntax elements or by changing the attributes of any elements. To do so can cause unpredictable behavior in the message broker, and is not supported.

A plug-in node can *only* modify the syntax element tree of a message that it has created by using the **cniCreateMessage** utility function.

## Parsing a message

The MQSeries Integrator broker is written to support what is called partial parsing. If an individual message contains hundreds or even thousands of individual fields, the parsing operation will require considerable memory and processor resources to complete. Because an individual message flow might reference only a few of these fields, or none at all, it is inefficient to parse every input message completely. For this reason, MQSeries Integrator allows parsing of messages on an as-needed basis. (This does not prevent a parser from processing the entire message all at once, and some parsers are written to do exactly this.)

Each syntax element in a logical message has two bits that indicate whether or not all the elements on either side of an element are complete, and whether its children are complete as well. Parsing is normally completed in a bottom to top, left to right manner. When a parser has completed the siblings of a particular element that precede the given element and the first child, it sets the first completion bit to one. Similarly, when the pointer to the next sibling of an element is complete, as well as its last child pointer, the other completion bit is set to a one.

In partial parsing, the broker waits until a part of the message is referenced, and then invokes the parser to parse that part of the message. MQSeries Integrator message processing nodes refer to fields within a message using hierarchical names. The name begins at the root of the message and proceeds down the message tree until the particular element is located. If an element is encountered without its completion bits set, and further navigation from this element is required, then the appropriate parser entry point is called to parse the necessary part of the message. The relevant part of the message is parsed, appropriate elements are added to the logical message tree, and the element in question is marked as complete.

## Errors and exception handling

The message broker generates C++ exceptions to handle error conditions. These exceptions are caught in the relevant software layers in the broker and handled accordingly. However, programs written in C cannot catch C++ exceptions, and any exceptions thrown will, by default, bypass any C plug-in code and be caught in a higher layer of the message broker.

Utility functions, by convention, normally use the return value to pass back requested data, for example, the address or handle of a broker object. The return value will sometimes indicate that a failure occurred. For example, if the address or handle of a broker object could not be retrieved, then zero (CCI_NULL_ADDR) is returned. Additionally, the reason for an error condition is stored in the return code output parameter, which is, by convention, part of the function prototype of all utility functions. If the utility function completed successfully and `returnCode` was not null, `returnCode` will contain CCI_SUCCESS. Otherwise, it will contain one of the return codes described below. The value of `returnCode` can always be tested safely to determine whether a utility function was successful.

If the invocation of a utility function causes the broker to generate an exception, this will be visible to the plug-in only if it specified a value for the `returnCode` parameter to that utility function. If a null value was specified for `returnCode`, and an exception occurs:

- The plug-in will not be aware of that exception
- The utility function will not return to the plug-in
- Execution control will pass to higher layers in the broker stack to process the exception

This means that a plug-in would be unable to perform any of its own error recovery. If, however, the `returnCode` parameter is specified, and an exception occurs, a return code of CCI_EXCEPTION is returned. In this case, **cciGetLastExceptionData** can be used to obtain diagnostic information on the type of exception that occurred, returning this data in the CCI_EXCEPTION_ST structure.

Message inserts can be returned in the CCI_STRING_ST members of the CCI_EXCEPTION_ST structure. The CCI_STRING_ST allows the plug-in to provide a buffer to receive any required inserts. The broker will copy the data into this buffer and will return the number of bytes output and the actual length of the data. If the buffer is not large enough, no data is copied and the “dataLength” member can be used to increase the size of the buffer, if needed.

The plug-in can then perform any error recovery, if required. If CCI_EXCEPTION is returned, all exceptions must be passed back to the message broker for additional error recovery to be performed. This is done by invoking **cciRethrowLastException**, which causes the C interface to re-throw the last exception so that it can be handled by other layers in the message broker.

If an exception occurs and is caught by a plug-in, the plug-in must not call any utility functions except **cciGetLastExceptionData** or **cciRethrowLastException**. An attempt to call other utility functions will result in unpredictable behavior which could comprise the integrity of the broker.

If a plug-in encounters a serious error, **cciThrowException** can be used to generate an exception that will be processed by the message broker in the correct manner. The generation of such an exception causes the supplied information to be written into the broker event log.

## Types of exception and broker behavior

The broker generates a set of exceptions that can be advised to a plug-in. These exceptions can also be generated by a plug-in when an error condition is encountered. The exception classes are:

| | |
|---|---|
| **Fatal** | Fatal exceptions are generated when a condition occurs that prevents the broker process from continuing execution safely, or where it is broker policy to terminate the process. Examples of fatal exceptions are a failure to acquire a critical system resource, or an internally caught severe software error. The broker process terminates following the throwing of a fatal exception. |
| **Recoverable** | These are generated for errors which, although not terminal in nature, mean that the processing of the current message flow has to be ended. Examples of recoverable exceptions are invalid data in the content of a message, or a failure to write a message to an output node. When a recoverable exception is thrown, the processing of the current message is aborted on that thread, but the thread recommences execution at its input node. |
| **Configuration** | Configuration exceptions are generated when a configuration request fails. This can be because of an error in the format of the configuration request, or an error in the data. When a configuration exception is thrown, the request is rejected and an error response message is returned. |
| **Parser** | These are generated by message parsers for errors which prevent the parsing of the message content or creating a bit-stream. A parser exception is treated as a recoverable exception by the broker. |
| **Conversion** | These are generated by the broker character conversion functions if invalid data is found when attempting to convert to another datatype. A conversion exception is treated as a recoverable exception by the broker. |
| **User** | These are generated when a ThrowNode throws a user-defined exception. |
| **Database** | These are generated when a database management system reports an error during broker operation. A database exception is treated as a recoverable exception by the broker. |

## Return codes

By convention, the return code output parameter of all utility functions is set to indicate successful completion, or otherwise. The following table lists all return codes with their meanings. These return codes are defined in **BipCci.h**.

*Table 3. Utility function return codes and values*

| Return code | Explanation |
|---|---|
| CCI_BUFFER_TOO_SMALL | The output buffer is not large enough to store the requested data. |
| CCI_EXCEPTION | An exception occurred. |
| CCI_EXCEPTION_CONFIGURATION | A configuration exception was detected when invoking the function. 1 |
| CCI_EXCEPTION_CONVERSION | A conversion exception was detected when invoking the function. 1 |
| CCI_EXCEPTION_DATABASE | A database exception was detected when invoking the function. |
| CCI_EXCEPTION_FATAL | A fatal exception was detected when invoking the function. 1 |
| CCI_EXCEPTION_PARSER | A parser exception was detected when invoking the function. 1 |
| CCI_EXCEPTION_RECOVERABLE | A recoverable exception was detected when invoking the function. 1 |
| CCI_EXCEPTION_UNKNOWN | An unknown exception was specified or encountered. |
| CCI_EXCEPTION_USER | A user exception was detected when invoking the function. 1 |
| CCI_FAILURE | A function was unsuccessful. |
| CCI_INV_DATA_BUFLEN | A data buffer length of zero was specified. |
| CCI_INV_DATA_POINTER | A null pointer was specified for the address of an output data area. |
| CCI_INV_DATASOURCE_NAME | A datasource name was not specified. |
| CCI_INV_ELEMENT_OBJECT | A null pointer was specified for the element object. |
| CCI_INV_FACTORY_NAME | A factory name that is not valid (blank) was specified. |
| CCI_INV_FACTORY_OBJECT | A null pointer was specified for the factory object. |
| CCI_INV_LENGTH | A length of zero was specified. |
| CCI_INV_LOG_TYPE | The specified log type is not valid. |
| CCI_INV_MESSAGE_CONTEXT | A null pointer was specified for the message context. |
| CCI_INV_MESSAGE_OBJECT | A null pointer was specified for the message object. |
| CCI_INV_NODE_NAME | A node name that is not valid (blank) was specified. |
| CCI_INV_NODE_OBJECT | A null pointer was specified for the node object. |
| CCI_INV_OBJECT_NAME | Characters specified in the object name were not valid. |
| CCI_INV_PARSER_NAME | A parser class name that is not valid (blank) was specified. |
| CCI_INV_PARSER_OBJECT | A null pointer was specified for the parser object. |
| CCI_INV_SQL_EXPR_OBJECT | A null pointer was specified for an SQL expression value. |
| CCI_INV_STATEMENT | A statement was not specified. |
| CCI_INV_TERMINAL_NAME | A terminal name that is not valid (blank) was specified. |
| CCI_INV_TERMINAL_OBJECT | A null pointer was specified for the terminal object. |
| CCI_INV_TRANSACTION_TYPE | An invalid value was specified for the transaction type. |
| CCI_INV_VFTP | A null pointer was specified for the address of the plug-in virtual function pointer table. |
| CCI_MISSING_IMPL_FUNCTION | A mandatory implementation function was not defined in the function pointer table. |
| CCI_NAME_EXISTS | A parser with the same class name already exists. |
| CCI_NO_BUFFER_EXISTS | No buffer exists for the specified parser object. |
| CCI_NO_EXCEPTION_EXISTS | No previous exception was found for this thread. |
| CCI_NULL_ADDR | A function that should return an address was unsuccessful; zero is returned instead. |
| CCI_PARSER_NAME_TOO_LONG | The name of the parser class is too long. |
| CCI_SUCCESS | Successful completion. |

**Note:**

1 This return code is returned only by **cniGetLastExceptionData** to indicate the type of the last exception.

## Compiling a plug-in

### Prerequisites

- Appropriate C++ compiler:
  - For Windows NT, Microsoft Visual Studio C++ Version 6.0
  - For AIX, VisualAge C++ for AIX Version 5.0
  - For Solaris, SparcCompiler SC5.0
- Installed “Samples and SDK” optional component on at least one system. The SDK provides the required header files and contains samples that you can modify to your own requirements.

### Header files

The C interfaces are defined by the following header files:

| | |
|---|---|
| **BipCni.h** | Message processing nodes |
| **BipCpi.h** | Message parsers |
| **BipCci.h** | Interfaces common to both nodes and parsers |
| **BipCos.h** | Platform specific definitions |

### File names

References are made throughout this chapter to the MQSeries Integrator home directory: that is, the directory into which MQSeries Integrator is installed. The location of the home directory is as follows:

| | |
|---|---|
| **For AIX** | `/usr/opt/mqsi` |
| **For Sun Solaris** | `/opt/mqsi` |
| **For Windows** | `C:\Program Files\IBM MQSeries Integrator 2.0`, or `C:\Program Files\IBM MQSeries Integrator 2.0.1` (note that this is the default path, which you can override if necessary) |

For convenience, the label `<mqsi_root>` is used throughout the book to refer to this home directory.

On Windows systems, “\” is used to separate levels in a hierarchical file name and “/” is used to indicate that the next word is a command flag (rather than a file name).

On Unix platforms, “/” is used to separate levels in a hierarchical file name and “\” is used to give a special meaning to the next character (for example, `\t` would mean “put a tab here”).

As a convenience, when a Windows application opens a file with a name that includes a “/”, it is interpreted as a level separator. So, coding

```
# include <plugin/BipSampPluginNode.h>
```

would have the expected effect on all platforms.

## Sample code

Sample code is provided with the product, to help you understand how to write nodes and parsers. The samples are located in the following directory:

```
<mqsi_root>\examples\plugin     (Windows)

<mqsi_root>/sample/plugin       (Unix)
```

*Table 4 (Page 1 of 2). Sample code and related files*

| File | Function |
|---|---|
| BipSampPluginNode.c | C source file containing sample implementations of (1) a message processing node that routes a message to one of five output terminals, depending on content (SampleSwitch), and (2) a simple fixed transformation of an input message into an output message (SampleTransform). |
| BipSampPluginNode.h | Header file for above |
| BipSampPluginParser.c | C source file containing sample implementations of a simple pseudo-XML parser. |
| BipSampPluginParser.h | Header file for above |
| ComIbmSampleSwitch | The XML interface definition file for the sample plug-in node called SampleSwitch. |
| ComIbmSampleSwitch.wdp | The WebDav properties file for the sample plug-in node called SampleSwitch. |
| ComIbmSampleTransform | The XML interface definition file for the sample plug-in node called SampleTransform. |
| ComIbmSampleTransform.wdp | The WebDav properties file for the sample plug-in node called SampleTransform. |
| SampleSwitch.gif | Gif used for the icon of the SampleSwitch plug-in node in the Control Center tree view (the minimum size) |
| SampleSwitch.properties | Properties file for the SampleSwitch plug-in node |
| SampleSwitch30.gif | Gif used for the icon of the SampleSwitch plug-in node for the 25% zoom. |
| SampleSwitch42.gif | Gif used for the icon of the SampleSwitch plug-in node for the 50% zoom. |
| SampleSwitch58.gif | Gif used for the icon of the SampleSwitch plug-in node for the 75% zoom. |
| SampleSwitch84.gif | Gif used for the icon of the SampleSwitch plug-in node for the 100% zoom. |
| SampleTransform.gif | Gif used for the icon of the SampleTransform plug-in node in the Control Center tree view (the minimum size). |
| SampleTransform30.gif | Gif used for the icon of the SampleTransform plug-in node for the 25% zoom. |
| SampleTransform42.gif | Gif used for the icon of the SampleTransform plug-in node for the 50% zoom. |
| SampleTransform58.gif | Gif used for the icon of the SampleTransform plug-in node for the 75% zoom. |

*Table 4 (Page 2 of 2). Sample code and related files*

| File | Function |
|---|---|
| SampleTransform84.gif | Gif used for the icon of the SampleTransform plug-in node for the 100% zoom. |
| SampleTransform.properties | Properties file for the SampleTransform plug-in node. |

The following sample programs are also provided:

- A sample property editor, TraceSettingPropertyEditor.java
- A sample customizer file, SampleSwitchCustomizer.java, and associated bean file SampleSwitchCustomizerBeanInfo.java.

## Compilation

The first step is to create the plug-in factory. Move to the directory where the plug-in code is located. For example, if you are creating a factory for the sample plug-in node:

```
cd <mqsi_root>\examples\plugin      (Windows)

cd <mqsi_root>/sample/plugin        (Unix)
```

### Compiling on Windows

Compile the plug-in node (assuming the Microsoft 32-bit C/C++ Compiler, available in Microsoft Visual Studio C++ Version 6.0) as follows:

```
cl /VERBOSE /LD /MD /Zi /I..\plugin /I..\..\include
   \plugin BipSampPluginNode.c -link /DLL ..\..\lib\imbdfplg.lib
   /OUT:BipSampPluginNode.lil
```

This creates the 'lil' file directly.

### Compiling on AIX

Compile and link the plug-in node as follows, using one of the supported C compilers:

```
xlc_r -I <mqsi_root>/include
      -I <mqsi_root>/include/plugin
      -c BipSampPluginNode.c
xlc_r -bM:SRE
      -bexpall
      -bnoentry
      -o BipSampPluginNode.lil
      -L <mqsi_root>/lib
      -l imbdfplg
chmod a+r BipSampPluginNode.lil
```

### Compiling on Sun Solaris

Compile and link the plug-in node as follows, using one of the supported C compilers:

```
cc -mt \
   -I <mqsi_root>/include\
   -I <mqsi_root>/include/plugin\
   -c BipSampPluginNode.c
   -o BipSampPluginNode.o
cc -mt \
   -I <mqsi_root>/include\
   -I <mqsi_root>/include/plugin\
   -c BipSampPluginUtil.c\
   -o BipSampPluginUtil.o
cc -G\
   -o BipSampPluginNode.lil\
   BipSampPluginNode.o\
   BipSampPluginUtil.o\
   -L <mqsi_root>/lib\
   -l imbdfplg
chmod a+r BipSampPluginNode.lil
```

# Chapter 7. Installing a plug-in node or parser

When you have written the C code for the plug-in, in accordance with the guidelines given in Chapter 6, “Implementing a plug-in node or parser” on page 65, the next step is to install the code on your MQSeries Integrator brokers. In the case of a plug-in node, it is also necessary to integrate the new node into the Control Center.

This chapter contains:

## Prerequisites

- Authorization to install the code for the plug-in on each system that will use it.
- Authorization to stop and restart the broker to make the plug-in available to the broker.
- Authorization to define the node in the Control Center (a member of mqbrdevt and, preferably, logging in as the superuser IMMQSI2).

## Installing a plug-in on a broker system

The plug-in ‘lil’ file can be installed by copying or moving it to the following directory:

```
<mqsi_root>\bin     (Windows)

<mqsi_root>/lil     (Unix)
```

This directory (or its equivalent if you chose to override the default location) is created during installation of MQSeries Integrator Version 2.0.1.

We recommend that, for Windows, you also create and install a ‘pdb’ file in the bin directory as this will help IBM service to respond more quickly to any problem determination queries that you may have.

You must install the ‘lil’ file on each system that requires the functionality of the plug-in node or parser that you have created. If all your brokers are on the same machine type, you can build the ‘lil’ once and copy it around your systems. If you have a cluster that consists of one AIX, one Sun Solaris, and one Windows broker, you will need to build the ‘lil’ separately on each machine type.

You must stop and restart each broker to enable it to detect the existence of the new ‘lil’.

On all types of system, you can remove a ‘lil’ by stopping the broker and removing or moving the file. You can update a ‘lil’ by stopping, removing or moving, and creating a new ‘lil’. Some types of system allow a different order; others allow you to use a ‘lil’ that is actually elsewhere on a network (for example, an NFS mount or a Windows shared drive).

| On Unix platforms, permissions are set so that only a superuser can create ‘lil’ files
| in the `<mqsi_root>/lil` directory. One way to allow other users to maintain ‘lil’ files
| is for the superuser to create symbolic links in the `<mqsi_root>/lil` directory so
| that the actual ‘lil’ files can be elsewhere and can be controlled according to the
system’s administration policy.

In the case of a plug-in node, you must also install the interface definition for the node in the Control Center. This task is described in “Integrating a plug-in node into the Control Center.”

## Integrating a plug-in node into the Control Center

When you have created the code that provides the function of your new node, you must define the node to MQSeries Integrator. You can then use it in the Control Center, include it in a message flow, and deploy that message flow to one or more brokers.

This section is written with file names that are expressed in the Windows convention. Make the appropriate changes if you are using a Unix platform.

This section describes the following tasks:

- “Defining the node interface” on page 93.
- “Defining optional node resources” on page 101.
- “Installing a new message processing node in the Control Center” on page 109.

These tasks involve the creation of a number of files: some of these are mandatory, and others are optional. The files are as follows.

Mandatory:

- The XML interface definition file
- The WDP file

Optional:

- The icon files
- The help file
- The properties file
- A property editor
- A customizer

These tasks, and the files created to complete them, are illustrated using the sample plug-in node shipped with MQSeries Integrator. A set of files for this sample plug-in node is supplied (see “Sample code” on page 88), and you can copy and update these files for your own new node, or you can create your own files.

**Note:** The file locations used within the example files use the forward slash (/) character to identify directory structure. You are recommended to use this character in the files you create. However, on the Windows NT system the use of the backslash character (\) is also supported.

**Note:** The sample files provided for the plug-in node do not conform to the recommendations documented here. In particular:

- `package` is set to `com.isv` in several files.
- `displayname` in the sample WDP file is incorrect.

However, the information here is consistent with the values and names used in the samples supplied, and provides a working example. Where the names and values differ from the recommendations given, this is noted in the text.

## Defining the node interface

This subtask is required. You must create two files to define the interface of the node. These are:

- The XML interface definition file.
- The WDP file.

Both these files are created in XML. You can use your favorite text editor to create new files, or to copy and update the samples supplied. You do not have to have any programming skills to complete this subtask. See "Storing the files in the MQSeries Integrator directory structure" on page 109 for the required location for these files.

If you have a good understanding of XML and DTD files, you can refer to the file `mqsi.dtd` that defines the rules of the XML used in these files. The file is stored in `<mqsi_root>\Tool`. The rules are summarized here to help you create files that provide the function you require.

### The XML interface definition file

The XML interface definition file defines the attributes of the node, and defines the interfaces that the node presents to other nodes within a message flow. The file name must match the name of the node, but **without** the suffix "Node". For example, the name of this file for the sample provided is `ComIbmSampleTransform` (shown in Figure 13 on page 94). There is no file extension. You must use the same file name and an extension of `.wdp` for the WDP file for this node (see "The WDP file" on page 100).

When you create the XML interface definition file for your node, you are recommended to copy this sample. Update the contents of the file following the guidance given in this section. You must leave all other content unchanged.

The tags and their properties are described below:

- **MessageProcessingNodeType**

  This tag describes the type of the new node. You must define one and only one tag of this type. If you define more than one, error BIP0056 is generated when you try to add the node to the workspace (see "Defining the node to the configuration repository" on page 110).

  The tag properties are:

  – longDescription

    This field can provide either a textual description of the node, or a value that is used as a key into the node's properties file (described in "Creating a properties file for the node" on page 104). If a value is provided, the textual description is looked up in the node's properties file. If a node properties file does not exist, or the key does not exist within the properties

```
<?xml version="1.0" encoding="UTF-8"?>

<!DOCTYPE MessageProcessingNodeType SYSTEM "mqsi.dtd" >

<MessageProcessingNodeType scaleableIcon=""
  longDescription="longDescription" icon="images/SampleTransform.gif"
  versionCreator="" package="com.isv" shortDescription="shortDescription"
  version="" creationTimestamp="" isPrimitive="true" creator=""
  versionTimestamp="" xmi.uuid="ComIbmSampleTransform"
  xmi.label="SampleTransform" collectionPath="">

<Attribute xmi.label="nodeTraceOutfile" type="String"
  value="" xmi.uuid="" valueMandatory="false" encoded="false"/>

<Attribute xmi.label="nodeTraceSetting" type="Integer"
  value="0" xmi.uuid="" valueMandatory="false" encoded="false"/>

<OutTerminal longDescription="" icon="images/OutTerminal.gif"
  versionCreator="" shortDescription="" creationTimestamp=""
  creator="" y="0" x="0" versionTimestamp=""
  xmi.uuid="0d06000c-0800-0000-0100-090507050000" xmi.label="failure">
<OutTerminalTypeRef xmi.label="OutTerminalType"
  type="OutTerminalType" icon="images/OutTerminal.gif"
  title="OutTerminal" refType="OutTerminalType"
  href="OutTerminalType/OutTerminalType" xml:link="simple"/>
</OutTerminal>

<OutTerminal longDescription="" icon="images/OutTerminal.gif"
  versionCreator="" shortDescription="" creationTimestamp=""
  creator="" y="0" x="0" versionTimestamp=""
  xmi.uuid="020c000c-0800-0000-0100-090507050000" xmi.label="out">
<OutTerminalTypeRef xmi.label="OutTerminalType" type="OutTerminalType"
  icon="images/OutTerminal.gif" title="OutTerminal" refType="OutTerminalType"
  href="OutTerminalType/OutTerminalType" xml:link="simple"/>
</OutTerminal>

<InTerminal longDescription="" icon="images/InTerminal.gif"
  versionCreator="" shortDescription="" creationTimestamp=""
  creator="" y="0" x="0" versionTimestamp=""
  xmi.uuid="0505000c-0800-0000-0100-090507050000" xmi.label="in">
<InTerminalTypeRef xmi.label="InTerminalType" type="InTerminalType"
  icon="images/InTerminal.gif" title="InTerminal" refType="InTerminalType"
  href="InTerminalType/InTerminalType" xml:link="simple"/>
</InTerminal>

</MessageProcessingNodeType>
```

*Figure 13. A sample plug-in XML interface definition file*

file, the value of this property is used as the textual description and appears when the node’s properties are displayed.

| Note that the text you enter into this field will be displayed when you right-click on Properties and then on the Description of a primitive node (that is, a node listed under the message flow category in the Message Flow Types pane). It is, however, not displayed if you right-click on Properties of an instance of the node (created by dragging and dropping into the Message Flow Definition pane).

The default behavior is for this property to be included on the *Description* tab when the node’s properties are displayed.

– icon

This field identifies the path (relative to `<mqsi_root>\Tool\`) and name of the `.gif` file that provides the icon for the node. See “Defining an icon for the node” on page 101 for further details about icons.

– package

  The package attribute identifies where the resources for this node's customizer, property editor, and properties files are stored on the local file system.

  The following values are recommended, but not enforced:

  - `com.ibm`. This is used for IBM supplied nodes.
  - `com.isv`. This is used for additional nodes supplied by ISVs and other companies. In the sample plug-in XML interface definition file supplied, this value is used instead of `com.ibm`. The value `com.isv` is assumed for this working example.

  The value set in `package` defines the directory structure under the directory `<mqsi_root>\Tool`. The period character (.) within `package` is replaced with the backslash (\) character to form the full directory structure (for example, `<mqsi_root>\Tool\com\isv`).

– shortDescription

  This field can provide either a brief textual description of the node, or a value that is used as a key into the node's properties file. If a value is provided, the textual description is looked up in the node's properties file. If a node properties file does not exist, or the key does not exist within the properties file, the value of this property is used as the textual description.

  The default behavior is for this property to be included on the *Description* tab when the node's properties are displayed.

– isPrimitive

  This attribute must be set to “true”.

– xmi.uuid

  This must be set to the full name of the node. The suffix “Node” is not part of this attribute value. The identifier specified must be unique within your broker domain, and therefore within your configuration repository. The value you specify for this property can be a maximum of 36 characters in length, and must be used as the file name for this interface file.

  The following naming convention is recommended, but not enforced, for this value:

  - `ComIbm<nodename>` for all nodes provided by IBM.
  - `Com<YourCompanyName><nodename>` for the nodes you create.

  Where `<nodename>` excludes the suffix “Node” in both cases.

  The sample provided conforms to this standard and has `xmi.uuid` set to `ComIbmSampleTransform`.

– xmi.label

  This character field defines the displayed label (name) of the node. The value you specify here must be the same as the value you specify for `xmi.label` in the WDP file (see “The WDP file” on page 100). This value is used by the Control Center when this node is displayed, and defines the name that must be used within the file name for the node icon, help, properties, and Customizer files (if defined). The sample provided has `xmi.label` set to `SampleTransform`.

  - The following attributes have no meaning in the current implementation, and must be left blank.
    - scaleableIcon
    - versionCreator
    - version
    - creationTimestamp
    - creator
    - versionTimestamp
    - collectionPath

- **Attribute**

  This tag defines an attribute of the node. You can define zero or more <Attribute> tags. The attributes can be specified individually using this tag (illustrated in the `SampleTransform` interface definition file), or defined together in one or more <AttributeGroup> tags (described below). You can use any combination of <Attribute> and <AttributeGroup> tags to complete the node definition. The attributes that are not defined to a group will appear on the default properties tab when the node properties are displayed.

  The <Attribute> tag has the following properties:

  - xmi.label

    This character field defines the displayed label (name) of the attribute. If a value is provided, it acts as a key into the node's properties file. If there is no properties file, or the key does not exist within the properties file, the value of this field is used and its contents are displayed.

  - type

    This is the type of the property. It determines which property editor is invoked to handle the input for this attribute, and therefore how it is validated. It must be one of:

    - A built-in type (handled by the default property editors supplied):
      - Boolean
      - Double
      - Float
      - Integer
      - Long
      - String
      - Date
      - Time
      - Timestamp
    - A sequence of possible values "value1 value2 ..." (an enumeration).
    - The definition of a property editor called <type>PropertyEditor or <type>Editor.

  - value

    This is the value of the <Attribute>. It is displayed as the initial value for the attribute.

    If <Attribute> is an enumerated type, the value set is used as a key into the properties file (described in "Creating a properties file for the node" on page 104) and the translated value is displayed as the default value in the drop-down list (that is, the first in the list). If there is no properties file, or the key does not exist within the properties file, the value of this field is used and its contents are displayed as the default value in the drop-down list. If no value is set (that is, `value=""`), the drop-down list appears in the order in which it is coded (that is, the first value in the type property is displayed as the default value in the drop-down list).

If <Attribute> is not an enumerated type, the value is displayed as entered and is not used as a key into the properties file.

For example, if you want <Attribute> to be an enumerated type, it looks like this:

```
<Attribute xmi.label="enumerated type sample"
   type="value1 value2 value3" value="value1"/>
```

The default value presented in the drop-down list will be `value1` (the one named on `value=`). The other possible values for selection are `value2` and `value3`

– xmi.uuid

This provides an identifier for this attribute that is used internally if this attribute is promoted. Set this field to “”. See *MQSeries Integrator Using the Control Center* for information about promoting attributes.

– valueMandatory

This indicates if the <Attribute> must be specified. You must set this property to “true” or “false”:

- Set “true” if the <Attribute> must be specified when an instance of the node is created (the <Attribute> is mandatory). The attribute label will be shown in bold.
- Set “false” if the <Attribute> does not have to be specified when an instance of the node is created (the <Attribute> is optional). If not specified, the <Attribute> takes the default value “false”.

– encoded

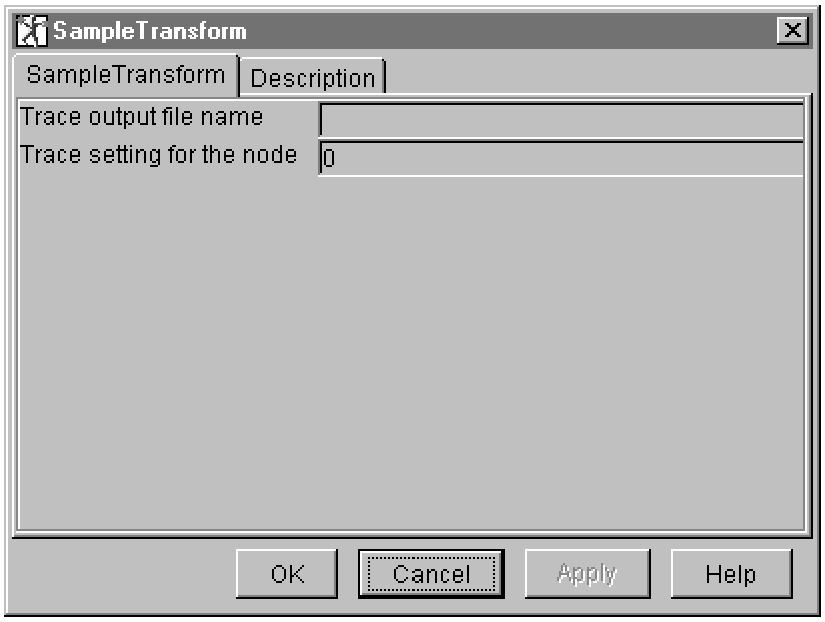
This indicates if the value of this <Attribute> must be encoded (the XML parser normalizes all strings: if tabs and line-feeds are to be retained, they must be encoded):

- A tab (‘\t’) is encoded as ‘\\t’.
- A line feed (‘\n’) is encoded as ‘\\n’.
- A space (‘ ’) is encoded as ‘+’.
- A plus (‘+’) is encoded as ‘\\+’.
- The backslash character (‘\’) is encoded as ‘\\’.

This normalizes a string to a one line string, and provides instructions to allow the original string to be reconstructed by the Control Center.

This property is optional. It can have the value “true” or “false”. If you do not include it, it takes the default value “false”.

If a MessageProcessingNodeType has <Attribute> tags, but no <AttributeGroup> tags (like the sample in Figure 13 on page 94), the properties dialog for the node might appear like this:



Trace output file name

Trace setting for the node 0

- **AttributeGroup**

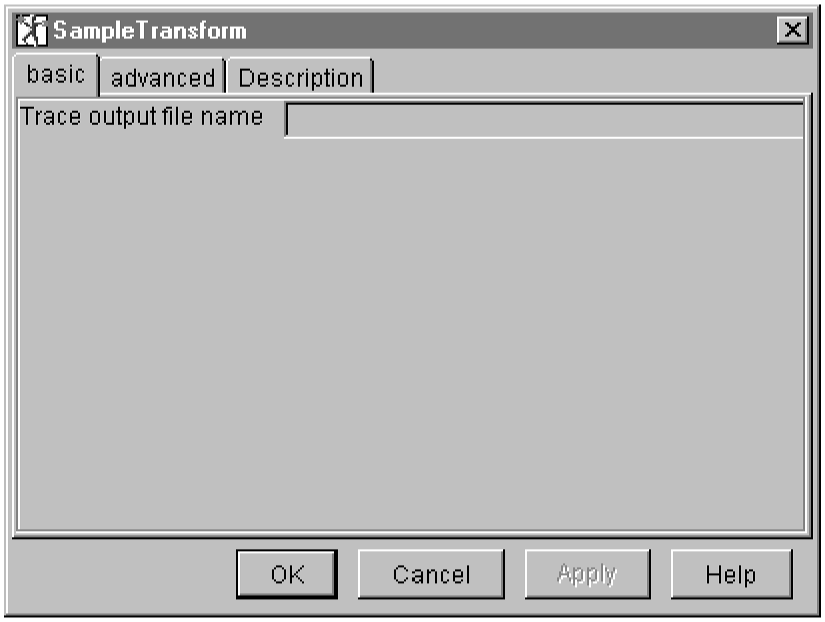
  An <AttributeGroup> defines a number of related attributes for the node, that are displayed together on a separate tab within the node properties dialog. The use of attribute groups is optional. You can define zero or more <AttributeGroup> tags. Each <AttributeGroup> tag can include one or more <Attribute> tags.

  The <AttributeGroup> tag has a single property:

  – xmi.label

    This character field defines the displayed label (name) of the tab that contains the group of attributes. If a value is provided, it acts as a key into the node's properties file. If there is no properties file, or the key does not exist within the properties file, the value of this field is used and its contents are displayed.

  If a MessageProcessingNodeType has attribute groups in addition to, or in place of, attributes, the properties dialog for the node might appear like this:



The XML definitions required for the <AttributeGroup> and <Attribute> tags that created this example are:

```
<AttributeGroup xmi.label="basic">
<Attribute xmi.label="nodeTraceOutfile" type="String" value=""
xmi.uuid="" valueMandatory="false" encoded="false"/>
</AttributeGroup>
<AttributeGroup xmi.label = "advanced">
<Attribute xmi.label="nodeTraceSetting" type="Integer"
value="0" xmi.uuid="" valueMandatory="false" encoded="false"/>
</AttributeGroup>
```

**Note:** You are recommended to ensure that a single attribute is included in a single attribute group. If you do not do so, the results are unpredictable.

- **OutTerminal**

  This tag defines an out terminal of the node. You must code one for each terminal through which your node propagates a message to another node (zero or more). For example, you might have an out terminal and a failure terminal, or a true terminal and a false terminal.

  If you do not have an out terminal in your node, you can remove this entire tag.

  You must set the following attributes of this tag:

  – xmi.uuid

    You must set this field to "". If you use the sample file supplied, you must modify this property to have this value.

  – xmi.label

    This field defines the displayed label of the terminal. It must be unique within this file, and it must be set to the same value as the name specified for the terminal in the plug-in code.

- **InTerminal**

  This tag defines an in terminal of the node. You must code one and only one in terminal for your node.

  You must set the following attributes of this tag:

  – xmi.uuid

    You must set this field to “”. If you use the sample file supplied, you must modify this property to have this value.

  – xmi.label

    This field defines the displayed label of the terminal. It must be unique within this file, and it must be set to the same value as the name specified for the terminal in the plug-in code.

## The WDP file

The WDP (WebDav Properties) file provides information required by the WebDav protocol that is used between the Control Center and the Configuration Manager. The filename must be same as the name of the XML interface definition file, with the extension `wdp`, for example, `ComIbmSampleTransform.wdp`

This file specifies several properties required by WebDav. The file `ComIbmSampleTransform.wdp`, illustrated in Figure 14, is supplied for you to copy and update as indicated below.

```
<?xml version="1.0"?>
 <properties xmlns:D="DAV:">
 <D:creationdate>1999-10-06T12:54:19-04:00</D:creationdate>
 <D:displayname>
  repository\private\MessageProcessingNodeType\ComIbmSampleTransform
 </D:displayname>
 <D:getcontenttype>text/plain</D:getcontenttype>
 <D:xmi.label>SampleTransform</D:xmi.label>
 <D:getcontenttype>text/plain</D:getcontenttype>
 <D:lockdiscovery xmlns:D="DAV:"/>
 <D:getcontenttype>text/plain</D:getcontenttype>
 <D:icon>images/SampleTransform.gif</D:icon>
</properties>
```

*Figure 14. Sample plug-in WDP file. The figure excludes repeated lines containing* `<D:getcontenttype>text/plain</D:getcontenttype>` *that you will see in the sample supplied. The duplicate lines are generated by WebDav but are not required: a single line is sufficient.*

You must update the following fields with the appropriate values for your own node within the WDP file:

- `displayname`

  Enter the name of the XML interface definition file (described in “The XML interface definition file” on page 93).

  **Note:** The value set in the sample file includes a partial path in addition to the name of the file. The path is not required.

- `xmi.label`

Enter the name of the new node type. This is the text string that will appear in the node tree in the Control Center (Message Flows view) to identify the type of the node.

This must be identical in value to the `xmi.label` property of the <MessageProcessingNodeType> tag in the XML interface definition file.

- `icon`

  Enter the path and name of the icon defined for this node relative to `<mqsi_root>\Tool`. This value must identify the minimum size icon. See "Defining an icon for the node" for more information about node icons and naming icon flies. For more information about file locations, see "Storing the files in the MQSeries Integrator directory structure" on page 109.

You can also update the following field if you choose:

- `creationdate`

  This field can be used to record the date and time at which you created this node. The contents of this field are not referenced within the implementation, but the format of the field is significant and must be maintained in full. If you modify the date, or time, or both, you must ensure that all other parts of this field are unchanged.

## Defining optional node resources

In addition to the node interface, you can also provide resources for the node that provide for a new icon, a properties file (for translation of character fields associated with the node), one or more property editors, and one or more customizers. These tasks are all optional.

### Defining an icon for the node

You are recommended to provide at least one icon to be used in the Control Center tree view (the minimum size). You can supply up to four additional icons of different sizes that are used for magnification when viewing and zooming the message flow composition pane. If any of the scaled icons do not exist, the closest in size is used, and is scaled to the expected size. If you do not supply an icon, the default node icon is used.

The name of the minimum icon file must be the value of `xmi.label` in the <MessageProcessingNodeType> tag in the XML interface definition file.

The following set of icons is supplied for the `SampleTransform` node:

- `SampleTransform.gif` for the tree view.
- `SampleTransform30.gif` for the 25% zoom.
- `SampleTransform42.gif` for the 50% zoom.
- `SampleTransform58.gif` for the 75% zoom.
- `SampleTransform84.gif` for the 100% zoom.

These icons are shown in Figure 15 on page 102.

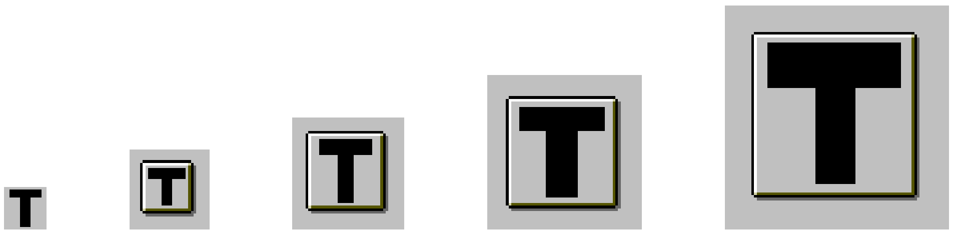


*Figure 15. Plug-in node icons*

You can reuse one or more of these icons when you create your own node by starting a graphics editor, making your changes, and using *File->Save As* to save the new icon with the appropriate name. You can also use the template icons supplied in `<mqsi_root>\Tool\images` directory. See "Storing the files in the MQSeries Integrator directory structure" on page 109 for information about where your icon files must be stored.

## Defining the help text for the node

This subtask is optional, but you are recommended to complete it to provide online help information for your Control Center users. The help you provide will be processed in an identical fashion to the help provided for all the IBM Primitive nodes. This sample uses the style sheet used for the IBM primitives, `bipnt.css`, which also makes the appearance of the help text identical. This style sheet file is in:

```
<mqsi_root>\Tool\help\com\ibm\ivm\mqitool\extensions
```

You need to either copy this style sheet file into the same directory as your online help file or make sure the full path for this file is included in the online help file.

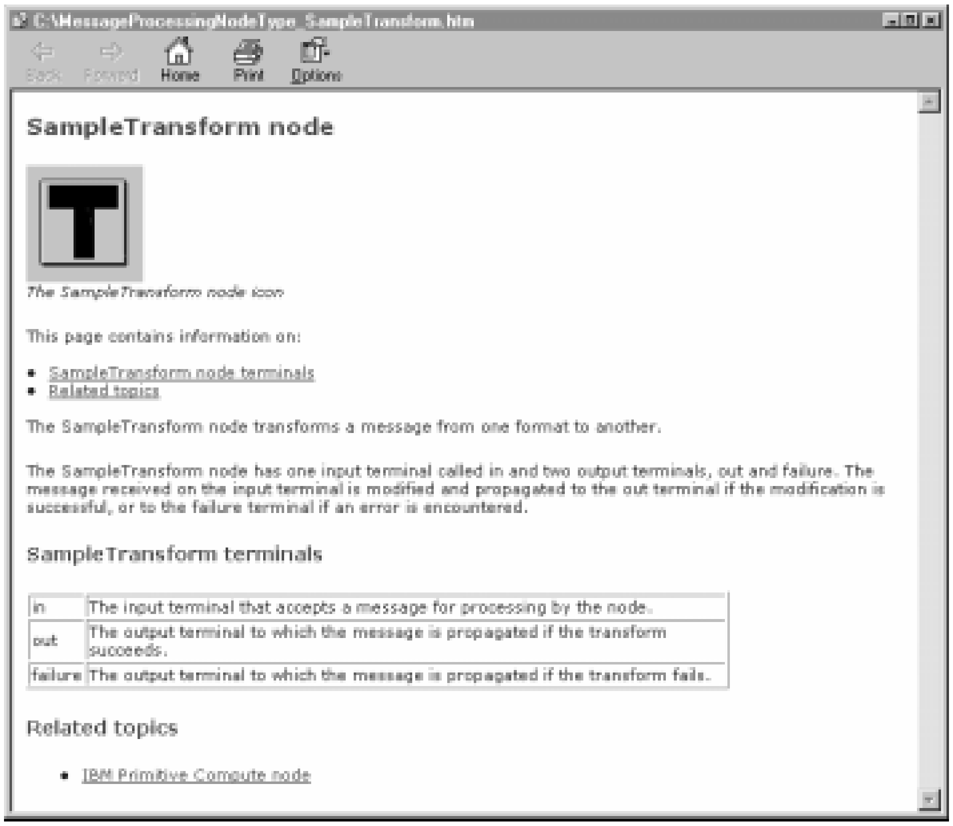
The name of the help file must be `MessageProcessingNodeType_<name>`, where `<name>` is the value set for `xmi.label` in the <MessageProcesssingNodeType> tag in the XML interface definition file. The file extension must be `.htm`. See "Storing the files in the MQSeries Integrator directory structure" on page 109 for information about where your help file must be stored.

An example of a help file for the sample plug-in is shown in Figure 16 on page 103. The file must be called `MessageProcessingNodeType_SampleTransform.htm`. The paths specified for the icon file and the related link included in the help assume that you are using the default directory for `<mqsi_root>`.

```
<HTML>
<HEAD>
<TITLE>SampleTransform node</TITLE>
<META HTTP-EQUIV="Content-Type" CONTENT="text/html; charset=iso-8859-1">
<LINK REL="StyleSheet" HREF="bipnt.css">
</HEAD>

<BODY>
<DIV STYLE="PAGE-BREAK-AFTER: ALWAYS">
<H1>SampleTransform node</H1>
<P>
<IMG SRC="C:\Program Files\IBM MQSeries Integrator 2.0\Tool\images\SampleTransform84.gif"><BR>
<I>The SampleTransform node icon</I>
<P>This page contains information on:

<BR><BR>
<LI><A HREF="#ST1">SampleTransform node terminals</LI></A>
<LI><A HREF="#ST2">Related topics</LI></A>
<BR><BR>
The SampleTransform node transforms a message from one format to another.

<P ALIGN="LEFT">
The SampleTransform node has one input terminal called in and two output
terminals, out and failure. The message received on the input terminal
is modified and propagated to the out terminal if the modification
is successful, or to the failure terminal if an error is encountered.<P>

<H3><A NAME="ST1">SampleTransform terminals</H3>
<P>
<TABLE BORDER="1" CELLSPACING="1" WIDTH="80%">
<TR>
<TD ROWSPAN="1" COLSPAN="1">
<P>in</TD>
<TD ROWSPAN="1" COLSPAN="1">
<P>The input terminal that accepts a message for processing by the node.</TD>
</TR>
<TR>
<TD ROWSPAN="1" COLSPAN="1">
<P>out</TD>
<TD ROWSPAN="1" COLSPAN="1">
<P>The output terminal to which the message is propagated if the
transform succeeds.</TD>
</TR>
<TR>
<TD ROWSPAN="1" COLSPAN="1">
<P>failure</TD>
<TD ROWSPAN="1" COLSPAN="1">
<P>The output terminal to which the message is propagated if the
transform fails.</TD>
</TR>
</TABLE>
<P>

<H3><A NAME="ST2">Related topics</H3></A>
<P>
<UL>
<LI>
<A HREF="C:\Program Files\IBM MQSeries Integrator 2.0\Tool\help\com\ibm\ivm\mqitool\
extensions\MessageProcessingNodeType_Compute.htm">IBM Primitive Compute node</A>
</UL>
<P>

</BODY>
</HTML>
```

*Figure 16. Sample plug-in node help file*

The displayed help might appear as follows:



SampleTransform node

*The SampleTransform node icon*

This page contains information on:

- SampleTransform node terminals
- Related topics

The SampleTransform node transforms a message from one format to another.

The SampleTransform node has one input terminal called in and two output terminals, out and failure. The message received on the input terminal is modified and propagated to the out terminal if the modification is successful, or to the failure terminal if an error is encountered.

SampleTransform terminals

| | |
|---|---|
| in | The input terminal that accepts a message for processing by the node. |
| out | The output terminal to which the message is propagated if the transform succeeds. |
| failure | The output terminal to which the message is propagated if the transform fails. |

Related topics

- IBM Primitive Compute node

## Creating a properties file for the node

This subtask is optional. You must create this file if you want to enable translation to other national languages for the properties of your node (for example, the descriptive text) that are displayed at the Control Center interface. The sample plug-in supplied with MQSeries Integrator includes a properties file, `SampleTransform.properties`.

The file must follow the required naming conventions: the name must be `<name>_<locale>.properties` where:

- `<name>` is the name of the node the value of `xmi.label` in the <MessageProcessingNodeType> tag in the XML interface definition file (for example, SampleTransform).
- `<locale>` is the two character country code and two character language code.

  This part of the name is optional: it can be omitted if the properties file is in the default locale of the system on which you are running. For example, if you are using the sample plug-in supplied, and your default locale is `de_DE`, the file `SampleTransform_de_DE.properties` is searched for. If this does not exist, `SampleTransform.properties` is referenced. If this latter file exists and its contents have been set up for locale `de_DE`, the translated values are displayed. If its contents are unchanged, the values defined are displayed regardless of the language in which they are written.

If a properties file exists for the node, values can be defined and referenced by the XML interface definition file for the node.

The sample node properties file is illustrated in Figure 17 on page 105.

```
shortDescription = Sample fixed transformation of an input message.
longDescription = The SampleTransform node is an example of a plug-in
 message processing node.
nodeTraceSetting = Trace setting for the node
nodeTraceOutfile = Trace output file name
```

*Figure 17. Sample plug-in node properties file*

The general form of the contents of the properties file is:

```
<keyname> = text describing attribute
```

`<keyname>` is the value assigned to the corresponding property of a tag (for example, the <MessageProcessingNodeType> tag) in the XML interface definition file (described in "The XML interface definition file" on page 93). The `keyname` must match the value set in the interface definition file. The descriptive text can be translated to the language required by your users.

## Creating a PropertyEditor

This subtask is optional. The supplied property editors validate and process the following types of properties:

- String
- Integer
- Date
- Time
- Float
- Long
- Double
- Boolean
- Timestamp

If you want to define properties of other datatypes, you must create your own property editor. This must follow the java.beans.PropertyEditor convention. The class must implement this interface and must be named <type>PropertyEditor or <type>Editor, where <type> is the value of the type property on the corresponding <Attribute> tag in the XML interface definition file.

The three types of property editor (text-based, graphics-based, and component-based) are supported.

- A property editor named <type>Editor is wrapped with the WrapperPropertyEditor class provided in the tool. This class supports the text-based property editor mode, and handles writing the Attribute value to the XML document as a string (encoded if necessary).
- If a property editor is to support the graphics or component-based property editor modes, it must be named <type>PropertyEditor. The property editor then must use the setAttribute() and getAttribute() methods in the org.w3c.dom.Element package to write the Attribute value to the XML document.

The setValue() method on the property editor must be supported by all three types of property editors. It is called with the org.w3c.dom.Element that represents the Attribute that is being edited.

The property editor works with a full copy (a clone) of the property. This allows it to support the full range of actions to apply, cancel, and undo any changes made to the properties by the user of the properties dialog. The final action of the user to accept the changes made in the dialog (**Apply** or **OK**) causes the original document to be updated.

The property editor has access to the entire XML document of which this node is a part. It is therefore able to access any relevant information defined within that document.

Figure 18 on page 107 illustrates an extract of Java code for a property editor that handles the `<Attribute xmi.label="nodeTraceSetting">` from the
| SampleTransform node with `type="TraceSetting"`. The full program is provided
| with the product as a sample called TraceSettingPropertyEditor.java in the
| installation directory (see “Sample code” on page 88).

The property editor is named <type>PropertyEditor, so it must call the setAttribute() and getAttribute() methods to set and get the Attribute’s value. Because it is an enumerated value, this property editor uses the getTags() method to get the valid values, and they are displayed in a comboBox (the call to getTags() and the use of the comboBox is handled by the tool).

When you have created your property editor, you must compile it (using, for example, `javac`) to create the `.class` file or files. You must ensure that you add the jar files for any class that you use in the Property editor to the class path (that is, to the CLASSPATH system environment variable) before you compile. For example, if you are using the sample property editor, you must add `<mqsi_root>\classes\xml4j.jar`.

When you have successfully compiled your property editor, you must store the compiled files in the correct directory (specified in “Storing the files in the MQSeries Integrator directory structure” on page 109). You must also add this directory to the class path.

## Creating a Customizer

This subtask is optional. If you need to control how the properties of your node are displayed, and how the attributes are written, and neither the default property editors nor a custom property editor support these requirements, you must provide a customizer for your node.

The customizer follows the conventions of the java.beans.Customizer. The class must implement this interface and must be named `<package>.<name>Customizer` where:

- `<package>` is the value set for `package` in the <MessageProcessingNodeType> tag in the XML interface definition file.
- `<name>` is the value set for `xmi.label` in the <MessageProcesssingNodeType> tag in the XML interface definition file.

```
public class TraceSettingPropertyEditor implements
  java.beans.PropertyEditor {
 Vector propertyChangeListeners = new Vector();
 Element element = null;

 public String getAsText() {
     return element.getAttribute("value");
 }

 public java.lang.String[] getTags() {
   String[] tags = {"0","1","2"};
          return tags;
 }

 public void setAsText(String value) {
          String oldValue = element.getAttribute("value");
   element.setAttribute("value",value);
   notifyListeners(oldValue);
 }

 public void setValue(Object value) {
          String oldValue = null;
   if(element != null) {
      oldValue = element.getAttribute("value");
   }
   element = (Element)value;
   notifyListeners(oldValue);
 }

 public Object getValue() {
          return element;
 }
}
```

*Figure 18. PropertyEditor sample code*

A Customizer for the SampleTransform node would therefore be called `com.isv.SampleTransformCustomizer`.

**Note:** This name is consistent with the content of the sample XML interface definition file and sample java files supplied with the product. It is not consistent with the recommended naming convention.

The setObject() method on the Customizer is called with the org.w3c.dom.Element that represents the MessageProcessingNode that is of the appropriate type.

The customizer works with a full copy (a clone) of the message processing node document. This allows it to support the full range of actions to apply, cancel, and undo any changes made to the properties by the user of the customizer dialog. The final action of the user to accept the changes made in the dialog (**Apply** or **OK**) causes the original document to be updated.

The customizer has access to the entire XML document of which this node is a part. It is therefore able to access any relevant information defined within that document.

Figure 19 on page 108 shows an extract of Java code for a customizer for the sample MessageProcessingNodeType named “SampleSwitch”. The sample customizer uses a radio button group and a file dialog to get values for attributes called “nodeTraceSetting” and “nodeTraceOutfile”. Only a part of the setObject() method (which is called by the tool upon instantiation of the customizer) and the method used to write the “nodeTraceSetting” attribute value to the XML document

```
public class SampleSwitchCustomizer extends Panel
 implements Customizer, ItemListener, ActionListener {
   private Vector propertyChangeListeners = new Vector();
   private Element rootNode = null;

   public void setObject(Object bean) {
    rootNode = (Element) bean;

    // get Attributes for this node
    NodeList Attributes = rootNode.getElementsByTagName("Attribute");
    Element typeref = null;

    for(int idx = 0; idx < Attributes.getLength(); idx++) {
      Element attribute = (Element)Attributes.item(idx);
      if(attribute.getAttribute("xmi.label").equals(TraceFileAttributeName)) {
        TraceFileAttribute = attribute;
      }
      if(attribute.getAttribute("xmi.label").equals(TraceSettingAttributeName)) {
        TraceSettingAttribute = attribute;
      }

    }
   ...
   }

   private void setTraceSetting(int setting) {
    //set Attribute value and notify listeners
    String oldValue = TraceSettingAttribute.getAttribute("value");
    String newValue = Integer.toString(setting);
    if(!oldValue.equals(newValue)) {
      //only if the value has changed
      TraceSettingAttribute.setAttribute("value",newValue);
      notifyListeners(oldValue, newValue);
    }
   }

}
```

*Figure 19. Customizer sample code*

| is shown here. The full source code is included with the product as a sample program called SampleSwitchCustomizer.java in the installation directory (see "Sample code" on page 88). SampleSwitchCustomizerBeanInfo.java has also been provided in order to use this customizer class as a bean.

When you have created your customizer, you must compile it (using, for example, `javac`) to create the `.class` file or files. You must ensure that you add the jar files for any class that you use in the customizer to the class path (that is, to the the CLASSPATH system environment variable) before you compile. For example, if you are using the sample customizer, you must add `<mqsi_root>\classes\xml4j.jar` and `<mqsi_root>\classes\swingall.jar`.

When you have successfully compiled your customizer, you must store the compiled files in the correct directory (specified in "Storing the files in the MQSeries Integrator directory structure" on page 109). You must also add the directory to the class path.

## Installing a new message processing node in the Control Center

To complete this task you must complete two subtasks:

- Placing the files you have created in the directories from which they can be accessed.
- Defining the node to the Configuration Manager's configuration repository to enable access by all users of the Control Center.

### Storing the files in the MQSeries Integrator directory structure

When you have created the files required by your new node, you must install them in specific directories to make them accessible to MQSeries Integrator. These directories are all subdirectories of the MQSeries Integrator home directory (into which MQSeries Integrator was installed on this system), identified by the label <mqsi_root>.

You are recommended to stop the Control Center before you copy these files to the appropriate directories.

- You should copy the files rather than move them. When you check in the new node in the Control Center, the files are removed from the directory shown below and stored in the configuration repository. Checking out the node does not bring them back, so you must ensure that you have a copy for making any future changes to the node.
- You must place the XML node interface file and the WDP file in the directory `<mqsi_root>\Tool\repository\private\`*hostname*\ *Queue_Manager_name*`\MessageProcessingNodeType` where:
  - *hostname* is the name of the system hosting the Configuration Manager
  - *Queue_Manager_name* is the name of the Configuration Manager's queue manager

  You have to specify these two values when you first establish the connection between the Control Center and the Configuration Manager. The Configuration Manager must have been created and started before the connection can complete.

  These files are retrieved from disk and stored in the configuration repository when you check in the new node (this task is described in "Defining the node to the configuration repository" on page 110). You must therefore store these files on the system on which you will invoke the Control Center to define the new node to the configuration repository.
- You must place the remaining files as follows:
  - The properties file, the property editor, and the customizer classes must be placed in `<mqsi_root>\Tool\<package>` where `<package>` is the location identified by the package attribute on the <MessageProcessingNodeType> tag in the XML interface definition file (with period delimiters replaced by backslash characters \). For example, if `<package>` is set to `com.isv`, you must store these files in `<mqsi_root>\Tool\com\isv`.
  - The help file must be placed in the subdirectory `<mqsi_root>\Tool\help\<package>` where `<package>` is the location identified by the package attribute of the <MessageProcessingNodeType> tag in the XML interface definition file (with period delimiters replaced by backslash characters \). For example, if `<package>` is set to `com.isv`, you

must store this file in `<mqsi_root>\Tool\help\com\isv`. Note that you have to create the directory structure under `Tool/help`; it is not created for you.

– The icon file or files must be placed in the subdirectory `<mqsi_root>\Tool\images`.

You must store these files in these directories on the local system of every user of the Control Center who needs to access the information about the new node. These files are only accessed locally to each instance of the Control Center: this information is not held centrally in the configuration repository for shared access.

## Defining the node to the configuration repository

When you have completed the definition of the files required by your node, and have installed the files in the appropriate directories, you must make these definitions available to the Control Center. You **must** complete the tasks detailed in "Defining the node interface" on page 93 and in "Storing the files in the MQSeries Integrator directory structure" on page 109 before you start this task.

1. Start the Control Center. The user ID you are using must be a member of the MQSeries Integrator group **mqbrdevt**. You are recommended to use the superuser IBMMQSI2 to complete this task[1]. This causes your new node to be locked under the same user ID as all the supplied IBM primitive nodes. If you do not use this user ID, the definition files in the configuration repository might be accidentally unlocked, and therefore open to unauthorized update.
2. Select the Message Flows view.
3. Select an existing Message Flow Category, or create a new one.
4. Right-click the selected category, and select *Add->Message Flow*.

   A list box is displayed showing all existing IBM-supplied primitive nodes and any defined message flows you have installed following the instructions provided.
5. Select the message flow.

   This node now appears within the message flow category you selected in the tree view in the left-hand pane.
6. Select your new node, and right-click. Select *Check In*.
7. Right-click again, and select *Lock*. Then right-click again and select *Check In* for a second time. After this check-in, the interface and WDP definition files disappear from the local directory and go into the shared repository, where they are available to all users of the Control Center. However, users can only use this new node if they have installed the additional files (icons, properties files, and so on) on their own system.

[1] You must take care if you change logon IDs to complete this task. Changing logon IDs can affect the operation of the Configuration Manager's queue manager if it is on this system, but is not running as a Windows NT service. See the *MQSeries Integrator Administration Guide* for more information about queue manager operation (Chapter 2) and the superuser IBMMQSI2 (Chapter 4).

### Updating a message processing node

If you need to update the XML interface definition file or any of the support files for a node you have created, you must follow these steps:

1. Start the Control Center. If you locked the node using the MQSeries Integrator superuser ID IBMMQSI2, you must be logged on with this user ID to make any changes[1]. If not, you can use any user ID that is a member of the MQSeries Integrator group **mqbrdevt**.
2. Select the Message Flows view.
3. Select the node that you want to update.
4. Check out, unlock and delete the selected primitive.
5. End your Control Center session.
6. Install the updated files for this node into the appropriate directories (described in "Storing the files in the MQSeries Integrator directory structure" on page 109). If you have updated files other than the XML interface definition file and the WDP file, you must remember to install the updated files on every system on which the Control Center is used.
7. Add your node back into the workspace following the instructions given in "Defining the node to the configuration repository" on page 110.

## Summary

The following section summarizes the tasks you need to perform to install the supplied sample plug-in node on the broker, and to represent the SampleTransform to the Control Center (assuming the Windows NT platform).

1. Check that you have the right prerequisites (compiler, "Samples and SDK component", and the necessary authorizations)
2. Compile the sample plug-in node BipSampPluginNode.c
3. Rename the resulting DLL as BipSampPluginNode.lil
4. Copy BipSampPluginNode.lil to the bin directory of any systems on which the node will be used.
5. Stop and restart the brokers on these systems to enable them to recognise the new lil file.
6. Copy and edit ComIbmSampleTransform
7. Store your copy of ComIbmSampleTranform in `<mqsi_root>\Tool\repository\private\ hostname\Queue_Manager_name \MessageProcessingNodeType`
8. Copy and edit ComIbmSampleTransform.wdp
9. Store your copy of ComIbmSampleTranform.wdp in `<mqsi_root>\Tool\repository\private\ hostname\Queue_Manager_name \MessageProcessingNodeType`
10. Define an icon for the node
11. Store in `<mqsi_root>\Tool\images` on the local system of every user of the Control Center who needs to access information about the new node.
12. Create an online help file

13. Copy bipnt.css (the style sheet for the online help files) into the same directory as the help
14. Store in `<mqsi_root>\Tool\help\package` on the local system of every user of the Control Center who needs to access information about the new node.
15. Create a directory structure matching the value of the `<package>` attribute in the XML interface definition file under `<mqsi_root>\Tool\help\`. Do this on the local system of every user of the Control Center who needs to access information about the new node.
16. Copy and edit SampleTransform.properties
17. Create property editor.
18. Add jar files for any classes you use in the property editor to the CLASSPATH system environment variable.
19. Compile property editor
20. Store in `<mqsi_root>\Tool\help\ <package>` on the local system of every user of the Control Center who needs to access information about the new node.
21. Add this directory to the CLASSPATH system environment variable.
22. Create customizer
23. Add jar files for any classes you use in the customizer to the CLASSPATH system environment variable.
24. Compile customizer
25. Store in `<mqsi_root>\Tool\help\ <package>` on the the local system of every user of the Control Center who needs to access information about the new node.
26. Add this directory to the CLASSPATH system environment variable.
27. Log on as IBMMQSI2
28. Start Control Center (make sure broker and Configuration Manager are also started)
29. Select Message Flows
30. Select a category or create a new one
31. Add the node to the category
32. Select node and check in.
33. Select node and Lock
34. Select node and check in again.

# Chapter 8. Node implementation and utility functions

The plug-in interface for a message flow node consists of:

1. A set of implementation functions that provide the functionality of the plug-in node. These functions are invoked by the message broker. The implementation functions are mandatory, and if not supplied by the developer will cause an exception at runtime.
2. A set of utility functions, the purpose of which is to create resources in the message broker or to request a service of the broker. These utility functions can be invoked by a plug-in node.

These functions are defined in the header file **BipCni.h**.

This chapter contains:

See also Chapter 10, "Node and parser utilities" on page 167 for additional utility functions that can be used by a plug-in node.

## Node implementation function overview

The plug-in needs to implement a function interface for the message broker to invoke during runtime execution. This includes functions to create a local context whenever a node instance is created, the setting and retrieval of attribute values, the function to actually perform the processing of the node itself and functions to examine messages.

The following functions are mandatory, and must be implemented by the developer.

Follow the page references to see the detailed descriptions of each implementation function.

### Mandatory functions

| | |
|---|---|
| **cniCreateNodeContext** | page 117 |
| **cniDeleteNodeContext** | page 117 |
| **cniEvaluate** | page 118 |
| **cniGetAttribute** | page 118 |
| **cniGetAttributeName** | page 119 |
| **cniSetAttribute** | page 120 |

## Node utility function overview

The following system-provided functions allow the C plug-in to create or define message broker objects, such as node factories, nodes, and terminals. Functions are also provided to send messages to an output terminal for propagation to connected nodes and to examine message content.

Follow the page references to see the detailed descriptions of each utility function.

## Initialization and resource creation

| | |
|---|---|
| **cniCreateNodeFactory** | page 127 |
| **cniDefineNodeClass** | page 128 |
| **cniCreateInputTerminal** | page 127 |
| **cniCreateOutputTerminal** | page 128 |
| **cniIsTerminalAttached** | page 134 |
| **cniGetBrokerInfo** | page 133 |

## Message management

| | |
|---|---|
| **cniCreateMessage** | page 127 |
| **cniDeleteMessage** | page 129 |
| **cniFinalize** | page 132 |
| **cniGetMessageContext** | page 133 |
| **cniPropagate** | page 136 |

## Message buffer access

| | |
|---|---|
| **cniBufferByte** | page 122 |
| **cniBufferPointer** | page 123 |
| **cniBufferSize** | page 123 |
| **cniWriteBuffer** | page 142 |

## Syntax element navigation

| | |
|---|---|
| **cniRootElement** | page 137 |
| **cniParent** | page 135 |
| **cniNextSibling** | page 135 |
| **cniPreviousSibling** | page 136 |
| **cniFirstChild** | page 133 |
| **cniLastChild** | page 135 |
| **cniSearchElement group** | page 137 |

## Syntax element access

| | |
|---|---|
| **cniAddAfter** | page 121 |
| **cniAddBefore** | page 122 |
| **cniAddAsFirstChild** | page 121 |
| **cniAddAsLastChild** | page 122 |
| **cniCopyElementTree** | page 123 |
| **cniCreateElementAfter** | page 124 |
| **cniCreateElementAfterUsingParser** | page 124 |
| **cniCreateElementBefore** | page 126 |
| **cniCreateElementBeforeUsingParser** | page 126 |
| **cniCreateElementAsFirstChild** | page 124 |
| **cniCreateElementAsFirstChildUsingParser** | page 125 |
| **cniCreateElementAsLastChild** | page 125 |
| **cniCreateElementAsLastChildUsingParser** | page 125 |
| **cniDetach** | page 129 |
| **cniElementName** | page 129 |
| **cniElementType** | page 130 |
| **cniElementValue group** | page 130 |
| **cniElementValueState** | page 131 |
| **cniElementValueType** | page 131 |
| **cniElementValueValue** | page 132 |
| **cniGetParserClassName** | page 134 |
| **cniSetElementName** | page 138 |
| **cniSetElementType** | page 138 |
| **cniSetElementValue group** | page 139 |
| **cniSetElementValueValue** | page 140 |

## SQL statement handling

| | |
|---|---|
| **cniSqlCreateStatement** | page 140 |
| **cniSqlExecute** | page 141 |
| **cniSqlSelect** | page 142 |
| **cniSqlDeleteStatement** | page 141 |

## Node implementation function interface

The plug-in needs to implement a function interface for the message broker to invoke during runtime execution. This includes functions to create a local context whenever a node instance is created, the setting and retrieval of attribute values, the function to actually perform the processing of the node itself and functions to examine messages.

The following functions must be implemented, using the prototypes as described.

The node implementation functions are defined in the header file **BipCni.h**.

## cniCreateNodeContext

Creates any plug-in context for an instance of a node object. It is invoked by the message broker whenever an instance of a node object is constructed. Nodes are constructed when a message flow is deployed by the broker.

The responsibilities of the plug-in are to:

1. (Optionally) verify that the name of the node specified in the `nodeName` parameter is supported by the factory.
2. Allocate any node instance specific data areas (such as context) that might be required (for attribute data and terminals, for example).
3. Perform any additional resource acquisition or initialization that might be required for the processing of the node.
4. Return the address of the context to the calling function. Whenever a plug-in implementation function for this node instance is invoked, the appropriate context is passed as an argument to that function. This means that a plug-in node developed in C need not maintain its own static pointers to per-instance data areas.

```
CciContext* cniCreateNodeContext(
  CciFactory*  factoryObject,
  CciChar*     nodeName,
  CciNode*     nodeObject);
```

| | |
|---|---|
| `factoryObject` | The address of the factory object that owns the node being created (input). |
| `nodeName` | The name of the node being created (input). |
| `nodeObject` | The address of the node object that has just been created (input). |

**Return values:** If successful, the address of the plug-in context is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned.

## cniDeleteNodeContext

Deletes any plug-in context for an instance of a node object. It is invoked by the message broker whenever an instance of a node object is destroyed. A message flow node may be deleted when reconfiguring or redeploying a broker.

The responsibilities of the plug-in are to:

1. Release any node instance specific data areas (such as context) that were acquired at construction or during node processing.

2. Release any additional resources that might have been acquired for the processing of the node.

```
void cniDeleteNodeContext(CciContext* context);
```

| | |
|---|---|
| `context` | The address of the plug-in context for the instance of the node, as created and returned by the **cniCreateNodeContext** function (input). |

**Return values:** None.

## cniEvaluate

Performs node processing. It is invoked by the message broker when a message is received on one of the input terminals of an instance of a node object. This function forms the main processing logic of the message flow node.

The responsibilities of the plug-in are to:

1. Process the message in accordance with the values of any attributes on the node instance.
2. Process the message based on content, if desired.
3. Propagate the message to any appropriate output terminals.
4. Throw an exception if an error occurs.

```
void cniEvaluate(
  CciContext  *context,
  CciMessage  *destinationList,
  CciMessage  *exceptionList,
  CciMessage  *message);
```

| | |
|---|---|
| `context` | The address of the plug-in context for the instance of the node, as created by the plug-in and returned by the **cniCreateNodeContext** function (input). |
| `destinationList` | The address of the input destination list object (input). |
| `exceptionList` | The address of the exception list for the message (input). |
| `message` | The address of the input message object (input). |

**Return values:** None.

## cniGetAttribute

Gets the value of an attribute on a specific node instance. It is invoked by the message broker when a report request is received that causes a retrieval of the value of a node attribute. The broker will have verified that the attribute name is valid for the node.

The responsibilities of the plug-in are to:

1. Return a character representation of the attribute value.
2. Return a null string if the data is sensitive and should not be displayed in reports.
3. Throw an exception if an error occurs.

```
int cniGetAttribute(
  CciContext*  context,
  CciChar*     attrName,
  CciChar*     buffer,
  int          bufsize);
```

| | |
|---|---|
| `context` | The address of the plug-in context for the instance of the node, as created by the plug-in and returned by the **cniCreateNodeContext** function (input). |
| `attrName` | The name of the attribute for which the value is to be retrieved (input). |
| `buffer` | The address of a buffer into which the attribute value is copied (output). |
| `bufsize` | The length, in bytes, of the buffer specified in the `buffer` parameter (input). |

**Return values:** If successful, zero is returned, and the character representation of the value of the attribute is returned in the specified buffer. If the name of the attribute does not identify one supported by the plug-in, a non-zero value is returned.

## cniGetAttributeName

Returns the name of a node attribute by an index. It is invoked by the message broker when it requires the names of attributes supported by a particular instance of a node. The function must guarantee to return the attributes in a known, defined order and to return the attribute name represented by the index parameter.

```
int cniGetAttributeName(
  CciContext*  context,
  int          index,
  CciChar*     buffer,
  int          bufsize);
```

| | |
|---|---|
| `context` | The address of the plug-in context for the instance of the node, as created by the plug-in and returned by the **cniCreateNodeContext** function (input). |
| `index` | Specifies the index of the attribute name (input). The index of the attributes starts from zero. |
| `buffer` | The address of a buffer into which the attribute name will be copied (output). |
| `bufsize` | The length, in bytes, of the buffer specified in the `buffer` parameter (input). |

**Return values:** If successful, zero is returned, and the name of the attribute is returned in the supplied buffer. If the end of the list of attributes is reached, a non-zero value is returned.

## cniSetAttribute

Sets the value of an attribute on a specific node instance. It is invoked by the message broker when a configuration request is received that attempts to set the value of a node attribute. A plug-in will receive requests to set attributes for the base. If an unknown attribute value is received, this function **must** return a non-zero value; this causes the broker to process the request correctly.

The responsibilities of the plug-in are to:

1. Verify that the value of the attribute is correctly specified. If not, a configuration exception should be thrown using the **cniThrowException** function.
2. Store the value of the attribute within the context, which should have been allocated in the **cniCreateNodeContext** function.
3. Throw a configuration exception if an error occurs, using the **cniThrowException** function.

```
int cniSetAttribute(
  CciContext*  context,
  CciChar*     attrName,
  CciChar*     attrValue);
```

| | |
|---|---|
| `context` | The address of the plug-in context for the instance of the node, as created by the plug-in and returned by the **cniCreateNodeContext** function (input). |
| `attrName` | The name of the attribute for which its value is to be set (input). |
| `attrValue` | The value of the attribute (input). |

**Return values:** If successful, zero is returned. If the name of the attribute does not identify one supported by the plug-in, a non-zero value is returned.

## Node utility function interface

The following system-provided functions allow the C plug-in to create or define message broker objects, such as node factories, nodes and terminals. Functions are also provided to send messages to an output terminal for propagation to connected nodes and to examine message content.

The node utility functions are defined in the header file **BipCni.h**.

### cniAddAfter

Adds an unattached syntax element after a specified syntax element. The currently unattached syntax element, and any child elements it might possess, is connected to the syntax element tree after the specified target element. The newly added element becomes the **next sibling** of the target element. The target element must be attached to a tree (that is, it must have a parent element).

```
void cniAddAfter(
int*         returnCode,
CciElement*  targetElement,
CciElement*  newElement);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| targetElement | Specifies the address of the target syntax element object (input). |
| newElement | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

### cniAddAsFirstChild

Adds an unattached syntax element as the first child of a specified syntax element. The currently unattached syntax element, and any child elements it might possess, is connected to the syntax element tree as the **first child** of the specified target element. The target element need not be attached.

```
void cniAddAsFirstChild(
  int*         returnCode,
  CciElement*  targetElement,
  CciElement*  newElement);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| targetElement | Specifies the address of the target syntax element object (input). |
| newElement | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniAddAsLastChild

Adds an unattached syntax element as the last child of a specified syntax element. The currently unattached syntax element, and any child elements it might possess, is connected to the syntax element tree as the **last child** of the specified target element. The new element need not be attached.

```
void cniAddAsLastChild(
  int*         returnCode,
  CciElement*  targetElement,
  CciElement*  newElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `newElement` | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniAddBefore

Adds an unattached syntax element before a specified syntax element. The currently unattached syntax element, and any child elements it might possess, is connected to the syntax element tree before the specified target element. The newly added element becomes the **previous sibling** of the target element. The target element must be attached to a tree (that is, it must have a parent element).

```
void cniAddBefore(
  int*         returnCode,
  CciElement*  targetElement,
  CciElement*  newElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `newElement` | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniBufferByte

Gets a single byte from the data buffer associated with (and owned by) the message object specified in the message argument. The value of the index argument indicates which byte in the byte array is to be returned.

```
CciByte cniBufferByte(
  int*         returnCode,
  CciMessage*  message,
  CciSize      index);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |

| | |
|---|---|
| `message` | Specifies the address of the message object for which the size of the data buffer is to be returned (input). |
| `index` | The offset to use as an index into the buffer (input). |

**Return values:** The requested byte is returned. If an error occurred the `returnCode` parameter indicates the reason for the error.

## cniBufferPointer

Get a pointer to the data buffer associated with (and owned by) the message object specified in the message argument.

```
const CciByte* cniBufferPointer(
  int*         returnCode,
  CciMessage*  message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `message` | Specifies the address of the message object for which the address of the data buffer is to be returned (input). |

**Return values:** If successful, the address of the data buffer is returned. Otherwise, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniBufferSize

Gets the size of the data buffer associated with (and owned by) the message object specified in the message argument.

```
CciSize cniBufferSize(
  int*         returnCode,
  CciMessage*  message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `message` | Specifies the address of the message object for which the size of the data buffer is to be returned (input). |

**Return values:** The size of the buffer in bytes. If an error occurred, zero (CCI_FAILURE) is returned, and the `returnCode` parameter indicates the reason for the error.

## cniCopyElementTree

Copies a part of the element tree from the source element to the target element. Only the child elements of the source element are copied. Before the copy is performed, all existing child elements of the target element are deleted, to be replaced by the child elements of the source element.

```
void cniCopyElementTree(
  int*         returnCode,
  CciElement*  sourceElement,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `sourceElement` | Specifies the address of the source syntax element object (input). |

`targetElement` Specifies the address of the target syntax element object (input).

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniCreateElementAfter

Creates a new syntax element and inserts it after the specified syntax element. The new element becomes the **next sibling** of the specified element.

```
CciElement* cniCreateElementAfter(
  int*        returnCode,
  CciElement*  targetElement);
```

`returnCode` This parameter receives the return code from the function (output).

`targetElement` The address of the element object (input).

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementAfterUsingParser

Creates a new syntax element, inserts it after the specified syntax element, and associates it with the specified parser class name. The new element becomes the **next sibling** of the specified element.

In MQSeries Integrator Version 2, a portion of the syntax element tree that is owned by a parser may **only** have its effective root at the first generation of elements (that is, as *immediate children of root*). The plug-in interface does not restrict the ability to create a subtree that appears to be owned by a different parser. However, it is not possible to serialize these element trees into a bitstream when outputting a message.

```
CciElement* cniCreateElementAfterUsingParser(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  parserClassName);
```

`returnCode` This parameter receives the return code from the function (output).

`TargetElement` The address of the element object (input).

`parserClassName` The name of the parser class (input).

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementAsFirstChild

Creates a new syntax element as the first child of the specified syntax element.

```
CciElement* cniCreateElementAsFirstChild(
int*        returnCode,
CciElement*  targetElement);
```

|  |  |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | The address of the element object (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementAsFirstChildUsingParser

Creates a new syntax element as the first child of the specified syntax element, and associates it with the specified parser class name.

In MQSeries Integrator Version 2, a portion of the syntax element tree that is owned by a parser may **only** have its effective root at the first generation of elements (that is, as *immediate children of root*). The plug-in interface does not restrict the ability to create a subtree that appears to be owned by a different parser. However, it is not possible to serialize these element trees into a bitstream when outputting a message.

```
CciElement* cniCreateElementAsFirstChildUsingParser(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  parserClassName);
```

|  |  |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | The address of the element object (input). |
| `parserClassName` | The name of the parser class (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementAsLastChild

Create a new syntax element as the last child of the specified syntax element.

```
CciElement* cniCreateElementAsLastChild(
  int*         returnCode,
  CciElement*  targetElement);
```

|  |  |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | The address of the element object (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementAsLastChildUsingParser

Creates a new syntax element as the last child of the specified syntax element, and associates it with the specified parser class name.

In MQSeries Integrator Version 2, a portion of the syntax element tree that is owned by a parser may **only** have its effective root at the first generation of elements (that is, as *immediate children of root*). The plug-in interface does not restrict the ability to create a subtree that appears to be owned by a different parser. However, it is not possible to serialize these element trees into a bitstream when outputting a message.

```
CciElement* cniCreateElementAsLastChildUsingParser(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  parserClassName);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | The address of the element object (input). |
| `parserClassName` | The name of the parser class (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementBefore

Creates a new syntax element and inserts it before the specified syntax element. The new element becomes the **previous sibling** of the specified element and shares the same parent element.

```
CciElement* cniCreateElementBefore(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | The address of the target element object (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateElementBeforeUsingParser

Creates a new syntax element, inserts it before the specified syntax element, and associates it with the specified parser class name. The new element becomes the **previous sibling** of the specified element.

In MQSeries Integrator Version 2, a portion of the syntax element tree that is owned by a parser may **only** have its effective root at the first generation of elements (that is, as *immediate children of root*). The plug-in interface does not restrict the ability to create a subtree that appears to be owned by a different parser. However, it is not possible to serialize these element trees into a bitstream when outputting a message.

```
CciElement* cniCreateElementBeforeUsingParser(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  parserClassName);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | The address of the element object (input). |

`parserClassName` The name of the parser class (input).

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateInputTerminal

Creates an input terminal on an instance of a node object, returning the address of the terminal object that was created. The terminal object is destroyed by the message broker when its owning node is destroyed. Note that this function must be called only from within the implementation function **cniCreateNodeContext**.

```
CciTerminal* cniCreateInputTerminal(
  int*      returnCode,
  CciNode*  nodeObject,
  CciChar*  name);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `nodeObject` | Specifies the address of the instance of the node object on which the input terminal is to be created (input). The address is returned from **cniCreateNodeContext**. |
| `name` | Specifies a name for the terminal being created (input). |

**Return values:** If successful, the address of the node terminal object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned.

## cniCreateMessage

Creates a new output message object.

```
CciMessage* cniCreateMessage(
  int*                returnCode,
  CciMessageContext*  messageContext);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `messageContext` | The address of the context for the message (input). Use **cniGetMessageContext** to get the context from an incoming message (one received in the **cniEvaluate** function, for instance). |

**Return values:** If successful, the address of the message object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniCreateNodeFactory

Creates a node factory in the message broker engine. A single instance of the named message flow node factory is created.

This function must be invoked only in the initialization function **bipGetMessageFlowNodeFactory** which is called when the 'lil' is loaded by the message broker. If **cniCreateNodeFactory** is invoked at any other time, the results are unpredictable.

```
CciFactory* cniCreateNodeFactory(
  int*      returnCode,
  CciChar*  name);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `name` | Specifies the name of the factory being created (input). |

**Return values:** If successful, the address of the node factory object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned, and the `returnCode` parameter indicates the reason for the error.

## cniCreateOutputTerminal

Creates an output terminal on an instance of a node object, returning the address of the terminal object that was created. The terminal object is destroyed when its owning node is destroyed. Note that this function must be called from within the implementation function **cniCreateNodeContext**.

```
CciTerminal* cniCreateOutputTerminal(
  int*      returnCode,
  CciNode*  nodeObject,
  CciChar*  name);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `nodeObject` | Specifies the address of the instance of the node object on which the output terminal is to be created (input). The address is returned from **cniCreateNodeContext**. |
| `name` | Specifies a name for the terminal being created (input). |

**Return values:** If successful, the address of the node terminal object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned.

## cniDefineNodeClass

Defines a node class, as specified by the `name` parameter, which is supported by the node factory specified as the `factoryObject` parameter. The parameter `functbl` is a pointer to a CNI_VFT structure that contains pointers to the C plug-in implementation functions (those functions that provide the function of the node itself).

```
void cniDefineNodeClass(
  int*         returnCode,
  CciFactory*  factoryObject,
  CciChar*     name,
  CNI_VFT*     functbl);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `factoryObject` | Specifies the address of the factory object which is to support the named node (input). The address is returned from **cniCreateNodeFactory**. |
| `name` | The name of the node to be defined (input). The name of the node must end with the characters “Node”. |

| | |
|---|---|
| `functbl` | The address of the CNI_VFT structure that contains pointers to the plug-in implementation functions (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniDeleteMessage

Deletes the specified message object.

```
void cniDeleteMessage(
  int*         returnCode,
  CciMessage*  message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `message` | Specifies the address of the message object to be deleted (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniDetach

Detaches the specified syntax element from the syntax element tree. The element is detached from its parent and siblings, but any child elements are left attached.

```
void cniDetach(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the syntax element object to be detached (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniElementName

Gets the value of the ‘name’ attribute for the specified syntax element. The syntax element name will have been set previously using **cniSetElementName** or **cpiSetElementName**.

```
CciSize            cniElementName(
  int*             returnCode,
  CciElement*      targetElement,
  const CciChar*   value,
  Ccisize          length);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | Specifies the address of a buffer into which the element name will be copied (input). |
| `length` | Specifies the length of the buffer specified by the `buffer` parameter (input). |

| **Return values:** If successful, the element name is copied into the supplied buffer and the number of characters copied is returned. If the buffer is not large enough to contain the element name, `returnCode` is set to CCI_BUFFER_TOO_SMALL and the number of bytes required is returned. For any other failures, CCI_FAILURE is returned and `returnCode` indicates the reason for the error.

## cniElementType

Gets the value of the 'type' attribute for the specified syntax element. The syntax element type will have been set previously using **cniSetElementType** or **cpiSetElementType**.

```
CciElementType cniElementType(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The value of the target element type is returned. If an error occurs, CCI_FAILURE is returned and the `returnCode` parameter indicates the reason for the error.

## cniElementValue group

These functions retrieve the value of the specified syntax element.

```
CciSize cniElementBitArrayValue(
  int*         returnCode,
  CciElement*  targetElement,
  const struct CciBitArray* value);

CciBool cniElementBooleanValue(
  int*         returnCode,
  CciElement*  targetElement);

CciSize cniElementByteArrayValue(
  int*         returnCode,
  CciElement*  targetElement,
  const struct CciBitArray* value);

CciSize cniElementCharacterValue(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);

struct CciDate cniElementDateValue(
  int*         returnCode,
  CciElement*  targetElement);
```

|
```
CciSize cniElementDecimalValue(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);

struct CciTimestamp cniElementGmtTimestampValue(
  int*         returnCode,
  CciElement*  targetElement);
```

```
struct CciTime cniElementGmtTimeValue(
  int*          returnCode,
  CciElement*   targetElement);

CciInt cniElementIntegerValue(
  int*          returnCode,
  CciElement*   targetElement);

CciReal cniElementRealValue(
  int*          returnCode,
  CciElement*   targetElement);

struct CciTimestamp cniElementTimestampValue(
  int*          returnCode,
  CciElement*   targetElement);

struct CciTime cniElementTimeValue(
  int*          returnCode,
  CciElement*   targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | The address of an output buffer into which the value of the syntax element is stored (input). Used on relevant function calls only. |
| `length` | The length of the output buffer specified by the `value` parameter expressed in `CciChar` characters (input). Used on relevant function calls only. |

**Return values:** The value of the target element is returned. If an error occurs, the `returnCode` parameter indicates the reason for the error. In cases where the size of an element's data can vary, the correct data size is returned. Also, if the specified length is too small, the error code is set to CCI_BUFFER_TOO_SMALL.

## cniElementValueState

Gets the state of the value of the specified syntax element.

```
CciValueState cniElementValueState(
  int*          returnCode,
  CciElement*   targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The state of the value of the target syntax element is returned. If an error occurs, CCI_VALUE_STATE_UNDEFINED is returned and the `returnCode` parameter indicates the reason for the error.

## cniElementValueType

Gets the ‘type’ attribute for the value of the specified syntax element. The state of an element after creation is undefined. When the value of the element is set, its state becomes valid.

```
CciValueType cniElementValueType(
  int*          returnCode,
  CciElement*   targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The type of the value of the target syntax element is returned. If an error occurs, CCI_ELEMENT_TYPE_UNKNOWN is returned and the `returnCode` parameter indicates the reason for the error.

## cniElementValueValue

Gets the address of the value object owned by the specified syntax element.

```
const CciElementValue* cniElementValueValue(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The address of the value object of the target syntax element is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniFinalize

Causes the broker to request parsers that support the finalize feature to perform their finalize processing on the specified message. The behavior of this processing is specific to each parser.

If the `options` parameter is set to CCI_FINALIZE_VALIDATE, a parser should also perform validation processing to ensure that the element tree owned by it is of the correct structure. This helps prevent messages with incorrectly formed element trees being propagated to other nodes in the message flow.

It is recommended that **cniFinalize** is called prior to propagating a message.

```
void cniFinalize(
  int*         returnCode,
  CciMessage*  message,
  int          options);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `message` | Specifies the address of the message object for which the element tree is to be finalized (input). |
| `options` | Specifies bit flags to identify the finalize or validate options to be used (input). Can be omitted, or set to CCI_FINALIZE_VALIDATE. |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniFirstChild

Returns the address of the syntax element object that is the first child of the specified syntax element.

```
CciElement* cniFirstChild(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| targetElement | Specifies the address of the target syntax element object (input). |

**Return values:** If successful, the address of the requested syntax element object is returned. If there is no first child, zero is returned and returnCode is set to CCI_SUCCESS. If an error occurs, zero (CCI_NULL_ADDR) is returned and the returnCode parameter indicates the reason for the error.

## cniGetBrokerInfo

Queries the current broker environment (for example, for information about broker name and message flow name). The information is returned in a structure of type CNI_BROKER_INFO_ST.

```
void cniGetBrokerInfo(
  int*                returnCode,
  CciNode*            nodeObject,
  CNI_BROKER_INFO_ST* broker_info_st);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| nodeObject | Specifies the message flow processing node for which broker environment information is being requested. |
| broker_info_st | Specifies the address of a CNI_BROKER_INFO_ST structure that will be used to return a message that represents the input destination (input). |

**Return values:** None. If an error occurs, the returnCode parameter indicates the reason for the error.

## cniGetMessageContext

Gets the address of the message context associated with the specified message. The context of an existing message is used to create an output message, for example using the **cniCreateMessage** function.

```
CciMessageContext* cniGetMessageContext(
  int*         returnCode,
  CciMessage*  message);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| message | Specifies the address of the message object (input). |

**Return values:** If successful, the address of the message context is returned. Otherwise, zero (CCI_NULL_ADDR) is returned and the returnCode parameter indicates the reason for the error.

## cniGetParserClassName

Gets the parser class name associated with the specified syntax element.

```
CciSize ImportExportPrefix ImportExportSuffix cniGetParserClassName(
  int*           returnCode,
  CciElement*    targetElement,
  const CciChar* value,
  CciSize        length);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the element for which the parser class name is to be returned (input). |
| `value` | Specifies the address of an output buffer into which the parser class name will be stored (input). |
| `length` | Specifies the length of the output buffer specified in the `value` parameter (input). |

**Return values:** If successful, the `returnCode` parameter indicates CCI_SUCCESS and the number of characters written to the buffer is returned. If the buffer is not large enough to retain the returned name, the `returnCode` parameter indicates CCI_BUFFER_TOO_SMALL and the returned value indicates the number of characters required to store the name. If any other error occurs, CCI_FAILURE is returned and the `returnCode` parameter indicates the reason for the error.

## cniIsTerminalAttached

Checks whether a terminal is attached to another node via a connector. It returns an integer value that specifies whether the specified terminal object is attached to one or more terminals on other message flow nodes. It can be used to test whether a message can be propagated to a terminal. However, note that it is *not* necessary to call this function prior to propagating a message with the **cniPropagate** utility function. The intention of this function is to allow a node to modify its behavior when a terminal is not connected.

```
int cniIsTerminalAttached(
  int*          returnCode,
  CciTerminal*  terminalObject);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `terminalObject` | Specifies the address of the input or output terminal to be checked for an attached connector (input). The address is returned from **cniCreateOutputTerminal**. |

**Return values:** If the terminal is attached to another node via a connector, a value of 1 is returned. If the terminal is not attached, or a failure occurred, a value of 0 is returned. If a failure occurred, the value of the `returnCode` parameter indicates the reason for the error.

## cniLastChild

Returns the address of the syntax element object that is the last child of the specified syntax element.

```
CciElement* cniLastChild(
  int*         returnCode,
  CciElement*  targetElement);
```

|  |  |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** If successful, the address of the requested syntax element object is returned. If there is no last child, zero is returned and `returnCode` is set to CCI_SUCCESS. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniNextSibling

Returns the address of the syntax element object that is the next sibling (right sibling) of the specified syntax element.

```
CciElement* cniNextSibling(
  int*         returnCode,
  CciElement*  targetElement);
```

|  |  |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** If successful, the address of the requested syntax element object is returned. If there is no next sibling, zero is returned and `returnCode` is set to CCI_SUCCESS. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniParent

Returns the address of the syntax element object that is the parent of the specified syntax element.

```
CciElement* cpiParent(
  int*         returnCode,
  CciElement*  targetElement);
```

|  |  |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** If successful, the address of the requested syntax element is returned. If there is no parent element, zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniPreviousSibling

Returns the address of the syntax element object that is the previous sibling (left sibling) of the specified syntax element.

```
CciElement* cniPreviousSibling(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** If successful, the address of the requested syntax element object is returned. If there is no previous sibling, zero is returned and `returnCode` is set to CCI_SUCCESS. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniPropagate

Propagates a message to a specified terminal object. If the terminal is not attached to another node by a connector, the message is simply not propagated, and the function is regarded as a no-op. Therefore, it is not necessary to check whether the terminal is attached prior to propagating, unless the action that the node takes would be different (in which case **cniIsTerminalAttached** can be used to check if the terminal is connected).

```
int cniPropagate(
  int*          returnCode,
  CciTerminal*  terminalObject,
  CciMessage*   destinationList,
  CciMessage*   exceptionList,
  CciMessage*   message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `terminalObject` | Specifies the address of the output terminal to receive the message (input). The address is returned by **cniCreateOutputTerminal**. |
| `destinationList` | Specifies the address of the destination list object to be sent with the message (input). Note: this message object is used by the publish/subscribe node supplied by the message broker. |
| `exceptionList` | The address of the exception list for the message (input). |
| `message` | Specifies the address of the message object to be sent (input). If the message being sent is the same as the input message, then this address will be the one passed on the **evaluate** implementation function. |

**Return values:** If successful, CCI_SUCCESS is returned Otherwise, CCI_FAILURE is returned and the `returnCode` parameter indicates the reason for the error.

## cniRootElement

Get the root syntax element associated with a specified message. It returns the root element that is associated with (and owned by) the message object identified by the message parameter. When a message object is constructed by the broker, a root element is automatically created.

```
CciElement* cniRootElement(
  int*        returnCode,
  CciMessage*  message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `message` | Specifies the address of the message object (input). |

**Return values:** If successful, the address of the root element object is returned. Otherwise, zero (CCI_NULL_ADDR) is returned, and the `returnCode` parameter indicates the reason for the error.

## cniSearchElement group

Searches previous siblings of the specified element for an element matching specified criteria. The search is performed starting at the syntax element specified in the element argument, and each of the four functions provides a search in a different tree direction:

1. **cniSearchFirstChild** searches the immediate child elements of the starting element from the first child until a match is found or the end of the child element chain is reached.
2. **cniSearchLastChild** searches the immediate child elements of the starting element from the last child until a match is found or the end of the child element chain is reached.
3. **cniSearchNextSibling** searches from the starting element to the next siblings until a match is found or the end of the sibling chain is reached.
4. **cniSearchPreviousSibling** searches from the starting element to the previous siblings until a match is found or the start of the sibling chain is reached.

```
CciElement* cniSearchFirstChild(
  int*            returnCode,
  CciElement*     targetElement,
  CciCompareMode  mode,
  CciElementType  type,
  CciChar*        name);

CciElement* cniSearchLastChild(
  int*            returnCode,
  CciElement*     targetElement,
  CciCompareMode  mode,
  CciElementType  type,
  CciChar*        name);

CciElement* cniSearchNextSibling(
  int*            returnCode,
  CciElement*     targetElement,
  CciCompareMode  mode,
  CciElementType  type,
  CciChar*        name);
```

```
CciElement* cniSearchPreviousSibling(
  int*            returnCode,
  CciElement*     targetElement,
  CciCompareMode  mode,
  CciElementType  type,
  CciChar*        name);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the syntax element object from which the search is started (input). |
| `mode` | The search mode to use (input). This indicates what combination of element type and element name is to be searched for. |
| `type` | The element type to search for (input). This is used only if the search mode involves a match on the type. |
| `name` | The element name to search for (input). This is used only if the search mode involves a match on the name. |

**Return values:** The address of the requested syntax element object is returned, unless there is no matching element, in which case zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniSetElementName

Sets the name of the specified syntax element.

```
void cniSetElementName(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  name);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `name` | Specifies the name of the element (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniSetElementType

Sets the type of the specified syntax element.

```
void cniSetElementType(
  int*            returnCode,
  CciElement*     targetElement,
  CciElementType  type);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `type` | Specifies the type of the element (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniSetElementValue group

Functions to set a value into the specified syntax element.

```
void cniSetElementBitArrayValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciBitArray*  value);
```

```
void cniSetElementBooleanValue(
  int*         returnCode,
  CciElement*  targetElement,
  CciBool      value);
```

```
void cniSetElementByteArrayValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciByteArray*  value);
```

```
void cniSetElementCharacterValue(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);
```

```
void cniSetElementDateValue(
  int*                   returnCode,
  CciElement*            targetElement,
  const struct CciDate*  value);
```

```
void cniSetElementDecimalValue(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value);
```

```
void cniSetElementGmtTimestampValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciTimestamp*  value);
```

```
void cniSetElementGmtTimeValue(
  int*                   returnCode,
  CciElement*            targetElement,
  const struct CciTime*  value);
```

```
void cniSetElementIntegerValue(
  int*         returnCode,
  CciElement*  targetElement,
  CciInt       value);
```

```
void cniSetElementRealValue(
  int*         returnCode,
  CciElement*  targetElement,
  CciReal      value);
```

```
void cniSetElementTimestampValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciTimestamp*  value);
```

```
void cniSetElementTimeValue(
  int*                   returnCode,
  CciElement*            targetElement,
  const struct CciTime*  value);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| targetElement | Specifies the address of the target syntax element object (input). |
| value | The value to store in the syntax element (input). |
| length | The length of the data value (input). Used on relevant function calls only. |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniSetElementValueValue

Sets the value object of the specified syntax element.

```
void cniSetElementValueValue(
  int*             returnCode,
  CciElement*      targetElement,
  CciElementValue* value);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| targetElement | Specifies the address of the target syntax element object (input). |
| value | The address of a value object that is used to set the value of the syntax element specified by the `targetElement` parameter (input). The address of the value object is obtained using **cniElementValueValue**. |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniSqlCreateStatement

Creates an SQL expression object representing the statement specified by the statement argument, using the syntax as defined for the **Compute** message flow processing node. This function returns a pointer to the SQL expression object, which is used as input to the functions that execute the statement, namely **cniSqlExecute** and **cniSqlSelect**. Multiple SQL expression objects can be created in a single message flow processing node. Although these objects can be created at any time, they will typically be created when the message flow processing node is instantiated, within the implementation function **cniCreateNodeContext**.

```
CciSqlExpression* cniSqlCreateStatement(
  int*               returnCode,
  CciNode*           nodeObject,
  CciChar*           dataSourceName,
  CciSqlTransaction  transaction,
  CciChar*           statement);
```

| | |
|---|---|
| returnCode | This parameter receives the return code from the function (output). |
| nodeObject | Specifies the message flow processing node the SQL expression object will be owned by (input). This pointer is passed to the **cniCreateNodeContext** implementation function. |
| dataSourceName | The ODBC data source name to be used if the statement references data in an external database (input). |

| | |
|---|---|
| `transaction` | Specifies whether a database commit will be performed after the statement is executed (input). Valid values are CCI_SQL_TRANSACTION_AUTO (the default) and CCI_SQL_TRANSACTION_COMMIT. The former value specifies that a database commit will be performed at the completion of the message flow (that is, as a fully globally coordinated or partially globally coordinated transaction). The latter value specifies that a commit will be performed after execution of the statement, and within the **cniSqlExecute** or **cniSqlSelect** function (that is, the message flow is partially broker coordinated). |
| `statement` | Specifies the SQL expression to be created, using the syntax as defined for the compute message flow processing node (input). |

**Return values:** If successful, the address of the SQL expression object is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cniSqlDeleteStatement

Deletes the SQL statement previously created using the **cniSqlCreateStatement** utility function, as defined by the `sqlExpression` argument.

```
void cniSqlDeleteStatement(
  int*               returnCode,
  CciSqlExpression*  sqlExpression);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `sqlExpression` | Specifies the SQL expression object to be deleted, as returned by the **cniSqlCreateStatement** utility function (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniSqlExecute

Executes an SQL statement previously created using the **cniSqlCreateStatement** utility function, as defined by the `sqlExpression` argument. This function is to be used when the statement does not return data, for example, when a PASSTHRU function is used.

```
void cniSqlExecute(
  int*               returnCode,
  CciSqlExpression*  sqlExpression,
  CciMessage*        destinationList,
  CciMessage*        exceptionList,
  CciMessage*        message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `sqlExpression` | Specifies the SQL expression object to be executed, as returned by the **cniSqlCreateStatement** utility function (input). |
| `destinationList` | The message representing the input destination list (input). |
| `exceptionList` | The message representing the input exception list (input). |
| `message` | The message representing the input message (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniSqlSelect

Executes an SQL statement previously created using the **cniSqlCreateStatement** utility function, as defined by the `sqlExpression` argument. If the statement returns data, then it is written into the message specified by the `outputMessage` argument.

```
void cniSqlSelect(
  int*              returnCode,
  CciSqlExpression*  sqlExpression,
  CciMessage*        destinationList,
  CciMessage*        exceptionList,
  CciMessage*        message,
  CciMessage*        outputMessage);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `sqlExpression` | Specifies the SQL expression object to be executed, as returned by the **cniSqlCreateStatement** utility function (input). |
| `destinationList` | The message representing the input destination list (input). |
| `exceptionList` | The message representing the input exception list (input). |
| `message` | The message representing the input message (input). |
| `outputMessage` | The message into which any data returned by the statement will be written (output). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cniWriteBuffer

Causes the syntax element tree associated with the specified message to be written to the data buffer owned by that message object. This operation serializes the element tree into a bitstream, which can then be processed as a sequence of contiguous bytes. This function should be used when writing the bitstream to a target that is outside the broker (that is, when writing a plug-in output node).

```
void cniWriteBuffer(
  int*         returnCode,
  CciMessage*  message);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `message` | Specifies the address of the message object for which the element tree is to be serialized (input). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

# Chapter 9. Parser implementation and utility functions

The plug-in interface for a message parser consists of:

1. A set of implementation functions, which provide the functionality of the plug-in parser. These functions are invoked by the message broker. Most implementation functions are mandatory, and if not supplied by the developer will cause an exception at runtime.
2. A set of utility functions, the purpose of which is to create resources in the message broker or to request a service of the broker. These utility functions can be invoked by a plug-in parser.

These functions are defined in the header file **BipCpi.h**.

This chapter contains:

- “Parser implementation function overview” on page 144.
- “Parser utility function overview” on page 145.
- “Parser implementation function interface” on page 147.
- “Parser utility function interface” on page 153.

See also Chapter 10, “Node and parser utilities” on page 167 for additional utility functions that can be used by a plug-in parser.

## Parser implementation function overview

A message parser plug-in implements its capability through a function interface that is invoked by the message broker during runtime execution. This interface includes functions to create and delete any local context storage associated with a parser object and the parsing operations.

Some of the following functions are mandatory, and must be implemented by the developer.

Follow the page references to see the detailed descriptions of each implementation function.

## Mandatory functions

| | |
|---|---|
| **cpiCreateContext** | page 147 |
| **cpiDeleteContext** | page 147 |
| **cpiParseBuffer** | page 149 |
| **cpiParseNextSibling** | page 150 |
| **cpiParsePreviousSibling** | page 151 |
| **cpiParseFirstChild** | page 150 |
| **cpiParseLastChild** | page 150 |
| **cpiWriteBuffer** | page 152 |

## Optional functions

| | |
|---|---|
| **cpiElementValue** | page 148 |
| **cpiNextParserClassName** | page 148 |
| **cpiNextParserCodedCharSetId** | page 148 |
| **cpiNextParserEncoding** | page 149 |
| **cpiParserType** | page 151 |
| **cpiSetElementValue** | page 151 |
| **cpiSetNextParserClassName** | page 152 |

## Parser utility function overview

The following functions allow the C plug-in to create or define message broker objects, such as message parser factories.

Follow the page references to see the detailed descriptions of each utility function.

## Initialization and resource creation

| | |
|---|---|
| **cpiCreateParserFactory** | page 156 |
| **cpiDefineParserClass** | page 157 |

## Message buffer access

| | |
|---|---|
| **cpiAppendToBuffer** | page 154 |
| **cpiBufferByte** | page 154 |
| **cpiBufferPointer** | page 155 |
| **cpiBufferSize** | page 155 |

## Syntax element navigation

| | |
|---|---|
| **cpiRootElement** | page 162 |
| **cpiParent** | page 161 |
| **cpiNextSibling** | page 161 |
| **cpiPreviousSibling** | page 161 |
| **cpiFirstChild** | page 160 |
| **cpiLastChild** | page 160 |

## Syntax element access

| | |
|---|---|
| **cpiAddAfter** | page 153 |
| **cpiAddBefore** | page 154 |
| **cpiAddAsFirstChild** | page 153 |
| **cpiAddAsLastChild** | page 153 |
| **cpiCreateAndInitializeElement** | page 155 |
| **cpiCreateElement** | page 156 |
| **cpiElementCompleteNext** | page 157 |
| **cpiElementCompletePrevious** | page 157 |
| **cpiElementName** | page 158 |
| **cpiElementType** | page 158 |
| **cpiElementValue group** | page 158 |
| **cpiElementValueValue** | page 160 |
| **cpiSetCharacterValueFromBuffer** | page 162 |
| **cpiSetElementCompleteNext** | page 162 |
| **cpiSetElementCompletePrevious** | page 163 |

|  |  |
|---|---|
| **cpiSetElementName** | page 163 |
| **cpiSetElementType** | page 163 |
| **cpiSetElementValue group** | page 164 |
| **cpiSetElementValueValue** | page 165 |
| **cpiSetNameFromBuffer** | page 165 |

## Parser implementation function interface

A message parser plug-in implements its capability through a function interface that is invoked by the message broker during runtime execution. This interface includes functions to create and delete any local context storage associated with a parser object and the parsing operations.

The following functions must be implemented, using the prototypes as described, except those functions that are specified as optional.

The parser implementation functions are defined in the header file **BipCpi.h**.

### cpiCreateContext

Creates a plug-in context associated with a parser object. It is invoked by the message broker when an instance of a parser object is constructed or allocated. This occurs when a message flow causes the message data to be parsed; the broker constructs or allocates a parser object to acquire the appropriate section of the message data. Before this function is called, the broker will have created a name element as the effective root element for the parser. However, this element is not named. The parser should name this element in the **cpiSetElementName** function.

The responsibilities of the plug-in are to:

1. Allocate any parser instance specific data areas (such as context) that might be required.
2. Perform any additional resource acquisition or initialization that might be required.
3. Return the address of the context to the calling function. Whenever a plug-in implementation function for this parser instance is invoked, the appropriate context is passed as an argument to that function. This means that a plug-in parser developed in C need not maintain its own static pointers to per-instance data areas.

```
CciContext* cpiCreateContext(CciParser* parser);
```

| | |
|---|---|
| `parser` | The address of the parser object that has been constructed (input). |

**Return values:** If successful, the address of the plug-in context is returned. Otherwise, a value of zero is returned.

### cpiDeleteContext

Deletes the plug-in context associated with a parser object. It is invoked by the message broker when an instance of a parser object is destroyed.

The responsibilities of the plug-in are to:

1. Release any parser instance specific data areas (such as context) that were acquired at construction or during parser processing.
2. Release any additional resources that might have been acquired for the processing of the parser.

```
void cpiDeleteContext(
  CciParser*   parser,
  CciContext*  context);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |

**Return values:** None.

## cpiElementValue

Optional function to get the value of a specified element. It is invoked by the broker when the value of a syntax element is to be retrieved. It provides an opportunity for a plug-in parser to override the behavior for retrieving element values.

```
const CciElementValue* cpiElementValue(
  CciParser*   parser,
  CciElement*  currentElement);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `currentElement` | The address of the current syntax element (input). |

**Return values:** The value of the target syntax element object is returned. This will have been returned by the **cpiElementValueValue** function.

## cpiNextParserClassName

Optional function to return the name of the next parser class in the chain, if any. It allows the parser to return to the broker the name of the parser class that handles the next section, or remainder, of the message content. Normally, for messages having a simple format type, there is only one message content parser; it is not necessary to provide this function. For messages having a more complex format type with multiple message parsers, each parser should identify the next one in the chain by returning its name in the `buffer` parameter. The last parser in the chain must return an empty string.

```
void cpiNextParserClassName(
  CciParser*   parser,
  CciContext*  context,
  CciChar*     buffer,
  int          size);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |
| `buffer` | The address of a buffer into which the parser class name should be put (input). |
| `size` | The length of the buffer provided by the broker (input). |

**Return values:** None.

## cpiNextParserCodedCharSetId

Optional function to return the coded character set ID (CCSID) of the data owned by the next parser class in the chain, if any.

```
int cpiNextParserCodedCharSetId(
  CciParser*   parser,
  CciContext*  context);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |

**Return values:** The CCSID of the data is returned. If it is not known, zero may be returned and a default CCSID will apply.

## cpiNextParserEncoding

Optional function to return the encoding of data owned by the next parser class in the chain, if any.

```
int cpiNextParserEncoding(
  CciParser*   parser,
  CciContext*  context);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |

**Return values:** The encoding of the data is returned. If it is not known, zero may be returned and default encoding will apply.

## cpiParseBuffer

Prepares a parser to parse a new message object. It is called the first time (for each message) that the message flow causes the message content to be parsed. Each plug-in parser that is used to parse a particular message format has this function invoked to:

- Perform any initialization that is required
- Return the length of the message content that it takes ownership for

The `offset` parameter indicates the offset within the message buffer where parsing is to commence. This is necessary because another parser might own a previous portion of the message (for example, an MQMD header will have been parsed by the message broker's internal parser). The offset must be positive and be less than the size of the buffer. It is recommended that the implementation function verifies that the offset is valid, as this could improve problem determination if a previous parser is in error.

The plug-in must return the size of the remaining buffer for which it takes ownership. This must be less than or equal to the size of the buffer less the current offset.

A parser must not attempt to cause parsing of other portions of the syntax element tree, for example, by navigating to the root element and to another branch. This can cause unpredictable results.

```
int cpiParseBuffer(
  CciParser*   parser,
  CciContext*  context,
  int          offset);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |
| `offset` | The offset into the message buffer at which parsing is to commence (input). |

**Return values:** The size (in bytes) of the remaining portion of the message buffer for which the parser takes ownership.

## cpiParseFirstChild

Parses the first child of a specified syntax element. It is invoked by the broker when the first child element of the current syntax element is required.

```
void cpiParseFirstChild(
  CciParser*   parser,
  CciContext*  context,
  CciElement*  currentElement);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |
| `currentElement` | The address of the current syntax element (input). |

**Return values:** None.

## cpiParseLastChild

Parses the last child of a specified syntax element. It is invoked by the broker when the last child element of the current syntax element is required.

```
void cpiParseLastChild(
  CciParser*   parser,
  CciContext*  context,
  CciElement*  currentElement);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |
| `currentElement` | The address of the current syntax element (input). |

**Return values:** None.

## cpiParseNextSibling

Parses the next (right) sibling of a specified syntax element. It is invoked by the broker when the next (right) sibling element of the current syntax element is required.

```
void cpiParseNextSibling(
  CciParser*   parser,
  CciContext*  context,
  CciElement*  currentElement);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |

| | |
|---|---|
| `currentElement` | The address of the current syntax element (input). |

**Return values:** None.

## cpiParsePreviousSibling

Parse the previous (left) sibling of a specified syntax element. It is invoked by the broker when the previous (left) sibling element of the current syntax element is required.

```
void cpiParsePreviousSibling(
  CciParser*   parser,
  CciContext*  context,
  CciElement*  currentElement);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |
| `currentElement` | The address of the current syntax element (input). |

**Return values:** None.

## cpiParserType

Optional function to return whether the parser is an implementation of a *standard* parser. Such a parser expects that the `Format` field of the preceding header will contain the name of the parser class that follows. *Non-standard* parsers expect that the `Domain` field will contain the parser class name. If the **cpiParserType** implementation function is not provided, the message broker assumes that the parser is of the *standard* type.

```
CciBool cpiParserType(
  CciParser*   parser,
  CciContext*  context);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |

**Return values:** If the implementation is of a standard parser, zero is returned. Otherwise, the implementation is assumed to be that of a non-standard parser and a non-zero value is returned.

## cpiSetElementValue

Optional function to set the value of a specified element. It is invoked by the broker when the value of a syntax element is to be set. It provides an opportunity for a plug-in parser to override the behavior for setting element values.

```
void cpiSetElementValue(
  CciParser*        parser,
  CciElement*       currentElement,
  CciElementValue*  value);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `currentElement` | The address of the current syntax element (input). |
| `value` | The value (input). |

**Return values:** None.

## cpiSetNextParserClassName

Optional function to advise a parser of the next parser in the chain. It is called during finalize processing, and returns to the plug-in parser a string containing the name of the next parser class in the chain. It allows a parser to take action during the finalize phase to modify the syntax element tree prior to the phase that causes serialization of the bit stream.

```
void cpiSetNextParserClassName(
  CciParser*   parser,
  CciContext*  context,
  CciChar*     name,
  CciBool      parserType);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |
| `name` | A pointer to a string containing the parser class name (output). |
| `parserType` | Indicates whether the referenced parser is *standard* (`parserType=0`) or *non-standard* (`parserType=non-zero`) (input). A standard parser expects that the `Format` field of the preceding header in the chain will contain the name of the parser class that follows. Non-standard parsers expect that the `Domain` field will contain the parser class name. |

**Return values:** None.

## cpiWriteBuffer

Writes a syntax element tree to the message buffer associated with a parser. It appends data to the bitstream in the message buffer associated with the parser object, using the current syntax element tree as a source. The element tree should not be modified during the execution of this implementation function. The **cpiAppendToBuffer** utility function can be used to append the message buffer (bitstream) with data from the element tree.

```
int cpiWriteBuffer(
  CciParser*   parser,
  CciContext*  context);
```

| | |
|---|---|
| `parser` | The address of the parser object (input). |
| `context` | The address of the plug-in context (input). |

**Return values:** The size in bytes of the data appended to the bitstream in the buffer.

## Parser utility function interface

The following functions allow the C plug-in to create or define message broker objects, such as message parser factories.

The parser utility functions are defined in the header file **BipCpi.h**.

### cpiAddAfter

Adds a new (and currently unattached) syntax element to the syntax element tree after the specified target element. The newly added element becomes the **next sibling** of the target element.

```
void cpiAddAfter(
  int*          returnCode,
  CciElement*   targetElement,
  CciElement*   newElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `newElement` | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

### cpiAddAsFirstChild

Adds a new (and currently unattached) syntax element to the syntax element tree as the first child of the specified target element.

```
void cpiAddAsFirstChild(
  int*          returnCode,
  CciElement*   targetElement,
  CciElement*   newElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `newElement` | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

### cpiAddAsLastChild

Adds a new (and currently unattached) syntax element to the syntax element tree as the last child of the specified target element.

```
void cpiAddAsLastChild(
  int*          returnCode,
  CciElement*   targetElement,
  CciElement*   newElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `newElement` | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiAddBefore

Adds a new (and currently unattached) syntax element to the syntax element tree before the specified target element. The newly added element becomes the **previous sibling** of the target element.

```
void cpiAddBefore(
  int*         returnCode,
  CciElement*  targetElement,
  CciElement*  newElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `newElement` | Specifies the address of the new syntax element object that is to be added to the tree structure (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiAppendToBuffer

Appends data to the buffer containing the bit stream representation of a message, for the specified parser object.

```
void cpiAppendToBuffer(
  int*        returnCode,
  CciParser*  parser,
  CciByte*    data,
  CciSize     length);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). |
| `data` | The address of the data to be appended to the buffer (input). |
| `length` | The size in bytes of the data to be appended to the buffer (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiBufferByte

Gets a single byte from the buffer containing the bit stream representation of the input message, for the specified parser object. The value of the index argument indicates which byte in the byte array is to be returned.

```
CciByte cpiBufferByte(
  int*        returnCode,
  CciParser*  parser,
  CciSize     index);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). |
| `index` | Specifies the offset to use as an index into the buffer (input). |

**Return values:** The requested byte is returned. If an error occurs, `returnCode` indicates the reason for the error.

## cpiBufferPointer

Gets a pointer to the buffer containing the bit stream representation of the input message, for the specified parser object.

```
const CciByte* cpiBufferPointer(
  int*        returnCode,
  CciParser*  parser);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). |

**Return values:** If successful, the address of the buffer is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned, and `returnCode` indicates the reason for the error.

## cpiBufferSize

Gets the size of the buffer containing the bit stream representation of the input message, for the specified parser object.

```
CciSize cpiBufferSize(
  int*        returnCode,
  CciParser*  parser);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). |

**Return values:** If successful, the size of the buffer, in bytes, is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned, and `returnCode` indicates the reason for the error.

## cpiCreateAndInitializeElement

Creates a syntax element, owned by the specified parser, that is not attached to a syntax tree. The element is partially initialized with the values of the `type`, `name`, `firstChildComplete`, and `lastChildComplete` parameters.

```
CciElement* cpiCreateAndInitializeElement(
  int*            returnCode,
  CciParser*      parser,
  CciElementType  type,
  const CciChar*  name,
  CciBool         firstChildComplete,
  CciBool         lastChildComplete);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). This address is passed to the plug-in as a parameter of the **cpiCreateContext** implementation function. |
| `type` | Specifies the type of the element being created (input). |
| `name` | Specifies a descriptive name for the element (input). |
| `fisrtChildComplete` | Specifies a value for the firstChildComplete flag of the syntax element (input). |
| `lastChildComplete` | Specifies a value for the lastChildComplete flag of the syntax element (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned, and `returnCode` indicates the reason for the error.

## cpiCreateElement

Creates a default syntax element that is not attached to a syntax tree. The element is owned by the specified parser. The element is incomplete in that none of its attributes (such as type or name) are set.

```
CciElement* cpiCreateElement(
  int*        returnCode,
  CciParser*  parser);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). |

**Return values:** If successful, the address of the new element object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned, and `returnCode` indicates the reason for the error.

## cpiCreateParserFactory

Creates a single instance of the named parser factory in the message broker. It must be invoked only in the initialization function **bipGetParserFactory** which is called when the ‘lil’ is loaded by the message broker. If **cpiCreateParserFactory** is invoked at any other time, the results are unpredictable.

```
CciFactory* cpiCreateParserFactory(
  int*      returnCode,
  CciChar*  name);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `name` | Specifies the name of the factory being created (input). |

**Return values:** If successful, the address of the parser factory object is returned. Otherwise, a value of zero (CCI_NULL_ADDR) is returned, and `returnCode` indicates the reason for the error.

## cpiDefineParserClass

Defines the name of a parser class that is supported by a parser factory. `functbl` is a pointer to a virtual function table containing pointers to the C plug-in implementation functions, that is, those functions that provide the function of the parser itself.

```
void cpiDefineParserClass(
  int*         returnCode,
  CciFactory*  factoryObject,
  CciChar*     name,
  CPI_VFT*     functbl);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `factoryObject` | Specifies the address of the factory object that supports the named parser (input). The address is returned from **cpiCreateParserFactory**. |
| `name` | The name of the parser class to be defined (input). The maximum length of a parser class name is 8 characters. |
| `functbl` | The address of the CPI_VFT structure that contains pointers to the plug-in implementation functions (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiElementCompleteNext

Gets the value of the ‘next child complete’ flag from the target syntax element. This attribute indicates whether the element tree is complete.

```
CciBool cpiElementCompleteNext(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The value of the attribute is returned. If an error occurs, `returnCode` indicates the reason for the error.

## cpiElementCompletePrevious

Gets the value of the ‘previous child complete’ flag from the target syntax element. This attribute indicates whether the element tree is complete.

```
CciBool cpiElementCompletePrevious(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |

| | |
|---|---|
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The value of the attribute is returned. If an error occurs, `returnCode` indicates the reason for the error.

## cpiElementName

Gets the name of the target syntax element. The syntax element name will have been set previously using **cniSetElementName** or **cpiSetElementName**.

```
Ccisize       cpiElementName(
  int*        returnCode,
  CciElement*  targetElement),
  const CciChar* value,
  CciSize        length);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | Specifies the address of a buffer into which the element name will be copied (input). |
| `length` | Specifies the length of the buffer specified by the `buffer` parameter (input). |

**Return values:** If successful, the element name is copied into the supplied buffer and the number of bytes copied is returned. If the buffer is not large enough to contain the element name, `returnCode` is set to CCI_BUFFER_TOO_SMALL and the number of bytes required is returned. For any other failures, CCI_FAILURE is returned and `returnCode` indicates the reason for the error.

## cpiElementType

Gets the type of the target syntax element. The syntax element type will have been set previously using **cniSetElementType** or **cpiSetElementType**.

```
CciElementType cpiElementType(
  int*        returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The value of the element type is returned. If an error occurs, `returnCode` indicates the reason for the error.

## cpiElementValue group

Functions to get the value of the specified syntax element.

```
| CciSize cpiElementBitArrayValue(
|   int*        returnCode,
|   CciElement*  targetElement,
|   const struct CciBitArray* value);
```

```
CciBool cpiElementBooleanValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
CciSize cpiElementByteArrayValue(
  int*        returnCode,
  CciElement*  targetElement,
  const struct CciByteArray* value);
```

```
CciSize cpiElementCharacterValue(
  int*           returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);
```

```
struct CciDate cpiElementDateValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
CciSize cpiElementDecimalValue(
  int*           returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);
```

```
struct CciTimestamp cpiElementGmtTimestampValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
struct CciTime cpiElementGmtTimeValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
CciInt cpiElementIntegerValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
CciReal cpiElementRealValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
struct CciTimestamp cpiElementTimestampValue(
  int*        returnCode,
  CciElement*  targetElement);
```

```
struct CciTime cpiElementTimeValue(
  int*        returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | The address of an output buffer into which the value of the syntax element is stored (input). Used on relevant function calls only. |
| `length` | The length of the output buffer specified by the `value` parameter (input). Used on relevant function calls only. |

**Return values:** The value of the element is returned.

In some cases, for example, **cpiElementCharacterValue** or **cpiElementDecimalValue**, if the buffer is not large enough to receive the data the data is not written into the buffer. The size of the required buffer is passed as the return value, and `returnCode` is set to CCI_BUFFER_TOO_SMALL.

If an error occurs, `returnCode` indicates the reason for the error.

## cpiElementValueValue

Gets the value object from the specified syntax element. This value object is opaque in that it cannot be interrogated. It can be used to set or derive the value of one element from another, without knowing its type, by using the **cpiSetElementValueValue** function. This can be used by parsers that override behavior by invoking the implementation functions **cpiElementValue** and **cpiSetElementValue**.

```
const CciElementValue* cpiElementValueValue(
  int*         returnCode,
  CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The address of the `CciElementValue` object stored in the specified target syntax element is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and `returnCode` indicates the reason for the error.

## cpiFirstChild

Returns the address of the syntax element object that is the first child of the specified target element.

```
CciElement* cpiFirstChild(
  int*               returnCode,
  const CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The address of the requested syntax element object is returned, unless there is no child in which case zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and `returnCode` indicates the reason for the error.

## cpiLastChild

Returns the address of the syntax element object that is the last child of the specified target element.

```
CciElement* cpiLastChild(
  int*               returnCode,
  const CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The address of the requested syntax element object is returned, unless there is no child in which case zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and `returnCode` indicates the reason for the error.

## cpiNextSibling

Returns the address of the syntax element object that is the next (right) sibling of the specified target element.

```
CciElement* cpiNextSibling(
  int*               returnCode,
  const CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The address of the requested syntax element object is returned, unless there is no next sibling in which case zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and `returnCode` indicates the reason for the error.

## cpiParent

Returns the address of the syntax element object that is the parent of the specified target element.

```
CciElement* cpiParent(
  int*               returnCode,
  const CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** If successful, the address of the requested syntax element is returned. If there is no parent element, zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and the `returnCode` parameter indicates the reason for the error.

## cpiPreviousSibling

Returns the address of the syntax element object that is the previous (left) sibling of the specified target element.

```
CciElement* cpiPreviousSibling(
  int*               returnCode,
  const CciElement*  targetElement);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |

**Return values:** The address of the requested syntax element object is returned, unless there is no previous sibling in which case zero is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned and `returnCode` indicates the reason for the error.

## cpiRootElement

Gets the address of the root syntax element of the specified parser object.

```
CciElement* cpiRootElement(
  int*        returnCode,
  CciParser*  parser);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `parser` | Specifies the address of the parser object (input). |

**Return values:** The address of the root syntax element is returned. If an error occurs, zero (CCI_NULL_ADDR) is returned, and `returnCode` indicates the reason for the error.

## cpiSetCharacterValueFromBuffer

Sets the value of the specified syntax element.

```
void cpiSetCharacterValueFromBuffer(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | The value to be set in the target element (input). |
| `length` | The length of the character string specified by the `value` parameter (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetElementCompleteNext

Sets the ‘next child complete’ flag in the target syntax element to the specified value.

```
void cpiSetElementCompleteNext(
  int*         returnCode,
  CciElement*  targetElement,
  CciBool      value);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | The value to be set in the flag (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetElementCompletePrevious

Sets the ‘previous child complete’ flag in the target syntax element to the specified value.

```
void cpiSetElementCompletePrevious(
  int*         returnCode,
  CciElement*  targetElement,
  CciBool      value);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | The value to be set in the flag (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetElementName

Sets the name of the specified syntax element.

```
void cpiSetElementName(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  name);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `name` | The name to be set in the target element (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetElementType

Sets the type of the specified syntax element.

```
void cpiSetElementType(
  int*            returnCode,
  CciElement*     targetElement,
  CciElementType  type);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `type` | The type to be set in the target element (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetElementValue group

Functions to set a value in the specified syntax element.

```
void cpiSetElementBitArrayValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciBitArray*  value);
```

```
void cpiSetElementByteArrayValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciByteArray*  value);
```

```
void cpiSetElementBooleanValue(
  int*         returnCode,
  CciElement*  targetElement,
  CciBool      value);
```

```
void cpiSetElementCharacterValue(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value,
  CciSize         length);
```

```
void cpiSetElementDateValue(
  int*                   returnCode,
  CciElement*            targetElement,
  const struct CciDate*  value);
```

```
void cpiSetElementDecimalValue(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  value);
```

```
void cpiSetElementGmtTimestampValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciTimestamp*  value);
```

```
void cpiSetElementGmtTimeValue(
  int*                   returnCode,
  CciElement*            targetElement,
  const struct CciTime*  value);
```

```
void cpiSetElementIntegerValue(
  int*         returnCode,
  CciElement*  targetElement,
  CciInt       value);
```

```
void cpiSetElementRealValue(
  int*         returnCode,
  CciElement*  targetElement,
  CciReal      value);
```

```
void cpiSetElementTimestampValue(
  int*                        returnCode,
  CciElement*                 targetElement,
  const struct CciTimestamp*  value);
```

```
void cpiSetElementTimeValue(
  int*                   returnCode,
  CciElement*            targetElement,
  const struct CciTime*  value);
```

| | |
|---|---|
| `returnCode` | This argument receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | The value to be set in the target element (input). |
| `length` | The length of the data value (input). Used on relevant function calls only. |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetElementValueValue

Sets the value of the specified syntax element. See **cpiElementValueValue** on page 160.

```
void ImportExportPrefix ImportExportSuffix cpiSetElementValueValue(
  int*              returnCode,
  CciElement*       targetElement,
  CciElementValue*  value);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `value` | Specifies the address of the `CciElementValue` object that contains the value to be stored in the specified target element (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

## cpiSetNameFromBuffer

Sets the name attribute of the target syntax element using the data supplied in the buffer pointed to by the `name` parameter. The size of the name is specified using the `length` parameter.

```
void cpiSetNameFromBuffer(
  int*            returnCode,
  CciElement*     targetElement,
  const CciChar*  name,
  CciSize         length);
```

| | |
|---|---|
| `returnCode` | Receives the return code from the function (output). |
| `targetElement` | Specifies the address of the target syntax element object (input). |
| `name` | The address of a buffer containing the name (input). |
| `length` | The length of the name (input). |

**Return values:** None. If an error occurs, `returnCode` indicates the reason for the error.

# Chapter 10. Node and parser utilities

MQSeries Integrator provides some additional utilities that can be used by plug-in nodes and plug-in parsers. These are:

- Exception handling and logging
- Character representation handling

These functions are defined in the header file **BipCci.h**.

This chapter contains:

## Utility function overview

The following utility functions are provided for use by plug-in nodes and parsers.

Follow the page references to see the detailed descriptions of each function.

## Exception handling and logging

| | |
|---|---|
| **cciLog** | page 169 |
| **cciGetLastExceptionData** | page 169 |
| **cciThrowException** | page 170 |
| **cciRethrowLastException** | page 170 |

## Character representation handling

| | |
|---|---|
| **cciMbsToUcs** | page 172 |
| **cciUcsToMbs** | page 172 |

## Exception handling and logging functions

The following exception handling and logging functions are provided for use by a plug-in node or a plug-in parser.

These functions are defined in the header file **BipCci.h**.

### cciGetLastExceptionData

Gets diagnostic information about the last exception generated. Information about the last exception generated on the current thread is returned in a CCI_EXCEPTION_ST output structure. It can be used by the plug-in to determine whether any recovery is required when a utility function returns an error code of CCI_EXCEPTION.

This function may be called when a utility function has indicated that an exception occurred by setting `returnCode` to CCI_EXCEPTION.

```
void* cciGetLastExceptionData(
  int*               returnCode,
  CCI_EXCEPTION_ST*  exception_st);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `exception_st` | Specifies the address of a CCI_EXCEPTION_ST structure to receive data about the last exception (output). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

### cciLog

Logs an error, warning or informational event. The event is logged by the message broker interface using the specified arguments as log data.

```
void cciLog(
  int*          returnCode,
  CCI_LOG_TYPE  type,
  char*         file,
  int           line,
  char*         function,
  CciChar*      messageSource,
  int           messageNumber,
  char*         traceText,
                ...);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `type` | The type of event, as defined by CCI_LOG_TYPE (input). Valid values are:<br>`CCI_LOG_ERROR`<br>`CCI_LOG_WARNING`<br>`CCI_LOG_INFORMATION` |
| `file` | The source file name where the function was invoked (input). The value is optional, but it can be useful for debugging purposes. |

| | |
|---|---|
| `line` | The line number in the source file where the function was invoked (input). The value is optional, but it can be useful for debugging purposes. |
| `function` | The function name that invoked the log function (input). The value is optional, but it can be useful for debugging purposes. |
| `messageSource` | A string that identifies the Windows message source or Unix message catalog. |
| `messageNumber` | The message number identifying the event (input). If `messageNumber` is specified as zero, it is assumed that a message is not available. If `messageNumber` is non-zero, the specified message is written into the broker event log with any inserts provided in the variable argument list (see below). |
| `traceText` | Trace information that is written into the broker service trace log (input). The information is optional, but it can be useful for debugging purposes. |
| `...` | A C variable argument list containing any message inserts that accompany the message (input). These inserts are treated as character strings, and the variable arguments are assumed to be of type pointer to char. |
| | **Note:** The last argument in this list **must** be (char*)0. |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cciRethrowLastException

Rethrows the last exception generated on the current thread. It is used to pass the exception back to the message broker for further handling.

```
void cciRethrowLastException(int* returnCode);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## cciThrowException

Throws an exception. The exception is thrown by the message broker interface using the specified arguments as exception data.

```
void cciThrowException(
  int*                returnCode,
  CCI_EXCEPTION_TYPE  type,
  char*               file,
  int                 line,
  char*               function,
  CciChar*            messageSource,
  int                 messageNumber,
  char*               traceText,
                      ...);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |

| | |
|---|---|
| `type` | The type of exception (input). Valid values are:<br>`CCI_FATAL_EXCEPTION`<br>`CCI_RECOVERABLE_EXCEPTION`<br>`CCI_CONFIGURATION_EXCEPTION`<br>`CCI_PARSER_EXCEPTION`<br>`CCI_CONVERSION_EXCEPTION`<br>`CCI_DATABASE_EXCEPTION`<br>`CCI_USER_EXCEPTION` |
| `file` | The source file name where the exception was generated (input). The value is optional, but it can be useful for debugging purposes. |
| `line` | The line number in the source file where the exception was generated (input). The value is optional, but it can be useful for debugging purposes. |
| `function` | The function name which generated the exception (input). The value is optional, but it can be useful for debugging purposes. |
| `messageSource` | A string that identifies the Windows message source or Unix message catalog (see "Using event logging from a plug-in" on page 75). |
| `messageNumber` | The message number identifying the exception (input). If `messageNumber` is specified as zero, it is assumed that a message is not available. If `messageNumber` is non-zero, the specified message is written into the broker event log with any inserts provided in the variable argument list. |
| `traceText` | Trace information that will be written into the broker service trace log (input). The information is optional, but it can be useful in debugging problems. |
| `...` | A C variable argument list that contains any message inserts that accompany the message (input). These inserts are treated as character strings and the variable arguments are assumed to be of pointer to char.<br>**Note:** The last argument in this list **must** be (char*)0. |

**Return values:** None. If an error occurs, the `returnCode` parameter indicates the reason for the error.

## Character representation handling functions

These utilities help you convert between MQSeries Integrator's internal processing code (in UCS-2) and file code (for example, ASCII).

These functions are defined in the header file **BipCci.h**.

### cciMbsToUcs

Converts multi-byte string data to Universal Character Set (UCS).

```
int cciMbsToUcs(
  int*         returnCode,
  const char*  mbString,
  CciChar*     ucsString,
  int          ucsStringLength,
  int          codePage);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `mbString` | The string to be converted, expressed as 'file code' (input). |
| `ucsString` | The location of the resulting UCS-2 Unicode string (input). This will have a trailing `CciChar` of 0, just as the `mbString` has a trailing byte of 0. |
| `ucsStringLength` | The length (in `CciChars`) of the buffer that you have provided (input). Each byte in `mbString` will expand to not more than one `CciChar` and this defines an upper limit for the buffer size required. |
| `codePage` | The code page of the source string (input). '1208' (meaning code page ibm-1208, which is UTF-8 Unicode) is a good choice if you are using **cciMbsToUcs** on an ASCII system to convert string constants for processing by MQSeries Integrator. |

**Return values:** The converted length in half-words (UCS-2 characters).

### cciUcsToMbs

Converts Universal Character Set (UCS) data to multi-byte string data. This function is, typically, used only for formatting diagnostic messages. Normal processing is best done in UCS-2, which can represent all characters from all languages.

The sample code (BipSampPluginUtil.c) shows more utilities for processing UCS-2 characters in a portable way.

```
int cciUcsToMbs(
  int*           returnCode,
  const CciChar* ucsString,
  char*          mbString,
  int            mbStringLength,
  int            codePage);
```

| | |
|---|---|
| `returnCode` | This parameter receives the return code from the function (output). |
| `ucsString` | The string to be converted, expressed as UCS-2 Unicode (input). |
| `mbString` | The location of the resulting string (input). The string will have a trailing byte of 0, just as the Unicode has a trailing `CciChar` of 0. |

| | |
|---|---|
| ucsStringLength | The length (in bytes) of the buffer that you have provided (input). Each CciChar in the source string will expand to one byte (for SBCS code pages) or up to not more than the code page’s MB_CUR_MAX value (typically less than five bytes) which defines an upper limit of the buffer size required. |
| codePage | The code page that you require (input). On a Unix system, nl_langinfo(CODEPAGE) gives you the code page that has been selected by 'setlocale'. '1208' gives you UTF-8 Unicode. |

**Return values:** The converted length in bytes.

# Part 3. Appendixes

# Appendix A.  Using filters in content-based routing

The language used in the specification of filters for content-based routing (CBR) forms a proper subset of the Filter node's language (See *MQSeries Integrator Using the Control Centre*.)  A subset of the language is provided is because the processing involved in the filtering of message content when a publication is made differs from that used in the Filter node.  This processing is performed by a component of the Publish/Subscribe function in the broker, named the Matching Engine.  At publication time, many filters must be tested to see if they match the publication and the Matching Engine has been optimized to perform this task.

## Field references

```
                           ┌─"."────────────────────────┐
►►──┬──────────────────┬───▼─field name──┬─────────┬────┴──►◄
    └─Correlation Name─┘                 └─[INDEX]─┘
```

The field references that may be used in CBR filters form a subset of those supported by the Filter node.  As with the Filter node, it is necessary to specify a path in order to reference a field in a filter.  Each element of the path comprises a (possibly indexed) field name.

The syntax of a field reference is shown above, where `field name` and `Correlation Name` are identifiers.  MQSeries Integrator represents all messages as a hierarchical syntax element tree.  Each path identifies a route through that tree, which leads to a particular syntax element, starting from one of the predefined correlation names that refer to fixed points that every message has.  The following correlation names are supported for CBR:

| | |
|---|---|
| Root | Identifies the root of a published message. |
| Properties | Identifies the portion of the message in which the standard properties of a message lie. |
| Body | Identifies the last child of the root of the message, which is usually, but not always, the application data that follows any headers. |
| None of Root, Properties or Body | An implicit `Body.` prefix is added to the field reference. |

Here are some examples of field references, together with their meanings:

| | |
|---|---|
| Person.Salary | Refers to the Salary field in the Person entity in the body of the message. |
| Body.Person.Address[0] | Refers to the first Address field in the Person entity in the body of the message. |
| Properties.Topic | Refers to the "Topic" field in the standard properties of a message. |
| Root.MQMD.UserIdentifier | Refers to the `UserIdentifier` field in the MQMD of the message. |

**Note:** Path elements of "`*`" and the array index "`LAST`" are not supported in CBR filters.

## Specifying a filter

A filter is specified through a combination of predicates as shown here:

```
►►──┬─────┬──Predicate──┬──────────────────────────────────────┬──────────►
    └─NOT─┘             │ ┌──────────────────────────────────┐ │
                        └─▼─AND──┬─────┬──Predicate──────────┴─┘
                                 └─NOT─┘

►──┬──────────────────────────────────┬──►◄
   │ ┌──────────────────────────────┐ │
   └─▼─OR──┬─────┬──Predicate───────┴─┘
           └─NOT─┘
```

```
►►──┬─SetPredicate────────┬─────────────────────────────────────────►◄
    ├─ComparisonPredicate─┤
    ├─BetweenPredicate────┤
    ├─NullPredicate───────┤
    ├─LikePredicte────────┤
    └─Expression──────────┘
```

```
►►──Expression──┬─<>─┬──Expression──────────────────────────────────►◄
                ├─<──┤
                ├─>──┤
                ├─<=─┤
                ├─>=─┤
                └─=──┘
```

```
►►──Expression──IS──┬─────┬──NULL───────────────────────────────────►◄
                    └─NOT─┘
```

```
►►──Expression──┬─────┬──BETWEEN──Expression──AND──Expression───────►◄
                └─NOT─┘
```

```
►►──Expression──┬─────┬──LIKE──String──┬──────────┬─────────────────►◄
                └─NOT─┘                └─/String──┘
```

```
►►──Expression──┬─────┬──IN──Expression──┬────────────────┬─────────►◄
                └─NOT─┘                  │ ┌─,──────────┐ │
                                         └─▼─Expression─┴─┘
```

**Note:** The Between predicate is Asymmetric only (that is, the lowest value must be specified as the first operand).

Predicates comprise expressions that can take the following form:

```
►►──┬─────┬──Element──┬──────────────────────────────────────┬──────────────────────────►
    ├─"+"─┤           │ ┌──────────────────────────────────┐ │
    └─"-"─┘           └─▼─┬─"*"─┬────┬─────┬────Element──┴─┘
                          └─"/"─┘    ├─"+"─┤
                                     └─"-"─┘

►──┬───────────────────────────────────────────────────────────────────────────────┬──►◄
   │ ┌───────────────────────────────────────────────────────────────────────────┐ │
   └─▼─┬─"*"─┬────┬─────┬────Element──┬────────────────────────────────────────┬─┴─┘
       └─"/"─┘    ├─"+"─┤             │ ┌────────────────────────────────────┐ │
                  └─"-"─┘             └─▼─┬─"*"─┬─────┬─────┬────Element───┴─┘
                                          └─"/"─┘     ├─"+"─┤
                                                      └─"-"─┘
```

An Element can be one of:

| | |
|---|---|
| A Field Reference | As described above |
| A String Literal | A character string. The length of the string is the number of characters in the sequence. If the length is zero, the value is called the empty string. The latter is not a NULL value. The String may include double quote characters. Single quotes or backslashes should be preceded by a backslash, so that: `Field1='Howard\'s "Bubble" Car\\Stephanie\'s Cycle'` expresses a single valid string literal that will be matched against a message with Field1 set to the string: `'Howard's "Bubble" Car\Stephanie's Cycle'` |
| An Integer Literal | Signed or unsigned, 64 bit, for example: `Field1 = -123` |
| A Floating Point Literal | Represented by two numbers separated by an "E". The first number may include a sign and a decimal point. The second may include a sign but not a decimal point. For example: `Field1=-1.79E+23` |
| A Boolean Literal | May be TRUE or FALSE. |
| A Filter specification | Allowing the nesting of filter expressions. |

## Some filter examples

| | |
|---|---|
| Person.Salary>10000 | Filtering against an integer literal |
| `"Person.Address"[1]NOT LIKE'Blen%'AND"Person.Salary">15000` | A more complex filter. Note that field identifiers may optionally be surrounded by double quotes. |
| Body.Date1='2000-02-14' | Filtering against a date. The date is matched as a string and care must be taken with its layout (see below). |
| Person.ApprovalFlag | Filtering against a Boolean field. |
| Person.Salary+Person.Bonus>Person.Limit | An arithmetic filter. |
| Properties.Topic='employees/marketing' | Filtering on a message property. |
| Root.MQMD.UserIdentifier='Blair' | Filtering on a message attribute. |
| Person.HourlyRate = 10.24 | Filtering against a float literal |

| | |
|---|---|
| Planet.DistanceFromSun = 0.93E8 | Filtering against a float literal in exponential format |

## Datatypes and type mappings

CBR exploits a set of four internal datatypes. These are:

- String
- Integer
- Float
- Boolean

The set of supported MQSeries Integrator datatypes are mapped to these types in the following way.

**Character**

A value of the CHARACTER datatype is mapped to a CBR String representation comprising two-byte Unicode characters.

**Boolean**

A value of the BOOLEAN datatype is mapped to the CBR Boolean type, which may be true or false. An implicit cast is supported between string literals 'TRUE' and 'FALSE' and the corresponding boolean values (for example, if message field Body.Field1 is set to 'True', it will match a boolean value of true).

**Integer**

A value of the INTEGER datatype is mapped to a CBR integer value, which is an exact numeric number stored with 64-bit binary precision.

**Float**

A value of the FLOAT datatype is mapped to a CBR float value, which is a 64-bit binary approximation of a real number, implemented as the platform's 'double precision'.

The number can be zero or can range from approximately -1.79769E+308 to -2.225E-307, or from 2.225E-307 to 1.79769E+308.

**Decimal**

A value of the DECIMAL datatype is mapped to a CBR float value which is a 64 bit binary approximation of a real number (see above).

**Date**

A value of the DATE datatype is mapped to a string representation of the form 'YYYY-MM-DD', allowing filters such as Body.Date1='2000-02-14' to be specified.

**Time and GMTTime**

A value of the TIME datatype is mapped to a string representation of the form ‘HH:MM:SS[.UUUUUU]’, allowing filters such as Body.Time1=‘10:36:11’ to be specified. (UUUUUU indicates a number of microseconds.)

**GMTTIMESTAMP**

A value of the DATE datatype is mapped to a string representation of the form ‘YYYY-MM-DD HH:MM:SS[.UUUUUU]’. (UUUUUU indicates a number of microseconds.)

**Interval**

A value of the Interval datatype is mapped to a string representation, allowing filters such as Body.Date1=‘2002-01 YEAR TO MONTH’ to be specified.

**Bit Array**

A value of the Bit Array datatype is mapped to a String of 0’s and 1’s which may be matched lexicographically against filters that include equivalent strings of 0’s and 1’s. There is no restriction on the number of 0’s and 1’s in the sequence.

**Byte Arrays**

A value of the Byte Array datatype is mapped to a string representation, so that, for example, a Byte Array with value 0x0102 is mapped into the ASCII string ‘0102’). This allows Byte Array values to be matched against filter expression string literals (for example, a filter that specified Body.Field1=‘0102’ will match a Byte Array field value of 0x0102 in the message).

## Implicit type casting

No explicit CAST operation is provided for use in CBR filters but a limited implicit casting scheme is provided. This is illustrated in the table below.

| Filter Expression | Publication Content | Implicit Cast |
|---|---|---|
| Integer Literal, for example: `Field1=100` or `Field2>100` | String, for example: `Field1 is ‘100’` | The publication content will be cast to an Integer, provided it is numeric and contains no decimal points or exponent. |
| Float Literal, for example: `Field1=1.78E+11` or `Field2>1.78E+11` | String, for example: `Field1 is ‘1.78E+11’` | The publication content may be cast to a Float, provided it is numeric. |
| Float Literal, for example: `Field1=1.78E+2` or `Field2<1.78E+2` | Integer, for example: `Field1 is 178` | The publication content may be cast to a Float. |

| Filter Expression | Publication Content | Implicit Cast |
|---|---|---|
| Integer Literal, for example: `Field1=178` or `Field2>178` | Float, for example: `Field1 is 1.78E+2` | The publication content may be cast to an Integer. An integer comparison is always performed in this case. |
| A boolean literal or expression, for example: `Field1=TRUE` or `Field2` | String, for example: `Field1 is ‘True’` or `Field2 is ‘True’` | The publication content may be cast to an Boolean, provided it is a string value of ‘True’ or ‘False’ (irrespective of case). |
| A String literal | Another type | The publication content may be cast to a string (a lexicographical comparison is made). |

## Error reporting and logging

The CBR Matching Engine will report errors found in a publication by returning a Response message with code MQRCCF_FILTER_ERROR to the publisher. For example, a message format error that is found when parsing a message for specific fields to match will be reported in this way.

Similarly, where the CBR Matching engine determines that a subscriber’s filter is in error, a Response message with code MQRCCF_FILTER_ERROR will be returned to the subscriber.

There are, however, a class of errors that will be found in subscriptions only at publication time. Such errors will be reported in the event log. One example of this kind of error would be where a filter sought to apply an arithmetic operation to a field in a message of String type that could not be implicitly cast to a numeric.

## Rounding errors and overflows

The CBR Matching Engine will disallow filter expressions that violate the boundaries of the numeric datatypes returning a message with an MQRCCF_FILTER_ERROR to the subscriber. It does not, however, check numeric datatype overflows that result from arithmetic expressions (for example, Field1+Field2*Field3>23E+200). In such cases, the results are unpredictable.

The CBR Float datatype can support 15 digits precision. Special care should be taken when performing arithmetic on floats because individual rounding errors rapidly become compounded.

# Appendix B. Notices

## Trademarks

# Part 4. Glossary and index

# Glossary of terms and abbreviations

This glossary defines MQSeries Integrator terms and abbreviations used in this book. If you do not find the term you are looking for, see the index or the *IBM Dictionary of Computing*, New York: McGraw-Hill, 1994.

This glossary includes terms and definitions from the *American National Dictionary for Information Systems*, ANSI X3.172-1990, copyright 1990 by the American National Standards Institute. Copies may be ordered from the American National Standards Institute, 11 West 42 Street, New York, New York 10036. Definitions are identified by the symbol (A) after the definition.

## A

**Access Control List (ACL)**. The list of principals that have explicit permissions (to publish, to subscribe to, and to request persistent delivery of a publication message) against a topic in the topic tree. The ACLs define the implementation of topic-based security.

**ACL**. Access Control List.

**AMI**. Application Messaging Interface.

**Application Messaging Interface (AMI)**. The programming interface provided by MQSeries that defines a high level interface to message queuing services. See also **MQI** and **JMS**.

## B

**blob**. Binary Large OBject. A block of bytes of data (for example, the body of a message) that has no discernible meaning, but is treated as one solid entity that cannot be interpreted. Also written as BLOB.

**broker**. See **message broker**.

**broker domain**. A collection of brokers that share a common configuration, together with the single Configuration Manager that controls them.

## C

**callback function**. See *implementation function*.

**category**. An optional grouping of messages that are related in some way. For example, messages that relate to a particular application.

**check in**. The Control Center action that stores a new or updated resource in the configuration or message respository.

**check out**. The Control Center action that extracts and locks a resoource from the configuration or message respository for local modification by a user. Resources from the two repositories can only be worked on when they are checked out by an authorized user, but can be viewed (read only) without being checked out.

**collective**. A hyperconnected (totally connected) set of brokers forming part of a multi-broker network for publish/subscribe applications.

**configuration**. In the broker domain, the brokers, execution groups, message flows and message sets assigned to them, topics and access control specifications.

**Configuration Manager**. A component of MQSeries Integrator that acts as the interface between the configuration repository and an executing set of brokers. It provides brokers with their initial configuration, and updates them with any subsequent changes. It maintains the broker domain configuration.

**configuration repository**. Persistent storage for broker configuration and topology definition.

**connector**. See **message processing node connector**.

**content-based filter**. An expression that is applied to the content of a message to determine how the message is to be processed.

**context tag**. A tag that is applied to an element within a message to enable that element to be treated differently in different contexts. For example, an element could be mandatory in one context and optional in another.

**Control Center**. The graphical interface that provides facilities for defining, configuring, deploying, and monitoring resources of the MQSeries Integrator network.

## D

**datagram**. The simplest form of message that MQSeries supports. Also known as *send-and-forget*. This type of message does not require a reply. Compare with *request/reply*.

**deploy**. Make operational the configuration and topology of the broker domain.

**destination list**. A list of internal and external destinations to which a message is sent. These can be nodes within a message flow (for example, when using the RouteToLabel and Label nodes) or MQSeries queues (when the list is examined by an MQOutput node to determine the final target for the message).

**distribution list**. A list of MQSeries queues to which a message can be put using a single statement.

**Document Type Definition**. The rules that specify the structure for a particular class of SGML or XML documents. The DTD defines the structure with elements, attributes, and notations, and it establishes constraints for how each element, attribute, and notation can be used within the particular class of documents. A DTD is analogous to a database schema in that the DTD completely describes the structure for a particular markup language.

**DTD**. Document Type Definition

## E

**e-business**. A term describing the commercial use of the Internet and World Wide Web to conduct business (short for electronic-business).

**element**. A unit of data within a message that has business meaning, for example, street name

**element qualifier**. See **context tag**.

**ESQL**. Extended SQL. A specialized set of SQL statements based on regular SQL, but extended with statements that provide specialized functions unique to MQSeries Integrator.

**exception list**. A list of exceptions that have been generated during the processing of a message, with supporting information.

**execution group**. A named grouping of message flows that have been assigned to a broker. The broker is guaranteed to enforce some degree of isolation between message flows in distinct execution groups by ensuring that they execute in separate address spaces, or as unique processes.

**Extensible Markup Language (XML)**. A W3C standard for the representation of data.

## F

**filter**. An expression that is applied to the content of a message to determine how the message is to be processed.

**format**. A format defines the internal structure of a message, in terms of the fields and order of those fields. A format can be self-defining, in which case the message is interpreted dynamically when read.

## G

**graphical user interface (GUI)**. An interface to a software product that is graphical rather than textual. It refers to window-based operational characteristics.

## I

**implementation function**. Function written by a third-party developer for a plug-in node or parser. Also known as a *callback function*.

**input node**. A message flow node that represents a source of messages for the message flow.

**installation mode**. The installation mode can be Full, Custom, or Broker only. The mode defines the components of the product installed by the installation process on Windows NT systems.

## J

**Java Database Connectivity (JDBC)**. An application programming interface that has the same characteristics as **ODBC** but is specifically designed for use by Java database applications.

**Java Development Kit (JDK)**. A software package that can be used to write, compile, debug, and run Java applets and applications.

**Java Message Service (JMS)**. An application programming interface that provides Java language functions for handling messages.

**Java Runtime Environment**. A subset of the Java Development Kit (JDK) that contains the core executables and files that constitute the standard Java platform. The JRE includes the Java Virtual Machine, core classes and supporting files.

**JDBC**. Java Database Connectivity.

**JDK**. Java Development Kit.

**JMS**. Java Message Service. See also **AMI** and **MQI**.

**JRE**. Java Runtime Environment.

## L

**local error log**. A generic term that refers to the logs to which MQSeries Integrator writes records on the local system. On Windows NT, this is the Event log. On UNIX systems, this is the syslog. See also system log. Note that MQSeries records many events in the log that are not errors, but information about events that occur during operation, for example, successful deployment of a configuration.

## M

**message broker**. A set of execution processes hosting one or more message flows.

**messages**. Entities exchanged between a broker and its clients.

**message dictionary**. A repository for (predefined) message type specifications.

**message domain**. The source of a message definition. For example, a domain of MRM identifies messages defined using the Control Center, a domain of NEON identifies messages created using the NEON user interfaces.

**message flow**. A directed graph that represents the set of activities performed on a message or event as it passes through a broker. A message flow consists of a set of message processing nodes and message processing node connectors.

**message flow component**. See **message flow**.

**message parser**. A program that interprets a message bitstream.

**message processing node**. A node in the message flow, representing a well defined processing stage. A message processing node can be one of several primitive types or can represent a subflow.

**message processing node connector**. An entity that connects the output terminal of one message processing node to the input terminal of another. A message processing node connector represents the flow of control and data between two message flow nodes.

**message queue interface (MQI)**. The programming interface provided by MQSeries queue managers. The programming interface allows application programs to access message queuing services. See also **AMI** and **JMS**.

**message repository**. A database holding message template definitions.

**message set**. A grouping of related messages.

**message template**. A named and managed entity that represents the format of a particular message. Message templates represent a business asset of an organization.

**message type**. The logical structure of the data within a message. For example, the number and location of character strings.

**metadata**. Data that describes the characteristic of stored data.

**MQI**. Message queue interface.

**MQRFH**. An architected message header that is used to provide metadata for the processing of a message. This header is supported by MQSeries Publish/Subscribe.

**MQRFH2**. An extended version of MQRFH, providing enhanced function in message processing.

**multi-level wildcard**. A wildcard that can be specified in subscriptions to match any number of levels in a topic.

## N

**node**. See **message processing node**.

## O

**ODBC**. Open Database Connectivity.

**Open Database Connectivity**. A standard application programming interface (API) for accessing data in both relational and non-relational database management systems. Using this API, database applications can access data stored in database management systems on a variety of computers even if each database management system uses a different data storage format and programming interface. ODBC is based on the call level interface (CLI) specification of the X/Open SQL Access Group.

**output node**. A message processing node that represents a point at which messages flow out of the message flow.

## P

**plug-in**. An extension to the broker, written by a third-party developer, to provide a new message processing node or message parser in addition to those supplied with the product. See also *implementation function* and *utility function*.

**point-to-point**. Style of messaging application in which the sending application knows the destination of the message. Compare with *publish/subscribe*.

**POSIX**. Portable Operating System Interface For Computer Environments. An IEEE standard for computer operating systems (for example, AIX and Sun Solaris).

**predefined message**. A message with a structure that is defined before the message is created or referenced. Compare with *self-defining message*.

**primitive**. A message processing node that is supplied with the product.

**principal**. An individual user ID (for example, a log-in ID) or a group. A group can contain individual user IDs and other groups, to the level of nesting supported by the underlying facility.

**property**. One of a set of characteristics that define the values and behaviors of objects in the Control Center. For example, message processing nodes and deployed message flows have properties.

**publication node**. An end point of a specific path through a message flow to which a client application subscribes. A publication node has an attribute, subscription point. If this is not specified, the publication node represents the default subscription point for the message flow.

**publish/subscribe**. Style of messaging application in which the providers of information (publishers) are decoupled from the consumers of that information (subscribers) using a broker. Compare with *point-to-point*. See also *topic*.

**publisher**. An application that makes information about a specified topic available to a broker in a publish/subscribe system.

## Q

**queue**. An MQSeries object. Message queuing applications can put messages on, and get messages from, a queue. A queue is owned and maintained by a queue manager. Local queues can contain a list of messages waiting to be processed. Queues of other types cannot contain messages: they point to other queues, or can be used as models for dynamic queues.

**queue manager**. A system program that provides queuing services to applications. It provides an application programming interface (the MQI) so that programs can access messages on the queues that the queue manager owns.

## R

**retained publication**. A published message that is kept at the broker for propagation to clients that subscribe at some point in the future.

**request/reply**. Type of messaging application in which a request message is used to request a reply from another application. Compare with *datagram*.

**rule**. A rule is a definition of a process, or set of processes, applied to a message on receipt by the broker. Rules are defined on a message format basis, so any message of a particular format will be subjected to the same set of rules.

## S

**self-defining message**. A message that defines its structure within its content. For example, a message coded in XML is self-defining. Compare with *pre-defined message*.

**send and forget**. See *datagram*.

**setup type**. The definition of the type of installation requested on Windows NT systems. This can be one of **Full**, **Broker only**, or **Custom**.

**shared**. All configuration data that is shared by users of the Control Center. This data is not operational until it has been deployed.

**signature**. The definition of the external characteristics of a message processing node.

**single-level wildcard**. A wildcard that can be specified in subscriptions to match a single level in a topic.

**subscriber**. An application that requests information about a specified topic from a publish/subscribe broker.

**subscription**. Information held within a publication node, that records the details of a subscriber application, including the identity of the queue on which that subscriber wants to receive relevant publications.

**subscription filter**. A predicate that specifies a subset of messages to be delivered to a particular subscriber.

**subscription point**. An attribute of a publication node that differentiates it from other publication nodes on the same message flow and therefore represents a specific path through the message flow. An unnamed publication node (that is, one without a specific subscription point) is known as the default publication node.

**system log**. A generic term used in the MQSeries Integrator messages (BIPxxx) that refers to the local error logs to which records are written on the local system. On Windows NT, this is the Event log. On UNIX systems, this is the syslog. See also local error log.

## T

**terminal**. The point at which one node in a message flow is connected to another node. Terminals enable you to control the route that a message takes, depending whether the operation performed by a node on that message is successful.

**topic**. A character string that describes the nature of the data that is being published in a publish/subscribe system.

**topic based subscription**. A subscription specified by a subscribing application that includes a topic for filtering of publications.

**topic security**. The use of ACLs applied to one or more topics to control subscriber access to published messages.

**topology**. In the broker domain, the brokers, collectives, and connections between them.

**transform**. A defined way in which a message of one format is converted into one or more messages of another format.

## U

**Uniform Resource Identifier**. The generic set of all names and addresses that refer to World Wide Web resources.

**Uniform Resource Locator**. A specific form of URI that identifies the address of an item on the World Wide Web. It includes the protocol followed by the fully qualified domain name (sometimes called the host name) and the request. The Web server typically maps the request portion of the URL to a path and file name. Also known as Universal Resource Locator.

**URI**. Uniform Resource Identifier

**URL**. Uniform Resource Locator

**User Name Server**. The MQSeries Integrator component that interfaces with operating system facilities to determine valid users and groups.

**utility function**. Function provided by MQSeries Integrator for the benefit of third-party developers writing plug-in nodes or parsers.

## W

**warehouse**. A persistent, historical datastore for events (or messages). The **Warehouse** node within a message flow supports the recording of information in a database for subsequent retrieval and processing by other applications.

**wildcard**. A character that can be specified in subscriptions to match a range of topics. See also *multilevel wildcard* and *single-level wildcard*.

**wire format**. This describes the physical representation of a message within the bit-stream.

**W3C**. World Wide Web Consortium. An international industry consortium set up to develop common protocols to promote evolution and interoperability of the World Wide Web.

## X

**XML**. Extensible Markup Language.

# Index

# Sending your comments to IBM

**MQSeries® Integrator**

**Programming Guide**

**SC34-5603-01**

If you especially like or dislike anything about this book, please use one of the methods listed below to send your comments to IBM.

Feel free to comment on what you regard as specific errors or omissions, and on the accuracy, organization, subject matter, or completeness of this book. Please limit your comments to the information in this book and the way in which the information is presented.

To request additional publications, or to ask questions or make comments about the functions of IBM products or systems, you should talk to your IBM representative or to your IBM authorized remarketer.

When you send comments to IBM, you grant IBM a nonexclusive right to use or distribute your comments in any way it believes appropriate, without incurring any obligation to you.

You can send your comments to IBM in any of the following ways:

- By mail, use the Readers' Comment Form
- By fax:
  - From outside the U.K., after your international access code use 44 1962 870229
  - From within the U.K., use 01962 870229
- Electronically, use the appropriate network ID:
  - IBM Mail Exchange: GBIBM2Q9 at IBMMAIL
  - IBMLink: HURSLEY(IDRCF)
  - Internet: idrcf@hursley.ibm.com

Whichever you use, ensure that you include:

- The publication number and title
- The page number or topic to which your comment applies
- Your name and address/telephone number/fax number/network ID.

# Readers' Comments

**MQSeries® Integrator**

**Programming Guide**

**SC34-5603-01**

Use this form to tell us what you think about this manual. If you have found errors in it, or if you want to express your opinion about it (such as organization, subject matter, appearance) or make suggestions for improvement, this is the form to use.

To request additional publications, or to ask questions or make comments about the functions of IBM products or systems, you should talk to your IBM representative or to your IBM authorized remarketer. This form is provided for comments about the information in this manual and the way it is presented.

When you send comments to IBM, you grant IBM a nonexclusive right to use or distribute your comments in any way it believes appropriate without incurring any obligation to you.

Be sure to print your name and address below if you would like a reply.

| | |
|---|---|
| Name | Address |
| Company or Organization | |
| Telephone | Email |

**MQSeries® Integrator**

**MQSeries Integrator Version 2.0.1 Programming Guide SC34-5603-01**

**You can send your comments POST FREE on this form from any one of these countries:**

| | | | | | |
|---|---|---|---|---|---|
| Australia | Finland | Iceland | Netherlands | Singapore | United States of America |
| Belgium | France | Israel | New Zealand | Spain | |
| Bermuda | Germany | Italy | Norway | Sweden | |
| Cyprus | Greece | Luxembourg | Portugal | Switzerland | |
| Denmark | Hong Kong | Monaco | Republic of Ireland | United Arab Emirates | |

If your country is not listed here, your local IBM representative will be pleased to forward your comments to us. Or you can pay the postage and send the form direct to IBM (this includes mailing in the U.K.).

1 Cut along this line

2 Fold along this line

By air mail
*Par avion*

IBRS/CCRI NUMBER: PHQ - D/1348/SO

NE PAS AFFRANCHIR

NO STAMP REQUIRED

REPONSE PAYEE
GRANDE-BRETAGNE

IBM United Kingdom Laboratories
Information Development Department (MP095)
Hursley Park,
WINCHESTER, Hants
SO21 2ZZ United Kingdom

3 Fold along this line

*From:* Name ____________________

Company or Organization ____________________

Address ____________________

____________________

EMAIL ____________________

Telephone ____________________

1 Cut along this line

4 Fasten here with adhesive tape

Printed in the United States of America
on recycled paper containing 10%
recovered post-consumer fiber.

SC34-5603-01