Application Programming Guide
Note!
Before using this information and the product it supports, be sure to read the general information under Appendix G, "Notices", on page 599.

Third edition (December 2002)
This edition applies to the following WebSphere MQ V5.3 products:
- WebSphere MQ for AIX
- WebSphere MQ for HP-UX
- WebSphere MQ for iSeries
- WebSphere MQ for Linux for Intel and Linux for zSeries™
- WebSphere MQ for Solaris
- WebSphere MQ for z/OS
- WebSphere MQ for Windows

and to all subsequent releases and modifications until otherwise indicated in new editions.

Some information applies to these products:
- MQSeries for AT&T GIS UNIX, V2.2
- MQSeries for Compaq NonStop Kernel, V5.1
- MQSeries for Compaq OpenVMS Alpha, V5.1
- MQSeries for Compaq Tru64 UNIX, V5.1
- MQSeries for OS/2 Warp, V5.1
- MQSeries for SINIX and DC/OSx, V2.2
- MQSeries for Sun Solaris, Intel Platform Edition, V5.1
- MQSeries for VSE/ESA, V2.1.1

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# Contents

**Figures** ........................................... xi

**Tables** ........................................... xiii

**About this book** ................................... xv
- Who this book is for ................................ xv
- What you need to know to understand this book ... xv
- How to use this book ................................ xv
- Appearance of text in this book ....................... xvi
- Terms used in this book ................................ xvi

**Summary of changes** ................................. xix
- Changes for this edition (SC34-6064-02) ............ xix
- Changes for the previous editions (SC34-6064-00 and -01) ........................................... xix

**Part 1. Designing applications that use WebSphere MQ** ........................................... 1

**Chapter 1. Introduction to message queuing** ........................................... 3
- What is message queuing? .............................. 3
- What is a message? .................................... 4
  - Message descriptor ................................ 4
  - Message channel agent ............................... 4
- What is a message queue? ............................. 4
- What is a queue manager? ............................ 5
- What is a cluster? ..................................... 5
- What is a shared queue, a queue-sharing group, and intra-group queuing? .................................... 6
- What is a WebSphere MQ client? ....................... 6
- Main features of message queuing .................... 6
  - WebSphere MQ clients and servers .................. 8
- Benefits of message queuing to the application designer and developer ................................. 8
- What can you do with WebSphere MQ products? ......... 9
  - WebSphere MQ for z/OS ................................ 9
  - WebSphere MQ for non-z/OS platforms ............... 10

**Chapter 2. Overview of application design** ........................................... 11
- Planning your design ................................ 11
- Using WebSphere MQ objects ......................... 12
- Designing your messages ............................... 13
- WebSphere MQ techniques .............................. 14
  - Waiting for messages ................................ 14
  - Correlating replies .................................. 14
  - Setting and using context information ............... 14
  - Starting WebSphere MQ programs automatically ... 15
- Generating WebSphere MQ reports .................... 15
- Clusters and message affinities ....................... 15
- Application programming .............................. 15
- Call interface ........................................ 16

**Chapter 3. WebSphere MQ messages** ........................................... 19
- Message descriptor .................................. 20
- Types of message .................................... 20
  - Datagrams .......................................... 20
  - Request messages ................................... 21
  - Reply messages ..................................... 21
  - Report messages .................................... 21
  - Reports and segmented messages .................... 23
- Format of message control information and message data ........................................... 26
  - Format of message control information .............. 26
  - Format of message data ............................... 26
  - Application data conversion ......................... 27
- Message priorities ................................... 28
- Message groups ....................................... 28
- Message persistence .................................. 30
- Selecting messages from queues ....................... 31
- Messages that fail to be delivered ..................... 31
- Messages that are backed out ......................... 31
- Reply-to queue and queue manager ..................... 32
- Message context ....................................... 32
  - Identity context .................................... 33
  - Origin context ....................................... 33

**Chapter 4. WebSphere MQ objects** ........................................... 35
- Queue managers ....................................... 35
  - Attributes of queue managers ....................... 35
  - Queue managers and workload management .......... 36
  - Queue-sharing groups ................................ 36
- Queues ................................................ 37
  - Types of queue ..................................... 37
  - Attributes of queues ................................ 39
  - Remote queues ...................................... 40
  - Alias queues ........................................ 40
  - Model queues ....................................... 41
  - Dynamic queues ..................................... 41
  - Transmission queues ................................ 43
  - Initiation queues ................................... 43
  - Dead-letter (undelivered message) queues .......... 44
  - System command queues ............................... 44
  - System default queues ............................... 44
- Namelists .............................................. 44
- Process definitions ................................... 45
- AUTHINFO objects .................................... 45
- Channels ............................................... 45
- Storage classes ........................................ 45
- Rules for naming WebSphere MQ objects ............... 46
  - Queue names ......................................... 46
  - Process definition, AUTHINFO and namelist names ........................................... 47

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# Table of Contents

## Chapter 16. Using and writing applications on WebSphere MQ for z/OS
- Environment-dependent WebSphere MQ for z/OS functions ........................................ 259
- Program debugging facilities .................................................................................. 260
- Syncpoint support .................................................................................................... 260
- Recovery support ..................................................................................................... 261
- The WebSphere MQ for z/OS interface with the application environment .......... 261
- The batch adapter ..................................................................................................... 261
- RRS batch adapter ................................................................................................... 261
- The CICS adapter .................................................................................................... 262
- The IMS adapter ...................................................................................................... 265
- Writing z/OS OpenEdition applications .................................................................. 266
- The API-crossing exit for z/OS ............................................................................... 267
- Using the API-crossing exit ................................................................................... 267
- Writing your own exit program ............................................................................... 268
- The sample API-crossing exit program, CSQCAPX ............................................. 270
- Preparing and using the API-crossing exit ............................................................. 270
- WebSphere MQ Workflow ....................................................................................... 271
- Application programming with shared queues ....................................................... 272
- Serialization your applications ............................................................................... 272
- Applications that are not suitable for use with shared queues ......................... 273
- Deciding whether to share non-application queues ............................................. 274
- Migrating your existing applications to use shared queues ............................... 274

## Chapter 17. Using and writing WebSphere MQ-CICS bridge applications for z/OS
- Using CICS DPL programs with the bridge ......................................................... 278
- CICS DPL bridge message structure ..................................................................... 278
- Application programming for the CICS DPL bridge ............................................. 279
- Using CICS transactions with the bridge ............................................................... 280
- Using CICS bridge vectors .................................................................................... 281
- CICS 3270 bridge message structure ..................................................................... 281
- Application programming for the CICS 3270 bridge ............................................ 283
- Transactions with start data .................................................................................... 295
- Programming for the distributed environment ..................................................... 295
- CICS transactions in the distributed environment ............................................... 295
- CICS DPL programs in the distributed environment ............................................ 296
- From 3270 legacy to 3270 bridge - an example .................................................... 296
- Exact emulation - no optimization ....................................................................... 297
- Improved emulation, with optimization ............................................................... 298
- Setting fields in the MQMD and MQCH structures ............................................. 299
- Setting the MQMD fields ...................................................................................... 299
- Setting the MQCH fields ....................................................................................... 300
- Setting the open options and put message options for the bridge request queue . 302
- Managing MsgId and CorrelId in a unit of work .................................................. 302
- Error handling by the CICS bridge ....................................................................... 304
- Debugging CICS bridge applications ................................................................... 306
- Application data structure terminology ............................................................... 308

## Chapter 18. IMS and IMS Bridge applications on WebSphere MQ for z/OS
- Writing IMS applications using WebSphere MQ ................................................. 311
- Syncpoints in IMS applications ........................................................................... 311
- MQI calls in IMS applications ............................................................................... 311
- Writing WebSphere MQ-IMS bridge applications .............................................. 315
- How the WebSphere MQ-IMS bridge deals with messages ............................. 315
- Writing your program ............................................................................................. 321

## Chapter 19. Object-oriented programming with WebSphere MQ
- What is in the WebSphere MQ Object Model? ..................................................... 325
- Classes ..................................................................................................................... 325
- Object references .................................................................................................... 326
- Return codes .......................................................................................................... 326
- Programming language considerations ................................................................. 326
- Coding in C++ ......................................................................................................... 326
- Coding in Java ........................................................................................................ 327
- Coding in ActiveX ................................................................................................. 327

## Part 3. Building a WebSphere MQ application
- EXTSHM environment variable ............................................................................. 331
- Deciding if you need to set EXTSHM=ON .............................................................. 331
- Preparing C programs ............................................................................................. 332
- Linking libraries ....................................................................................................... 332
- Preparing COBOL programs .................................................................................. 333
- Preparing COBOL programs using IBM COBOL .................................................. 333
- Set for AIX .............................................................................................................. 333
- Preparing COBOL programs using Micro Focus COBOL ................................... 333
- Preparing PL/I programs ....................................................................................... 334
- Preparing CICS programs ...................................................................................... 334
- CICS on Open Systems support ............................................................................ 334

## Chapter 20. Building your application on AIX
- Preparing C programs ............................................................................................. 337
- C compiler flags ..................................................................................................... 337
- Linking libraries ....................................................................................................... 337

## Chapter 21. Building your application on AT&T GIS UNIX
- Preparing C programs ............................................................................................. 337
- C compiler flags ..................................................................................................... 337
- Linking libraries ....................................................................................................... 337

## Chapter 22. Building your application on Compaq NonStop Kernel
- Preparing C programs ............................................................................................. 339
- C compiler flags ..................................................................................................... 339
- Linking libraries ....................................................................................................... 339
Preparing CICS and Transaction Server programs .................. 376
Preparing COBOL programs ........................................ 377
Preparing CICS and Transaction Server programs .................. 378
Preparing PL/I programs ........................................... 379
Preparing Visual Basic programs .................................. 379
Introduction to security exits ....................................... 380

Chapter 33. Building your application on z/OS ...................... 383
Preparing your program to run ........................................ 383
Building z/OS batch applications .................................... 384
Building CICS applications ........................................... 385
Building IMS (BMP or MPP) applications ............................ 386
Dynamically calling the WebSphere MQ stub ......................... 387
Debugging your programs ............................................. 391
Debugging CICS programs ............................................ 392
Debugging TSO programs ............................................. 394

Chapter 34. Using lightweight directory access protocol services with WebSphere MQ for Windows .......... 395
What is a directory service? ........................................... 395
What is LDAP? ................................................................ 395
Using LDAP with WebSphere MQ ...................................... 396
LDAP sample program ................................................... 397
Building the sample program .......................................... 397
Configuring the directory .............................................. 397
Configuring the IBM eNetwork LDAP server ....................... 398
Configuring the Netscape directory server ......................... 399
Running the sample program ......................................... 399
Program design ......................................................... 400

Part 4. Sample WebSphere MQ programs ............................... 403

Chapter 35. Sample programs (all platforms except z/OS) ............ 405
Features demonstrated in the sample programs ...................... 406
Samples for Compaq OpenVMS Alpha and UNIX systems ........... 406
Samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows ............................................. 408
PL/I samples for WebSphere MQ for AIX, MQSeries for OS/2 Warp, and WebSphere MQ for Windows ............................................. 409
Visual Basic samples for WebSphere MQ for Windows ............. 410
Samples for WebSphere MQ for iSeries .............................. 410
Samples for MQSeries for Compaq NonStop Kernel ................ 412
Samples for MQSeries for VSE/ESA ................................ 412
Preparing and running the sample programs ....................... 413
OS/400 ................................................................. 413
UNIX systems ......................................................... 413
Compaq OpenVMS Alpha ............................................. 414
OS/2 and Windows systems .......................................... 414

Compaq NonStop Kernel ............................................... 415
Running the sample programs ........................................ 420
The Put sample programs .............................................. 422
Running the amqsput and amqsputc samples ....................... 422
Running the amqput sample .......................................... 422
Running the AMQSPUT4 C sample ................................... 422
Running the AMQSPUT4 COBOL sample ............................. 423
Design of the Put sample program .................................. 423
The Distribution List sample program ............................... 423
Running the Distribution List sample, amqsptl0 ................... 423
Design of the Distribution List sample ............................. 424
The Browse sample programs ......................................... 424
OS/2, UNIX systems, Compaq OpenVMS Alpha, and Windows systems ............................................. 424
OS/400 ................................................................. 425
Design of the Browse sample program ............................... 425
The Browser sample program ........................................ 426
The Get sample programs .............................................. 426
Running the amqsget and amqsgetc samples ....................... 426
Running the amqget sample ......................................... 427
Running the AMQSGET4 and the AMQ0GET4 samples ............ 427
Design of the Get sample program .................................. 427
The Reference Message sample programs ............................ 428
Notes for OS/400 users ............................................... 428
Running the Reference Message samples ............................ 429
Design of the Put Reference Message sample (amqsprma.c, AMQSPRM4) ............................................. 433
Design of the Reference Message Exit sample (amqsxrma.c, AMQSXRM4) ............................................. 434
Design of the Get Reference Message sample (amqsgrma.c, AMQSGRM4) ............................................. 436
The Request sample programs ........................................ 436
Running the amqsreq0.c, amqsreq, and amqsreqc samples ....... 436
Running the amq0req0.cbl sample .................................. 437
Running the AMQSREQ4 sample ..................................... 437
Running the AMQ0REQ4 sample .................................... 437
Running the Request sample using triggering ....................... 437
Design of the Request sample program ............................. 440
The Inquire sample programs ........................................ 441
Design of the Inquire sample program ............................... 442
The Set sample programs ............................................. 443
Design of the Set sample program ................................. 443
The Echo sample programs ........................................... 444
Design of the Echo sample programs ................................ 445
The Data-Conversion sample program ............................... 445
Design of the data-conversion sample .............................. 445
The Triggering sample programs ..................................... 446
Running the amqstrg0.c, amqstrg, and amqstrgc samples ....... 446
Running the AMQSTRG4 sample ..................................... 446
Design of the triggering sample ..................................... 446
Running the AMQSERV4 sample ..................................... 447
Design of the trigger server ......................................... 447
Ending the triggering sample programs on OS/400 .................. 447
Running the samples using remote queues ......................... 448
Database coordination samples ...................................... 448
Creating the databases and tables .................................. 450
Figures

1. Message queuing compared with traditional communication ............ 7
2. Representation of a message .................................. 19
3. Group of logical messages ................................... 29
4. Segmented messages ......................................... 30
5. How distribution lists work .................................. 114
6. Opening a distribution list in C ................................ 116
7. Opening a distribution list in COBOL .......................... 116
8. Putting a message to a distribution list in C ................. 117
9. Putting a message to a distribution list in COBOL .......... 118
10. Logical order on a queue .................................... 125
11. Physical order on a queue ................................... 126
12. Skipping backout using MQGMO_MARK_SKIP_BACKOUT ... 144
13. Sample JCL used to invoke the CSQUCVX utility ............ 157
14. Flow of application and trigger messages ...................... 194
15. Relationship of queues within triggering ....................... 195
16. Setting of key fields for many CICS user programs in a unit of work .......... 303
17. Setting of key fields: WebSphere MQ - conversational 3270 transaction .......... 304
18. User program abends (only program in the unit of work) ........ 305
19. Fragments of JCL to link-edit the object module in the batch environment, using single-phase commit .......... 384
20. Fragments of JCL to link-edit the object module in the batch environment, using two-phase commit .......... 385
21. Fragments of JCL to link-edit the object module in the CICS environment ........ 386
22. Fragments of JCL to link-edit the object module in the IMS environment ........ 387
23. Dynamic linking using COBOL in the batch environment .......... 388
24. Dynamic linking using COBOL in the CICS environment .......... 389
25. Dynamic linking using COBOL in the IMS environment .......... 389
26. Dynamic linking using assembler language in the batch environment .......... 389
27. Dynamic linking using assembler language in the CICS environment .......... 390
29. Dynamic linking using C language in the batch environment .......... 390
30. Dynamic linking using C language in the CICS environment .......... 390
31. Dynamic linking using C language in the IMS environment .......... 391
32. Dynamic linking using PL/I in the batch environment .......... 391
33. Dynamic linking using PL/I in the IMS environment .......... 391
34. Running the Reference Message samples ....................... 429
35. Request and Inquire samples using triggering ................. 438
36. Sample OS/400 Client/Server (Echo) program flowchart .......... 441
37. The database coordination samples .......................... 449
38. Example of ubbstxcc.cfg file for UNIX systems ............... 460
39. Example of ubbstxcn.cfg file for WebSphere MQ for Windows .......... 462
40. Sample TUXEDO makefile for WebSphere MQ for Windows .......... 463
41. How TUXEDO samples work together ........................... 465
42. Example of a report from the Print Message sample application .......... 490
43. Programs and panels for the TSO versions of the Mail Manager ............... 497
44. Programs and panels for the CICS version of the Mail Manager ............... 498
45. Example of a panel showing a list of waiting messages ............... 499
46. Example of a panel showing the contents of a message ............... 500
47. Immediate Inquiry panel for the Credit Check sample application .......... 502
48. Programs and queues for the Credit Check sample application (COBOL programs only) .......... 504
49. Initial screen for Message Handler sample ........................ 514
50. Message list screen for Message Handler sample .......... 515
51. Chosen message is displayed ............................ 516

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Tables

1. The MQ_CONNECT_TYPE environment variable ................................................. 93
2. Resolving queue names when using MQOPEN .................................................. 97
3. How queue attributes and options of the MQOPEN call affect access to queues . 101
4. Using message and correlation identifiers ................................................. 131
5. Using the group identifier .............................................................................. 132
6. Skeleton source files ....................................................................................... 156
7. Linking MQSeries for OS/2 Warp with CICS Version 3 applications ............. 185
8. Essential code for CICS applications — XA initialization routine .................. 189
9. MQXR_BEFORE exit processing ...................................................................... 224
10. Valid combinations of function identifiers and ExitReasons ....................... 231
11. API exit errors and appropriate actions to take .......................................... 254
12. z/OS environmental features ........................................................................ 260
13. When to use a shared-initiation queue .......................................................... 275
14. Mapping WebSphere MQ messages to IMS transaction types ...................... 316
15. Essential Code for CICS applications (AIX) .................................................. 334
16. Summary of supported languages and environments ..................................... 339
17. Using the correct version of the MQI library for MQSeries for Compaq NonStop Kernel .......................................................... 341
18. C include files for MQSeries (Compaq Tru64 UNIX Version 4.0) .................. 345
19. C include files for MQSeries (Compaq Tru64 UNIX Version 5.0) ................. 346
20. C++ include files for MQSeries (Compaq Tru64 UNIX Version 4.0) ............ 347
21. C++ include files for MQSeries (Compaq Tru64 UNIX Version 5.0) ............ 349
22. Essential Code for CICS applications (HP-UX) .............................................. 353
23. C include files for WebSphere MQ ................................................................. 355
24. Example of CRTPGM in the nonthreaded environment .................................. 361
25. Example of CRTPGM in the threaded environment ....................................... 362
26. Essential Code for CICS applications (SINIX) ............................................. 367
27. Essential Code for CICS applications (Solaris) .............................................. 371
28. Context initiators and their associated context acceptors ............................ 380
29. Call names for dynamic linking .................................................................... 387
30. CICS adapter trace entries ............................................................................ 392
31. WebSphere MQ on UNIX and Compaq OpenVMS Alpha sample programs demonstrating use of the MQI ........................................ 406
32. MQSeries for OS/2 Warp and WebSphere MQ for Windows sample programs demonstrating use of the MQI ......................................................... 408
33. WebSphere MQ for AIX, MQSeries for OS/2 Warp and WebSphere MQ for Windows sample programs demonstrating use of the MQI ............................................... 410
34. WebSphere MQ for Windows sample programs demonstrating use of the MQI .......................................................... 410
35. WebSphere MQ for iSeries sample programs demonstrating use of the MQI .......................................................... 410
36. MQSeries for Compaq NonStop Kernel C and Cobol sample programs demonstrating use of the MQI .......................................................... 412
37. MQSeries for Compaq NonStop Kernel TAL sample programs demonstrating use of the MQI .......................................................... 412
38. MQSeries for VSE/ESA COBOL sample programs demonstrating use of the MQI .......................................................... 413
39. Where to find the samples for WebSphere MQ on UNIX systems ............... 413
40. Where to find the samples for MQSeries for Compaq OpenVMS Alpha .... 414
41. Where to find the samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows .......................................................... 414
42. Source for the distributed queuing exit samples ............................................. 475
43. Source for the data conversion exit samples (Assembler language only) .... 475
44. Source and JCL for the Put and Get samples ................................................ 476
45. Source and JCL for the Browse sample ......................................................... 476
46. Source for the Print Message sample (C language only) ............................ 476
47. Source and JCL for the Mail Manager (TSO) sample .................................... 477
48. Source for the Message Handler sample ....................................................... 478
49. Source and JCL for the Put and Get samples ................................................ 479
50. Source for the Queue Attributes sample ....................................................... 480
51. Source and JCL for the Mail Manager (CICS) sample (COBOL only) ......... 480
52. Source and JCL for the Credit Check CICS sample .................................... 480
53. Source and JCL for the Credit Check IMS sample (C only) .......................... 482
54. Language compilers and assemblers for WebSphere MQ for AIX ............... 521
55. Language compilers and assemblers for MQSeries for AT&T GIS UNIX .... 521
56. Language compilers and assemblers for MQSeries for Compaq NonStop Kernel .......................................................... 521
57. Language compilers and assemblers for MQSeries for Compaq OpenVMS Alpha .......................................................... 521
58. Language compilers and assemblers for MQSeries for Compaq Tru64 UNIX .... 521
59. Language compilers and assemblers for WebSphere MQ for HP-UX ......... 522
60. Language compilers and assemblers for WebSphere MQ for iSeries ......... 522
61. Language compilers and assemblers for WebSphere MQ for Linux .......... 522
62. Language compilers and assemblers for MQSeries for OS/2 Warp ............. 522
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.</td>
<td>Language compilers and assemblers for MQSeries for SINIX and DC/OSx.</td>
<td>522</td>
</tr>
<tr>
<td>64.</td>
<td>Language compilers and assemblers for WebSphere MQ for Solaris.</td>
<td>523</td>
</tr>
<tr>
<td>65.</td>
<td>Language compilers and assemblers for MQSeries for VSE/ESA.</td>
<td>523</td>
</tr>
<tr>
<td>66.</td>
<td>Language compilers and assemblers for WebSphere MQ for Windows.</td>
<td>523</td>
</tr>
<tr>
<td>67.</td>
<td>Language compilers and assemblers for WebSphere MQ for z/OS.</td>
<td>523</td>
</tr>
<tr>
<td>68.</td>
<td>Language compilers and assemblers for VM/ESA clients.</td>
<td>524</td>
</tr>
<tr>
<td>69.</td>
<td>Language compilers and assemblers for Windows 98 clients.</td>
<td>524</td>
</tr>
<tr>
<td>70.</td>
<td>C include files for WebSphere MQ.</td>
<td>592</td>
</tr>
<tr>
<td>71.</td>
<td>Visual Basic module files for WebSphere MQ for Windows.</td>
<td>592</td>
</tr>
<tr>
<td>72.</td>
<td>COBOL copy files.</td>
<td>594</td>
</tr>
<tr>
<td>73.</td>
<td>System/390 assembler-language macros</td>
<td>595</td>
</tr>
<tr>
<td>74.</td>
<td>PL/I include files.</td>
<td>597</td>
</tr>
</tbody>
</table>
About this book

The products and version levels listed in the "Edition Notice" on page ii are referred to in this book collectively as WebSphere® MQ. They provide application programming services that enable you to write applications in which the constituent programs communicate with each other using message queues.

This book introduces the concepts of messages and queues, and shows you in detail how to design and write applications that use the services that WebSphere MQ provides.

For a full description of the WebSphere MQ programming interface, see the appropriate application programming reference book for your platform. These are:

- **WebSphere MQ Application Programming Reference**, SC34-6062
- **WebSphere MQ for iSeries V5.3 Application Programming Reference (ILE RPG)**, SC34-6071

For information on the use of C++, see **WebSphere MQ Using C++**. For information on the use of Java™, see **WebSphere MQ Using Java**.

IBM® ships sample programs with WebSphere MQ which are explained in **Part 4, “Sample WebSphere MQ programs”, on page 403. Also, appendixes Appendix B, “C language examples”, on page 525 through Appendix E, “PL/I examples”, on page 575 give programming examples in the various languages. You may find it useful to refer to these.

Who this book is for

This book is for the designers of applications that use message queuing techniques, and for the programmers who have to implement those designs.

What you need to know to understand this book

To write message queuing applications using WebSphere MQ, you need to know how to write programs in at least one of the programming languages that WebSphere MQ supports. Appendix A, “Language compilers and assemblers”, on page 521 contains details of supported compilers and assemblers listed by WebSphere MQ platform.

If the applications you are writing will run within a CICS® or IMS™ system, you must also be familiar with CICS or IMS, and their application programming interfaces.

To understand this book, you do not need to have written message queuing programs before.

How to use this book

This book contains guidance information to help you design an application, and procedural information to help you to write an application.

The book is divided into five parts:
About this book

Part 1, “Designing applications that use WebSphere MQ”, on page 1
Introduces the message queuing style of application design, describes
WebSphere MQ messages and queues, and shows how to design a message
queuing application.

Part 2, “Writing a WebSphere MQ application”, on page 57
Describes how to use the IBM Message Queue Interface (MQI) to write the
programs that comprise a message queuing application. The chapters guide
you through the coding of each MQI call, showing you what information
to supply as input and what returns to expect. These chapters first describe
simple uses of the MQI calls, then go on to describe how to use all the features of each call.

Read Part 1, “Designing applications that use WebSphere MQ”, on page 1
to understand the concepts involved when designing WebSphere MQ
applications. The second part is self-contained: use an individual chapter
when you are performing the task described in it.

Part 3, “Building a WebSphere MQ application”, on page 329
Explains how to build your WebSphere MQ application on each platform.

Part 4, “Sample WebSphere MQ programs”, on page 403
Lists and explains how the sample programs work, for all platforms.

The appendixes
Contain examples of how to use the MQI calls in each of the programming
languages supported by WebSphere MQ.

Appearance of text in this book
This book uses the following type style:

CompCode
Example of the name of a parameter of a call, or the attribute of an object

Terms used in this book
In the body of this book, the following shortened names are used for these sets of
products:

CICS CICS for iSeries, CICS for MVS/ESA™, CICS for VSE/ESA, CICS
Transaction Server for OS/2, CICS Transaction Server for z/OS, TXSeries™
for AIX, TXSeries for HP-UX, TXSeries for Solaris, and TXSeries for
Windows products.

IMS The IMS/ESA product.

WebSphere MQ on UNIX® systems
WebSphere MQ for AIX, MQSeries for AT&T GIS UNIX, MQSeries for
Compaq Tru64 UNIX, WebSphere MQ for HP-UX, WebSphere MQ for
Linux, MQSeries for SINIX and DC/OSx, and WebSphere MQ for Solaris
(SPARC and Intel Platform Editions).

WebSphere MQ for Solaris
WebSphere MQ for Solaris (SPARC and Intel Platform Editions).

z/OS™ The z/OS System Product.

Windows® systems
Microsoft® Windows NT® or Microsoft Windows 2000

The following terms are used with a special meaning:
thlqual

The high-level qualifier of the installation library on z/OS.
Summary of changes

This section describes changes in this edition of WebSphere MQ Application Programming Guide. Changes since the previous edition of the book are marked by vertical lines to the left of the changes.

Changes for this edition (SC34-6064-02)

This edition provides additions and clarifications for users of Version 5.1 of MQSeries for Compaq NonStop Kernel, MQSeries for Compaq OpenVMS Alpha, and MQSeries for Compaq Tru64 UNIX.

Changes for the previous editions (SC34-6064-00 and -01)

The first two editions for WebSphere MQ included the following major changes:

- Changes throughout the book reflect the rebranding of MQSeries to WebSphere MQ.
- Information has been added about new functions in V5.3:
  - Message grouping in WebSphere MQ for z/OS
  - Shared (thread independent) connection handles
  - MQCONNXAny call for Visual Basic
  - API exits
  - Secure Sockets Layer (SSL) support
- Information for V5.2 previously published elsewhere has been consolidated:
  - UNIX signal handling
  - Support for WebSphere MQ for Linux
- Information has been removed about:
  - Web Administration
  - Internet Gateway
  - LotusScript extensions
- The section on "Configuring API exits" has been removed. The information can be found in the WebSphere MQ System Administration Guide.
- The section on "Elementary data types" has been removed. The information can be found in the WebSphere MQ Application Programming Reference.
- References to sample programs that are no longer shipped have been removed: amqspuwt and amqsgetw.
- The instructions for compiling C programs (including API exits and data-conversion exits) on HP-UX V11.00 have been corrected.
- A section on compiling API exits under Linux has been added.
- Other technical and editorial changes have been made.
Changes
 Part 1. Designing applications that use WebSphere MQ

Chapter 1. Introduction to message queuing
What is message queuing? ........ 3
What is a message? ................. 4
  Message descriptor ............... 4
  Message channel agent .......... 4
What is a message queue? .......... 4
What is a queue manager? .......... 5
What is a cluster? ................. 5
What is a shared queue, a queue-sharing group, and intra-group queuing? ...... 6
What is a WebSphere MQ client? ..... 6
Main features of message queuing .... 6
  WebSphere MQ clients and servers 8
Benefits of message queuing to the application designer and developer .... 8
What can you do with WebSphere MQ products? .... 9
  WebSphere MQ for z/OS ........... 9
  WebSphere MQ for non-z/OS platforms 10

Chapter 2. Overview of application design
Planning your design ............. 11
Using WebSphere MQ objects ....... 12
Designing your messages .......... 13
WebSphere MQ techniques ......... 14
  Waiting for messages .......... 14
  Correlating replies .......... 14
  Setting and using context information 14
Starting WebSphere MQ programs automatically 15
Generating WebSphere MQ reports 15
Clusters and message affinities .... 15
Application programming .......... 15
  Call interface ................ 16
  Design for performance - hints and tips 16
  Programming platforms ......... 16
  Applications for more than one platform 16
Testing WebSphere MQ applications 17

Chapter 3. WebSphere MQ messages
Message descriptor ............... 20
Types of message ................ 20
  Datagram s .................. 20
  Request messages .......... 21
  Reply messages .......... 21
  Report messages .......... 21
    Types of report message 21
    Report message options 22
Reports and segmented messages .... 23
  For reports generated by WebSphere MQ 24
  For reports generated by applications 24
  Retrieval of reports .......... 24
  Back-level queue managers .... 25
Format of message control information and message data ................. 26
  Format of message control information 26
  Format of message data .......... 26
  Application data conversion .... 27

Chapter 4. WebSphere MQ objects
Queue managers ................. 35
  Attributes of queue managers 35
  Queue managers and workload management 36
  Queue-sharing groups .......... 36
Queues ........................ 37
  Types of queue .......... 37
  Types of local queue .... 38
Attributes of queues ............... 39
Remote queues ....................... 40
Alias queues ....................... 40
Model queues ....................... 41
Dynamic queues ..................... 41
  Properties of temporary dynamic queues 42
  Properties of permanent dynamic queues 42
Uses of dynamic queues ............. 42
  Recommendations for uses of dynamic queues 43
Transmission queues ................ 43
  Initiation queues .......... 44
  Dead-letter (undelivered message) queues 44
  System command queues .... 44
  System default queues .... 44
Namelists .......................... 44
  Process definitions ......... 45
  AUTHINFO objects .......... 45
Channels ........................... 45
Storage classes ..................... 45
Rules for naming WebSphere MQ objects 46
  Queue names ................. 46
  Process definition, AUTHINFO and namelist names 47
  Channel names ............. 47
  Reserved object names .... 47

Chapter 5. Handling program errors
Locally determined errors .......... 49
  Failure of an MQI call ....... 49
  System interruptions .......... 50
Messages containing incorrect data 51
Using report messages for problem determination 52
  Creating report messages .... 52

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Requesting and receiving (MQGET) report
messages ........................................ 52
Remotely determined errors .................. 53
Problems delivering a message .............. 53
  Retry message delivery ................. 53
  Return message to sender .............. 53
Using the dead-letter (undelivered message)
queue ........................................... 53
  Dead-letter queue processing .......... 54
Chapter 1. Introduction to message queuing

The WebSphere MQ products enable programs to communicate with one another across a network of unlike components – processors, operating systems, subsystems and communication protocols – using a consistent application programming interface.

Applications designed and written using this interface are known as message queuing applications, as they use the messaging and queuing style:

**Messaging**

Programs communicate by sending each other data in messages rather than calling each other directly.

**Queuing**

Messages are placed on queues in storage, allowing programs to run independently of each other, at different speeds and times, in different locations, and without having a logical connection between them.

This chapter introduces messaging and queuing concepts, under these headings:
- “What is message queuing?”
- “What is a message?” on page 4
- “What is a message queue?” on page 4
- “What is a queue manager?” on page 5
- “What is a cluster?” on page 5
- “What is a WebSphere MQ client?” on page 6
- “Main features of message queuing” on page 6
- “Benefits of message queuing to the application designer and developer” on page 8
- “What can you do with WebSphere MQ products?” on page 9

What is message queuing?

Message queuing has been used in data processing for many years. It is most commonly used today in electronic mail. Without queuing, sending an electronic message over long distances requires every node on the route to be available for forwarding messages, and the addressees to be logged on and conscious of the fact that you are trying to send them a message. In a queuing system, messages are stored at intermediate nodes until the system is ready to forward them. At their final destination they are stored in an electronic mailbox until the addressee is ready to read them.

Even so, many complex business transactions are processed today without queuing. In a large network, the system might be maintaining many thousands of connections in a ready-to-use state. If one part of the system suffers a problem, many parts of the system become unusable.

You can think of message queuing as being electronic mail for programs. In a message queuing environment, each program from the set that makes up an application suite is designed to perform a well-defined, self-contained function in response to a specific request. To communicate with another program, a program must put a message on a predefined queue. The other program retrieves the message from the queue, and processes the requests and information contained in the message. So message queuing is a style of program-to-program communication.
Queuing is the mechanism by which messages are held until an application is ready to process them. Queuing allows you to:

- Communicate between programs (which may each be running in different environments) without having to write the communication code.
- Select the order in which a program processes messages.
- Balance loads on a system by arranging for more than one program to service a queue when the number of messages exceeds a threshold.
- Increase the availability of your applications by arranging for an alternative system to service the queues if your primary system is unavailable.

What is a message?

In message queuing, a message is simply a collection of data sent by one program and intended for another program.

WebSphere MQ defines four types of message:

- **Datagram**: A simple message for which no reply is expected
- **Request**: A message for which a reply is expected
- **Reply**: A reply to a request message
- **Report**: A message that describes an event such as the occurrence of an error

See “Types of message” on page 20 for more information about these message types.

Message descriptor

A WebSphere MQ message consists of control information and application data. The control information is defined in a message descriptor structure (MQMD) and contains such things as:

- The type of the message
- An identifier for the message
- The priority for delivery of the message

The structure and content of the application data is determined by the participating programs, not by WebSphere MQ.

Message channel agent

A message channel agent moves messages from one queue manager to another. References are made to them in this book when dealing with report messages and you will need to consider them when designing your application. See WebSphere MQ Intercommunication for more information.

What is a message queue?

A message queue, known simply as a queue, is a named destination to which messages can be sent. Messages accumulate on queues until they are retrieved by programs that service those queues.

Queues reside in, and are managed by, a queue manager (see “What is a queue manager?” on page 5). The physical nature of a queue depends on the operating system on which the queue manager is running. A queue can either be a volatile buffer area in the memory of a computer, or a data set on a permanent storage...
device (such as a disk). The physical management of queues is the responsibility of the queue manager and is not made apparent to the participating application programs.

Programs access queues only through the external services of the queue manager. They can open a queue, put messages on it, get messages from it, and close the queue. They can also set, and inquire about, the attributes of queues.

**What is a queue manager?**

A *queue manager* is a system program that provides queuing services to applications. It provides an application programming interface so that programs can put messages on, and get messages from, queues. A queue manager provides additional functions so that administrators can create new queues, alter the properties of existing queues, and control the operation of the queue manager.

For WebSphere MQ message queuing services to be available on a system, there must be a queue manager running:

- On OS/400®, z/OS, OS/2, Windows systems, Compaq OpenVMS Alpha, and UNIX systems, you can have more than one queue manager running on a single system (for example, to separate a test system from a “live” system). To an application, each queue manager is identified by a *connection handle* (**Hconn**).
- On the VSE/ESA platform you can have only one queue manager running on a single system. **Hconn** is still used, but only to give compatibility with other WebSphere MQ platforms.

Many different applications can make use of the queue manager’s services at the same time and these applications can be entirely unrelated. For a program to use the services of a queue manager, it must establish a connection to that queue manager.

For applications to be able to send messages to applications that are connected to other queue managers, the queue managers must be able to communicate among themselves. WebSphere MQ implements a *store-and-forward* protocol to ensure the safe delivery of messages between such applications.

**What is a cluster?**

A *cluster* is a network of queue managers that are logically associated in some way. Clustering is available to queue managers on all WebSphere MQ V5.3 platforms.

In a WebSphere MQ network using distributed queuing without clustering, every queue manager is independent. If one queue manager needs to send messages to another it must have defined a transmission queue and a channel to the remote queue manager.

If you group queue managers in a cluster, the queue managers can make the queues that they host available to every other queue manager in the cluster. Then, assuming you have the necessary network infrastructure in place, any queue manager can send a message to any other queue manager in the same cluster without the need for explicit channel definitions, remote queue definitions, or transmission queues.

There are two quite different reasons for using clusters: to reduce system administration and to improve availability and workload balancing.
Definition of terms

As soon as you establish even the smallest cluster you will benefit from simplified system administration. Queue managers that are part of a cluster need fewer definitions and so the risk of making an error in your definitions is reduced.

For details of all aspects of clustering, see [WebSphere MQ Queue Manager Clusters](#).

---

What is a shared queue, a queue-sharing group, and intra-group queuing?

Shared queues, queue-sharing groups, and intra-group queuing are only available on WebSphere MQ for z/OS.

A *shared queue* is a type of local queue whose messages can be accessed by one or more queue managers that are in a sysplex. (This is not the same as a queue being “shared” by more than one application, via the same queue manager.)

The queue managers that can access the same set of shared queues form a group called a *queue-sharing group* (QSG). They communicate with each other by means of a coupling facility (CF) that stores the shared queues. See [WebSphere MQ for z/OS Concepts and Planning Guide](#) for a full discussion of queue-sharing groups.

Message transfer between queue managers in a queue-sharing group is called *intra-group queuing* (IGQ), and lets you perform fast message transfer without defining channels.

---

What is a WebSphere MQ client?

*WebSphere MQ clients* are independently installable components of WebSphere MQ products. A client allows you to run WebSphere MQ applications, by means of a communications protocol, to interact with one or more Message Queue Interface (MQI) servers on other platforms and to connect to their queue managers.

For full details on how to install and use WebSphere MQ client components, see [WebSphere MQ Clients](#).

---

Main features of message queuing

The main features of applications that use message queuing techniques are:

- There are no direct connections between programs.
- Communication between programs can be time-independent.
- Work can be carried out by small, self-contained programs.
- Communication can be driven by events.
- Applications can assign a priority to a message.
- Security.
- Data integrity.
- Recovery support.

**No direct connections between programs**

Message queuing is a technique for indirect program-to-program communication. It can be used within any application where programs communicate with each other. Communication occurs by one program putting messages on a queue (owned by a queue manager) and another program getting the messages from the queue.

Programs can get messages that were put on a queue by other programs. The other programs can be connected to the same queue manager as the
receiving program, or to another queue manager. This other queue manager might be on another system, a different computer system, or even within a different business or enterprise.

There are no physical connections between programs that communicate using message queues. A program sends messages to a queue owned by a queue manager, and another program retrieves messages from the queue (see Figure 1).

As with electronic mail, the individual messages that may be part of a transaction travel through a network on a store-and-forward basis. If a link between nodes fails, the message is kept until the link is restored, or the operator or program redirects the message.

The mechanism by which a message moves from queue to queue is hidden from the programs. Therefore the programs are simpler.

Time-independent communication
Programs requesting others to do work do not have to wait for the reply to a request. They can do other work, and process the reply either when it arrives or at a later time. When writing a messaging application, you need not know (or be concerned) when a program sends a message, or when the target is able to receive the message. The message is not lost; it is retained by the queue manager until the target is ready to process it. The message stays on the queue until it is removed by a program.

Small programs
Message queuing allows you to exploit the advantages of using small, self-contained programs. Instead of a single, large program performing all the parts of a job sequentially, you can spread the job over several smaller, independent programs. The requesting program sends messages to each of

---

Figure 1. Message queuing compared with traditional communication

As with electronic mail, the individual messages that may be part of a transaction travel through a network on a store-and-forward basis. If a link between nodes fails, the message is kept until the link is restored, or the operator or program redirects the message.

The mechanism by which a message moves from queue to queue is hidden from the programs. Therefore the programs are simpler.

Program A
Comms code

Program B
Comms code

Networking software

WebSphere MQ
comms code
(Queue Manager)

Networking software
Main features

the separate programs, asking them to perform their function; when each program is complete, the results are sent back as one or more messages.

Event-driven processing

Programs can be controlled according to the state of queues. For example, you can arrange for a program to start as soon as a message arrives on a queue, or you can specify that the program does not start until there are, for example, 10 messages above a certain priority on the queue, or 10 messages of any priority on the queue.

Message priority

A program can assign a priority to a message when it puts the message on a queue. This determines the position in the queue at which the new message is added.

Programs can get messages from a queue either in the order in which the messages appear in the queue, or by getting a specific message. (A program may want to get a specific message if it is looking for the reply to a request it sent earlier.)

Security

Authorization checks are carried out on each resource, using the tables that are set up and maintained by the WebSphere MQ administrator.

- Security Server (formerly known as RACF®) or other external security managers may be used within WebSphere MQ for z/OS.
- Within WebSphere MQ on UNIX systems, Windows systems, Compaq OpenVMS Alpha, Compaq NonStop Kernel, and OS/400, a security manager called the Object Authority Manager (OAM) is provided as an installable service. By default, the OAM is active.

Data integrity

Data integrity is provided via units of work. The synchronization of the start and end of units of work is fully supported as an option on each MQGET or MQPUT, allowing the results of the unit of work to be committed or rolled back. Syncpoint support operates either internally or externally to WebSphere MQ depending on the form of syncpoint coordination selected for the application.

Recovery support

For recovery to be possible, all persistent WebSphere MQ updates are logged. Hence, in the event that recovery is necessary, all persistent messages will be restored, all in-flight transactions will be rolled back and any syncpoint commit and backouts will be handled in the normal way of the syncpoint manager in control. For more information on persistent messages, see “Message persistence” on page 30.

WebSphere MQ clients and servers

A server application will not have to be changed to be able to support additional WebSphere MQ clients on new platforms.

Similarly, the WebSphere MQ client will, without change, be able to function with additional types of server. See [WebSphere MQ Clients] for more information.

Benefits of message queuing to the application designer and developer

Some of the benefits of message queuing are:
Benefits of message queuing

- You can design applications using small programs that you can share between many applications.
- You can quickly build new applications by reusing these building blocks.
- Applications written to use message queuing techniques are not affected by changes in the way queue managers work.
- You do not need to use any communication protocols. The queue manager deals with all aspects of communication for you.
- Programs that receive messages need not be running at the time messages are sent to them. The messages are retained on queues.

Designers can reduce the cost of their applications because development is faster, fewer developers are needed, and demands on programming skill are lower than those for applications that do not use message queuing.

What can you do with WebSphere MQ products?

WebSphere MQ products are queue managers and application enablers. They support the IBM Message Queue Interface (MQI) through which programs can put messages on a queue and get messages from a queue.

WebSphere MQ for z/OS

With WebSphere MQ for z/OS you can write applications that:

- Use message queuing within CICS or IMS.
- Send messages between batch, CICS, and IMS applications, selecting the most appropriate environment for each function.
- Send messages to applications that run on other WebSphere MQ platforms.
- Process several messages together as a single unit of work that can be committed or backed out.
- Send messages to and interact with IMS applications by means of the IMS bridge.
- Participate in units of work coordinated by RRS.

See Appendix A, “Language compilers and assemblers”, on page 521 for details of the supported programming languages.

Each environment within z/OS has its own characteristics, advantages, and disadvantages. The advantage of WebSphere MQ for z/OS is that applications are not tied to any one environment, but can be distributed to take advantage of the benefits of each environment. For example, you can develop end-user interfaces using TSO or CICS, you can run processing-intensive modules in z/OS batch, and you can run database applications in IMS or CICS. In all cases, the various parts of the application can communicate using messages and queues.

Designers of WebSphere MQ applications must be aware of the differences and limitations imposed by these environments. For example:

- WebSphere MQ provides facilities that allow intercommunication between queue managers (this is known as distributed queuing).
- Methods of committing and backing out changes differ between the batch and CICS environments.
- WebSphere MQ for z/OS provides support in the IMS environment for online message processing programs (MPPs), interactive fast path programs (IFPs), and
batch message processing programs (BMPs). If you are writing batch DL/I programs, follow the guidance given in this book for z/OS batch programs.

- Although multiple instances of WebSphere MQ for z/OS can exist on a single z/OS system, a CICS region can connect to only one queue manager at a time. However, more than one CICS region can be connected to the same queue manager. In the IMS and z/OS batch environments, programs can connect to more than one queue manager.

- WebSphere MQ for z/OS allows local queues to be shared by a group of queue managers, giving improved throughput and availability. Such queues are called shared queues, and the queue managers form a queue-sharing group, which can process messages on the same shared queues. Batch applications can connect to one of several queue managers within a queue-sharing group by specifying the queue-sharing group name, instead of a particular queue manager name. This is known as group batch attach, or more simply group attach. See WebSphere MQ for z/OS Concepts and Planning Guide for a full discussion of queue-sharing groups.

The differences between the supported environments, and their limitations, are discussed further in Chapter 16, “Using and writing applications on WebSphere MQ for z/OS”, on page 259.

WebSphere MQ for non-z/OS platforms

With WebSphere MQ for non-z/OS platforms you can write applications that:

- Send messages to other applications running under the same operating systems. The applications can be on either the same or another system.

- Send messages to applications that run on other WebSphere MQ platforms.

- Use message queuing from within CICS Transaction Server for OS/2®, CICS for iSeries, TXSeries for AIX®, TXSeries for HP-UX, CICS for Siemens Nixdorf SINIX, TXSeries for Solaris, and TXSeries for Windows systems applications.

- Use message queuing from within Encina® for AIX, HP-UX, SINIX, Solaris, and Windows systems.

- Use message queuing from within Sybase for AIX, Solaris, and Windows systems.

- Use message queuing from within Tuxedo for AIX, AT&T, HP-UX, SINIX and DC/OSx, Solaris, Compaq Tru64 UNIX, and Windows systems.

- WebSphere MQ can act as a transaction manager, and will coordinate updates made by external resource managers within WebSphere MQ units of work. These external resource managers must comply to the X/Open XA interface.

- Process several messages together as a single unit of work that can be committed or backed out.

- Run from a full WebSphere MQ environment, or run from a WebSphere MQ client environment on the following platforms:
  - OS/400 (Java client only)
  - Compaq OpenVMS Alpha
  - OS/2
  - UNIX systems
  - VM/ESA®
  - Windows NT or Windows 2000
  - Windows 98

See Appendix A, “Language compilers and assemblers”, on page 521 for details of the supported programming languages.
Chapter 2. Overview of application design

This chapter introduces the design of WebSphere MQ applications, under these headings:

- “Planning your design”
- “Using WebSphere MQ objects” on page 12
- “Designing your messages” on page 13
- “WebSphere MQ techniques” on page 14
- “Application programming” on page 15
- “Testing WebSphere MQ applications” on page 17

These subjects are discussed in greater detail in the remaining chapters of this book.

Planning your design

When you have decided how your applications are able to take advantage of the platforms and environments available to you, you need to decide how to use the features offered by WebSphere MQ. Some of the key aspects are:

What types of queue should you use?

Do you want to create a queue each time you need one, or do you want to use queues that have already been set up? Do you want to delete a queue when you have finished using it, or is it going to be used again? Do you want to use alias queues for application independence? To see what types of queues are supported, refer to “Queues” on page 37.

Should you make use of shared queues and queue-sharing groups?

Only available on WebSphere MQ for z/OS.

You may want to take advantage of the increased availability, scalability, and workload balancing that are possible when you use shared queues with queue-sharing groups. See the WebSphere MQ for z/OS Concepts and Planning Guide for a full discussion of this topic.

What types of message should you use?

You may want to use datagrams for simple messages, but request messages (for which you expect replies) for other situations. You may want to assign different priorities to some of your messages.

How can you control your WebSphere MQ programs?

You may want to start some programs automatically or make programs wait until a particular message arrives on a queue, (using the WebSphere MQ triggering feature, see Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191). Alternatively, you may want to start up another instance of an application when the messages on a queue are not getting processed fast enough (using the WebSphere MQ instrumentation events feature as described in WebSphere MQ Event Monitoring).

Will your application run on a WebSphere MQ client?

The full MQI is supported in the client environment and this enables almost any WebSphere MQ application to be relinked to run on a WebSphere MQ client. Link the application on the WebSphere MQ client to the MQIC library, rather than to the MQI library. The exceptions are:
Planning your design

- An application that needs syncpoint coordination with other resource managers.
- Get(signal) on z/OS is not supported.

**Note:** An application running on a WebSphere MQ client may connect to more than one queue manager concurrently, or use a queue manager name with an asterisk (*) on an MQCONN or MQCONNX call. The application will have to be changed if you want to link to the queue manager libraries instead of the client libraries, as this function will not be available.

See [WebSphere MQ Clients](#) for more information.

How can you secure your data and maintain its integrity?

You can use the context information that is passed with a message to test that the message has been sent from an acceptable source. You can use the syncpointing facilities provided by WebSphere MQ or your operating system to ensure that your data remains consistent with other resources (see Chapter 13, “Committing and backing out units of work”, on page 175 for further details). You can use the persistence feature of WebSphere MQ messages to assure the delivery of important messages.

How should you handle exceptions and errors?

You need to consider how to process messages that cannot be delivered, and how to resolve error situations that are reported to you by the queue manager. For some reports, you must set report options on MQPUT.

The remainder of this chapter introduces the features and techniques that WebSphere MQ provides to help you answer questions like these.

Using WebSphere MQ objects

The MQI uses the following types of object:
- Queue managers
- Queues
- Namelists
- Process definitions
- Channels
- Storage classes (WebSphere MQ for z/OS only)
- AUTHINFO objects

These objects, and queue-sharing groups (which are only supported on WebSphere MQ for z/OS and which are not strictly objects), are discussed in Chapter 4, “WebSphere MQ objects”, on page 35.

With the exception of dynamic queues, these objects must be defined to the queue manager before you can work with them.

You define objects using:
- The PCF commands described in [WebSphere MQ Programmable Command Formats and Administration Interface](#) (not on z/OS or VSE/ESA)
- The MQSC commands described in [WebSphere MQ Script (MQSC) Command Reference](#)
- The WebSphere MQ for z/OS operations and control panels, described in [WebSphere MQ for z/OS System Administration Guide](#)
- The WebSphere MQ Explorer (Windows systems only)
You can also display or alter the attributes of objects, or delete the objects.

Alternatively, for sequences of WebSphere MQ for z/OS commands that you use regularly, you can write administration programs that create messages containing commands and that put these messages on the system-command input queue. The queue manager processes the messages on this queue in the same way that it processes commands entered from the command line or from the operations and control panels. This technique is described in [WebSphere MQ for z/OS System Administration Guide](https://www.ibm.com) and demonstrated in the Mail Manager sample application delivered with WebSphere MQ for z/OS. For a description of this sample, see Chapter 36, “Sample programs for WebSphere MQ for z/OS”, on page 471.

For sequences of WebSphere MQ for iSeries commands you use regularly you can write CL programs.

For sequences of MQSeries® or WebSphere MQ commands on OS/2, Windows systems, and UNIX systems, you can use the MQSC facility to run a series of commands held in a file. For information on how to do this, see [WebSphere MQ Script (MQSC) Command Reference](https://www.ibm.com).

### Designing your messages

You create a message when you use an MQI call to put the message on a queue. As input to the call, you supply some control information in a message descriptor (MQMD) and the data that you want to send to another program. But at the design stage, you need to consider the following questions, because they affect the way you create your messages:

**What type of message should I use?**

Are you designing a simple application in which you can send a message, then take no further action? Or are you asking for a reply to a question? If you are asking a question, you may include in the message descriptor the name of the queue on which you want to receive the reply.

Do you want your request and reply messages to be synchronous? This implies that you set a timeout period for the reply to answer your request, and if you do not receive the reply within that period, it is treated as an error.

Or would you prefer to work asynchronously, so that your processes do not have to depend upon the occurrence of specific events, such as common timing signals?

Another consideration is whether you have all your messages inside a unit of work.

**Should I assign different priorities to some of the messages I create?**

You can assign a priority value to each message, and define the queue so that it maintains its messages in order of their priority. If you do this, when another program retrieves a message from the queue, it always gets the message with the highest priority. If the queue does not maintain its messages in priority order, a program that retrieves messages from the queue will retrieve them in the order in which they were added to the queue.

Programs can also select a message using the identifier that the queue manager assigned when the message was put on the queue. Alternatively, you can generate your own identifiers for each of your messages.
Will my messages be discarded when the queue manager restarts?
The queue manager preserves all persistent messages, recovering them
when necessary from the WebSphere MQ log files, when it is restarted.
Nonpersistent messages and temporary dynamic queues are not preserved.
Any messages that you do not want discarded must be defined as
persistent at the time they are created. When writing an application for
MQSeries for OS/2 Warp, WebSphere MQ for Windows, or WebSphere MQ
on UNIX systems, make sure that you know how your system has been set
up in respect of log file allocation to reduce the risk of designing an
application that will run to the log file limits.

Note that as messages on shared queues (only available on WebSphere MQ
for z/OS) are held in the Coupling Facility (CF), non-persistent messages
are preserved across restarts of a queue manager so long as the CF remains
available. If the CF should fail, then non-persistent messages will be lost.

Do I want to give information about myself to the recipient of my messages?
Normally, the queue manager sets the user ID, but suitably authorized
applications can also set this field, so that you can include your own user
ID and other information that the receiving program can use for
accounting or security purposes.

WebSphere MQ techniques

For a simple WebSphere MQ application, you need to decide which WebSphere
MQ objects to use in your application, and which types of message you want to
use. For a more advanced application, you may want to use some of the
techniques introduced in the following sections.

Waiting for messages

A program that is serving a queue can await messages by:

- Making periodic calls on the queue to see whether a message has arrived
  (polling).
- Waiting until either a message arrives, or a specified time interval expires (see
  “Waiting for messages” on page 139).
- Setting a signal so that the program is informed when a message arrives
  (WebSphere MQ for z/OS only). For information about this, see “Signaling” on
  page 140.

Correlating replies

In WebSphere MQ applications, when a program receives a message that asks it to
do some work, the program usually sends one or more reply messages to the
requester. To help the requester to associate these replies with its original request,
an application can set a correlation identifier field in the descriptor of each message.
Programs should copy the message identifier of the request message into the
correlation identifier field of their reply messages.

Setting and using context information

Context information is used for associating messages with the user who generated
them, and for identifying the application that generated the message. Such
information is useful for security, accounting, auditing, and problem determination.

When you create a message, you can specify an option that requests that the queue
manager associates default context information with your message.
For more information on using and setting context information, see “Message context” on page 32.

Starting WebSphere MQ programs automatically

WebSphere MQ triggering enables a program to be started automatically when messages arrive on a queue. You can set trigger conditions on a queue so that a program is started to process that queue:

- Every time a message arrives on the queue
- When the first message arrives on the queue
- When the number of messages on the queue reaches a predefined number

For more information on triggering, see Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191.

Note: Triggering is just one way of starting a program automatically. For example, you can start a program automatically on a timer using non-WebSphere MQ facilities.

Generating WebSphere MQ reports

You can request the following reports within an application:

- Exception reports
- Expiry reports
- Confirm-on-arrival (COA) reports
- Confirm-on-delivery (COD) reports
- Positive action notification (PAN) reports
- Negative action notification (NAN) reports

These are described in “Report messages” on page 21.

Clusters and message affinities

Before starting to use clusters with multiple definitions for the same queue, you must examine your applications to see whether there are any that require an exchange of related messages. Within a cluster, a message may be routed to any queue manager that hosts an instance of the appropriate queue. Therefore, the logic of applications with message affinities may be upset.

For example, you may have two applications that rely on a series of messages flowing between them in the form of questions and answers. It may be important that all the questions are sent to the same queue manager and that all the answers are sent back to the other queue manager. In this situation, it is important that the workload management routine does not send the messages to any queue manager that just happens to host an instance of the appropriate queue.

You should attempt, where possible, to remove the affinities. Removing message affinities improves the availability and scalability of applications.

For more information see WebSphere MQ Queue Manager Clusters.

Application programming

WebSphere MQ supports the IBM Message Queue Interface (MQI) and the Application Messaging Interface (AMI). The MQI includes a set of calls with which you can send and receive messages, and manipulate MQSeries objects. The Application Messaging Interface (AMI), a simpler interface than the MQI, may be
Application programming

sufficient in some cases. Further information about the AMI is outside the scope of this book. For full details, refer to WebSphere MQ Application Messaging Interface.

Call interface

The MQI calls allow you to:
• Connect programs to, and disconnect programs from, a queue manager
• Open and close objects (such as queues, queue managers, namelists, and processes)
• Put messages on queues
• Receive messages from a queue, or browse them (leaving them on the queue)
• Inquire about the attributes (or properties) of WebSphere MQ objects, and set some of the attributes of queues
• Commit and back out changes made within a unit of work, in environments where there is no natural syncpoint support, for example, UNIX systems
• Coordinate queue manager updates and updates made by other resource managers

The MQI provides structures (groups of fields) with which you supply input to, and get output from, the calls. It also provides a large set of named constants to help you supply options in the parameters of the calls. The definitions of the calls, structures, and named constants are supplied in data definition files for each of the supported programming languages. Also, default values are set within the MQI calls.

Design for performance - hints and tips

Here are a few ideas to help you design efficient applications:
• Design your application so that processing goes on in parallel with a user’s thinking time:
  – Display a panel and allow the user to start typing while the application is still initializing.
  – Don’t be afraid to get the data you need in parallel from different servers.
• Keep connections and queues open if you are going to reuse them instead of repeatedly opening and closing, connecting and disconnecting.
• However, a server application which is putting only one message should use MQPUT1.
• Keep your messages within a unit of work, so that they can be committed or backed out simultaneously.
• Use the nonpersistent option for messages that do not need to be recoverable.

Programming platforms

For details of supported programming platforms, please refer to the product announcements at

Applications for more than one platform

Will your application run on more than one platform? Do you have a strategy to move to a different platform from the one you use today? If the answer to either of these questions is “yes”, you need to make sure that you code your programs for platform independence.
If you are using C, make sure that you code in ANSI standard C. Use a standard C library function rather than an equivalent platform-specific function even if the platform-specific function is faster or more efficient. The exception is when efficiency in the code is paramount, when you should code for both situations using #ifdef. For example:

```c
#ifdef _AIX
  AIX specific code
#else
  generic code
#endif
```

When the time comes to move the code to another platform, you can now search the source for #ifdef with the platform specific identifiers, in this example _AIX, and add or change code as necessary.

It is worth considering keeping portable code in separate source files from the platform-specific code, and using a simple naming convention to split the categories.

### Testing WebSphere MQ applications

The application development environment for WebSphere MQ programs is no different from that for any other application, so you can use the same development tools as well as the WebSphere MQ trace facilities.

When testing CICS applications with WebSphere MQ for z/OS, you can use the CICS Execution Diagnostic Facility (CEDF). CEDF traps the entry and exit of every MQI call as well as calls to all CICS services. Also, in the CICS environment, you can write an API-crossing exit program to provide diagnostic information before and after every MQI call. For information on how to do this, see [Chapter 16, “Using and writing applications on WebSphere MQ for z/OS”, on page 259](#).

When testing OS/400 applications, you can use the standard Debugger. To start this, use the STRDBG command.
Chapter 3. WebSphere MQ messages

WebSphere MQ messages are made up of two parts:
• Message descriptor
• Application data

Figure 2 represents a message and shows how it is logically divided into message data and application data.

The application data carried in a WebSphere MQ message is not changed by a queue manager unless data conversion is carried out on it. Also, WebSphere MQ does not put any restrictions on the content of this data. The length of the data in each message cannot exceed the value of the MaxMsgLength attribute of both the queue and queue manager.

In WebSphere MQ for AIX, WebSphere MQ for iSeries, WebSphere MQ for HP-UX, WebSphere MQ for Linux, MQSeries for OS/2 Warp, WebSphere MQ for Solaris, MQSeries for Compaq Tru64 UNIX, and WebSphere MQ for Windows, the MaxMsgLength defaults to 100 MB (104 857 600 bytes).

Note: If you are intending to use WebSphere MQ messages greater than 15 MB on OS/400, see Chapter 28, “Building your application on OS/400”, on page 361.

In WebSphere MQ for z/OS, the MaxMsgLength attribute of the queue manager is fixed at 100 MB and the MaxMsgLength attribute of the queue defaults to 4 MB (4 194 304 bytes) which you can change up to a maximum of 100 MB if required. However, the limit is 63 KB when using shared queues accessed by queue managers in a queue-sharing group.

In MQSeries for AT&T GIS UNIX, MQSeries for Compaq OpenVMS Alpha, MQSeries for SINIX and DC/OSx, MQSeries for Compaq NonStop Kernel, and MQSeries for VSE/ESA the MaxMsgLength defaults to 4 MB.

However, you should make your messages slightly shorter than the value of the MaxMsgLength attribute in some circumstances. See “The data in your message” on page 109 for more information.

You create a message when you use the MQPUT or MQPUT1 MQI calls. As input to these calls, you supply the control information (such as the priority of the message, and the name of a reply queue) and your data, and the call then puts the message on a queue. See WebSphere MQ Application Programming Reference for more information on these calls.

This chapter introduces WebSphere MQ messages, under these headings:
Message descriptor

You can access message control information using the MQMD structure, which defines the message descriptor. For a full description of the MQMD structure, see WebSphere MQ Application Programming Reference.

See “Message context” on page 32 for a description of how to use the fields within the MQMD that contain information about the origin of the message.

There are different versions of the Message Descriptor defined. Additional information for grouping and segmenting messages (see “Message groups” on page 28) is provided in Version 2 of the Message Descriptor (or the MQMDE). This is the same as the Version 1 Message Descriptor but has additional fields. These are described in WebSphere MQ Application Programming Reference.

Types of message

There are four types of message defined by WebSphere MQ:
- Datagram
- Request
- Reply
- Report

Applications can use the first three types of messages to pass information between themselves. The fourth type, report, is for applications and queue managers to use to report information about events such as the occurrence of an error.

Each type of message is identified by an MQMT_.* value. You can also define your own types of message. For the range of values you can use, see the description of the MsgType field in WebSphere MQ Application Programming Reference.

Datagrams

You should use a datagram when you do not require a reply from the application that receives the message (that is, gets the message from the queue).

An example of an application that could use datagrams is one that displays flight information in an airport lounge. A message could contain the data for a whole screen of flight information. Such an application is unlikely to request an acknowledgement for a message because it probably does not matter if a message is not delivered. The application will send an update message after a short period of time.
Request messages

You should use a request message when you want a reply from the application that receives the message.

An example of an application that could use request messages is one that displays the balance of a checking account. The request message could contain the number of the account, and the reply message would contain the account balance.

If you want to link your reply message with your request message, there are two options:

- You can give the application that handles the request message the responsibility of ensuring that it puts information into the reply message that relates to the request message.
- You can use the report field in the message descriptor of your request message to specify the content of the MsgId and CorrelId fields of the reply message:
  - You can request that either the MsgId or the CorrelId of the original message is to be copied into the CorrelId field of the reply message (the default action is to copy MsgId).
  - You can request that either a new MsgId is generated for the reply message, or that the MsgId of the original message is to be copied into the MsgId field of the reply message (the default action is to generate a new message identifier).

Reply messages

You should use a reply message when you reply to another message.

When you create a reply message, you should respect any options that were set in the message descriptor of the message to which you are replying. Report options specify the content of the message identifier (MsgId) and correlation identifier (CorrelId) fields. These fields allow the application that receives the reply to correlate the reply with its original request.

Report messages

Report messages inform applications about events such as the occurrence of an error when processing a message. They can be generated by:

- A queue manager,
- A message channel agent (for example, if they cannot deliver the message),

or

- An application (for example, if it cannot use the data in the message).

Note that report messages can be generated at any time, and they may arrive on a queue when your application is not expecting them.

Types of report message

When you put a message on a queue, you can select to receive:

- An exception report message. This is sent in response to a message that had the exceptions flag set. It is generated by the message channel agent (MCA) or the application.
- An expiry report message. This indicates that an application attempted to retrieve a message that had reached its expiry threshold; the message is marked to be discarded. This type of report is generated by the queue manager.
Types of message

- A confirmation of arrival (COA) report message. This indicates that the message has reached its target queue. It is generated by the queue manager.
- A confirmation of delivery (COD) report message. This indicates that the message has been retrieved by a receiving application. It is generated by the queue manager.
- A positive action notification (PAN) report message. This indicates that a request has been successfully serviced (that is, the action requested in the message has been performed successfully). This type of report is generated by the application.
- A negative action notification (NAN) report message. This indicates that a request has not been successfully serviced (that is, the action requested in the message has not been performed successfully). This type of report is generated by the application.

Note: Each type of report message contains one of the following:
- The entire original message
- The first 100 bytes of data in the original message
- No data from the original message

You may request more than one type of report message when you put a message on a queue. If you select the delivery confirmation report message and the exception report message options, in the event that the message fails to be delivered, you will receive an exception report message. However, if you select only the delivery confirmation report message option and the message fails to be delivered, you will not get an exception report message.

The report messages you request, when the criteria for generating a particular message are met, are the only ones you will receive.

Report message options

You have the option to discard a message after an exception has arisen. If you select the discard option, and have requested an exception report message, the report message goes to the ReplyToQ and ReplyToQMgr, and the original message is discarded.

Note: A benefit of this is you can reduce the number of messages going to the dead-letter queue. However, it does mean that your application, unless it sends only datagram messages, has to deal with returned messages. When an exception report message is generated, it inherits the persistence of the original message.

If a report message cannot be delivered (if the queue is full, for instance), the report message will be placed on the dead-letter queue.

If you wish to receive a report message, you must specify the name of your reply-to queue in the ReplyToQ field; otherwise the MQPUT or MQPUT1 of your original message will fail with MQRC_MISSING_REPLY_TO_Q.

You can use other report options in the message descriptor (MQMD) of a message to specify the content of the MsgId and CorrelId fields of any report messages that are created for the message:
- You can request that either the MsgId or the CorrelId of the original message is to be copied into the CorrelId field of the report message. The default action is to copy the message identifier. MQRO_COPY_MSG_ID_TO_CORRELID should be used because it enables the sender of a message to correlate the reply or
report message with the original message. The correlation identifier of the reply or report message will be identical to the message identifier of the original message.

- You can request that either a new *MsgId* is generated for the report message, or that the *MsgId* of the original message is to be copied into the *MsgId* field of the report message. The default action is to generate a new message identifier. MQRO_NEW_MSG_ID should be used because it ensures that each message in the system has a different message identifier, and therefore can be distinguished unambiguously from all other messages in the system.

- Specialized applications may need to use MQRO_PASS_MSG_ID and, or MQRO_PASS_CORREL_ID. However, the application that reads the messages from the queue may need careful design in order to ensure that it will work correctly. In particular when the queue contains multiple messages with the same message identifier.

Server applications should check the settings of these flags in the request message, and set the *MsgId* and *CorrelId* fields in the reply or report message appropriately.

Applications which act as intermediaries between a requester application and a server application should not need to check the settings of these flags. This is because these applications usually need to forward the message to the server application with the *MsgId*, *CorrelId*, and *Report* fields unchanged. This allows the server application to copy the *MsgId* from the original message in the *CorrelId* field of the reply message.

When generating a report about a message, server applications should test to see if any of these options have been set.

For more information on how to use report messages, see the description of the *Report* field in [WebSphere MQ Application Programming Reference](#).

To indicate the nature of the report, queue managers use a range of feedback codes. They put these codes in the *Feedback* field of the message descriptor of a report message. Queue managers can also return MQI reason codes in the *Feedback* field. WebSphere MQ defines a range of feedback codes for applications to use.

For more information on feedback and reason codes, see the description of the *Feedback* field in [WebSphere MQ Application Programming Reference](#).

An example of a program that could use a feedback code is one that monitors the work loads of other programs serving a queue. If there is more than one instance of a program serving a queue, and the number of messages arriving on the queue no longer justifies this, such a program could send a report message (with the feedback code MQFB_QUIT) to one of the serving programs to indicate that the program should terminate its activity. (A monitoring program could use the MQINQ call to find out how many programs are serving a queue.)

### Reports and segmented messages

Not supported in WebSphere MQ for z/OS.

If a message is segmented (see [“Message segmentation” on page 134](#) for a description of this) and you ask for reports to be generated, you may receive more reports than you would have done had the message not been segmented.
Types of message

For reports generated by WebSphere MQ
If you segment your messages or allow the queue manager to do so, there is only one case in which you can expect to receive a single report for the entire message. This is when you have requested only COD reports, and you have specified MQGMO_COMPLETE_MSG on the getting application.

In other cases your application must be prepared to deal with several reports; usually one for each segment.

Note: If you segment your messages, and you need only the first 100 bytes of the original message data to be returned, you must change the setting of the report options to ask for reports with no data for segments that have an offset of 100 or more. If you do not do this, and you leave the setting so that each segment requests 100 bytes of data, and you retrieve the report messages with a single MQGET specifying MQGMO_COMPLETE_MSG, the reports assemble into a large message containing 100 bytes of read data at each appropriate offset. If this happens, you need a large buffer or you need to specify MQGMO_ACCEPT_TRUNCATED_MSG.

For reports generated by applications
If your application generates reports, you should always copy the WebSphere MQ headers that are present at the start of the original message data to the report message data. Then add none, 100 bytes, or all of the original message data (or whatever other amount you would normally include) to the report message data.

You can recognize the WebSphere MQ headers that must be copied by looking at the successive Format names, starting with the MQMD and continuing through any headers present. The following Format names indicate these WebSphere MQ headers:
• MQMDE
• MQDLH
• MQXQH
• MQIIH
• MQH*

MQH* means any name starting with the characters MQH.

The Format name occurs at specific positions for MQDLH and MQXQH, but for the other WebSphere MQ headers it occurs at the same position. The length of the header is contained in a field that also occurs at the same position for MQMDE, MQIMS and all MQH* headers.

If you are using a Version 1 of the MQMD, and you are reporting on a segment, or a message in a group, or a message for which segmentation is allowed, the report data must start with an MQMDE. You should set the OriginalLength field to the length of the original message data excluding the lengths of any WebSphere MQ headers that you find.

Retrieval of reports
If you ask for COA or COD reports, you can ask for them to be reassembled for you with MQGMO_COMPLETE_MSG. An MQGET with MQGMO_COMPLETE_MSG is satisfied when enough report messages (of a single type, for example COA, and with the same GroupId) are present on the queue to represent one complete original message. This is true even if the report messages themselves do not contain the complete original data; the OriginalLength field in each report message gives the length of original data represented by that report message, even if the data itself is not present.
This technique can be used even if there are several different report types present on the queue (for example, both COA and COD), because an MQGET with MQGMO_COMPLETE_MSG reassembles report messages only if they have the same Feedback code. Note, however, that you cannot normally use the technique for exception reports, since in general these have different Feedback codes.

You can use this technique to get a positive indication that the entire message has arrived. However, in most circumstances you need to cater for the possibility that some segments arrive while others may generate an exception (or expiry, if you have allowed this). You cannot use MQGMO_COMPLETE_MSG in this case because in general you may get different Feedback codes for different segments and, as noted above, you may get more than one report for a given segment. You can, however, use MQGMO_ALL_SEGMENTS_AVAILABLE.

To allow for this you may need to retrieve reports as they arrive, and build up a picture in your application of what happened to the original message. You can use the GroupId field in the report message to correlate reports with the GroupId of the original message, and the Feedback field to identify the type of each report message. The way in which you do this depends on your application requirements.

One approach is as follows:

- Ask for COD reports and exception reports.
- After a specific time, check whether a complete set of COD reports has been received using MQGMO_COMPLETE_MSG. If so, your application knows that the entire message has been processed.
- If not, and exception reports relating to this message are present, the problem should be handled just as for unsegmented messages, though provision must also be made for “orphan” segments to be cleaned up at some point.
- If there are segments for which there are no reports of any kind, the original segments (or the reports) may be waiting for a channel to be reconnected, or the network might be overloaded at some point. If no exception reports at all have been received (or if you think that the ones you have may be temporary only), you may decide to let your application wait a little longer.

As before, this is similar to the considerations you have when dealing with unsegmented messages, except that you must also consider the possibility of “orphan” segments which have to be cleaned up.

If the original message is not critical (for example, if it is a query, or a message that can be repeated later), set an expiry time to ensure that orphan segments are removed.

**Back-level queue managers**

When a report is generated by a queue manager that supports segmentation, but is received on a queue manager that does not support segmentation, the MQMDE structure (which identifies the Offset and OriginalLength represented by the report) is always included in the report data, in addition to zero, 100 bytes, or all of the original data in the message.

However, if a segment of a message passes through a queue manager that does not support segmentation, you should be aware that if a report is generated there, the MQMDE structure in the original message will be treated purely as data. It will not therefore be included in the report data if zero bytes of the original data have been requested. Without the MQMDE, the report message may not be useful.
Types of message

You should therefore request at least 100 bytes of data in reports if there is a possibility that the message might travel through a back-level queue manager.

Format of message control information and message data

The queue manager is only interested in the format of the control information within a message, whereas applications that handle the message are interested in the format of both the control information and the data.

Format of message control information

Control information in the character-string fields of the message descriptor must be in the character set used by the queue manager. The CodedCharSetId attribute of the queue manager object defines this character set. Control information must be in this character set because when applications pass messages from one queue manager to another, message channel agents that transmit the messages use the value of this attribute to determine what data conversion they must perform.

Format of message data

You can specify any of the following:
- The format of the application data
- The character set of the character data
- The format of numeric data

To do this, use these fields:

Format

This indicates to the receiver of a message the format of the application data in the message.

When the queue manager creates a message, in some circumstances it uses the Format field to identify the format of that message. For example, when a queue manager cannot deliver a message, it puts the message on a dead-letter (undelivered message) queue. It adds a header (containing more control information) to the message, and changes the Format field to show this.

The queue manager has a number of built-in formats with names beginning “MQ”, for example MQFMT_STRING. If these do not meet your needs, you must define your own formats (user-defined formats), but you should not use names beginning with “MQ” for these.

When you create and use your own formats, you must write a data-conversion exit to support a program getting the message using MQGMO_CONVERT.

CodedCharSetId

This defines the character set of character data in the message. If you want to set this character set to that of the queue manager, you can set this field to the constant MQCCSI_Q_MGR or MQCCSI_INHERIT.

When you get a message from a queue, you should compare the value of the CodedCharSetId field with the value that your application is expecting. If the two values differ, you may need to convert any character data in the message or use a data-conversion message exit if one is available.

Encoding

This describes the format of numeric message data that contains binary
Application data conversion

Application data may need to be converted to the character set and the encoding required by another application where different platforms are concerned. It may be converted at the sending queue manager, or at the receiving queue manager. If the library of built-in formats does not meet your needs, you must define your own. The type of conversion depends on the message format which is specified in the format field of the message descriptor, MQMD.

Note: Messages with MQFMT_NONE specified are not converted.

Conversion at the sending queue manager

You must set the CONVERT channel attribute to YES if you need the sending message channel agent (MCA) to convert the application data.

The conversion is performed at the sending queue manager for certain built-in formats and for user-defined formats if a suitable user exit is supplied.

Built-in formats: These include:

- Messages that are all characters (using the format name MQFMT_STRING)
- WebSphere MQ defined messages, for example Programmable Command Formats

WebSphere MQ uses Programmable Command Format messages for administration messages and events (the format name used is MQFMT_ADMIN in this case). You can use the same format (using the format name MQFMT_PCF) for your own messages, and take advantage of the built-in data conversion.

The queue manager built-in formats all have names beginning with MQFMT. They are listed and described in WebSphere MQ Application Programming Reference under the Format field of the Message descriptor (MQMD).

Application-defined formats: For user-defined formats, application data conversion must be performed by a data-conversion exit program (for more information, see Chapter 11, “Writing data-conversion exits”, on page 153). In a client-server environment, the exit is loaded at the server and conversion takes place there.

Conversion at the receiving queue manager

Application message data may be converted by the receiving queue manager for both built-in and user-defined formats. The conversion is performed during the
Message format

processing of an MQGET call if the MQGMO_CONVERT option is specified. For details, see WebSphere MQ Application Programming Reference.

Coded character sets
WebSphere MQ products support the coded character sets that are provided by the underlying operating system.

When you create a queue manager, the queue manager coded character set ID (CCSID) used is based on that of the underlying environment. If this is a mixed code page, WebSphere MQ uses the SBCS part of the mixed code page as the queue manager CCSID.

For general data conversion, if the underlying operating system supports DBCS code pages then WebSphere MQ is able to use it.

See the documentation for your operating system for details of the coded character sets that it supports.

You need to consider application data conversion, format names, and user exits when writing applications that span multiple platforms. For details of the MQGET call, the Convert characters call, the MQGMO_CONVERT option, and the built-in formats, see WebSphere MQ Application Programming Reference. See Chapter 11, “Writing data-conversion exits”, on page 153 for information about invoking and writing data-conversion exits.

Message priorities

You set the priority of a message (in the Priority field of the MQMD structure) when you put the message on a queue. You can set a numeric value for the priority, or you can let the message take the default priority of the queue.

The MsgDeliverySequence attribute of the queue determines whether messages on the queue are stored in FIFO (first in, first out) sequence, or in FIFO within priority sequence. If this attribute is set to MQMDS_PRIORITY, messages are enqueued with the priority specified in the Priority field of their message descriptors; but if it is set to MQMDS_FIFO, messages are enqueued with the default priority of the queue. Messages of equal priority are stored on the queue in order of arrival.

The DefPriority attribute of a queue sets the default priority value for messages being put on that queue. This value is set when the queue is created, but it can be changed afterwards. Alias queues, and local definitions of remote queues, may have different default priorities from the base queues to which they resolve. If there is more than one queue definition in the resolution path (see “Name resolution” on page 97), the default priority is taken from the value (at the time of the put operation) of the DefPriority attribute of the queue specified in the open command.

The value of the MaxPriority attribute of the queue manager is the maximum priority that you can assign to a message processed by that queue manager. You cannot change the value of this attribute. In WebSphere MQ, the attribute has the value 9; you can create messages having priorities between 0 (the lowest) and 9 (the highest).

Message groups

Segmentation is not supported on WebSphere MQ for z/OS.
Messages can occur within groups. This allows ordering of messages (see “Logical and physical ordering” on page 124), and, except on WebSphere MQ for z/OS, segmentation of large messages (see “Message segmentation” on page 134) within the same group.

The hierarchy within a group is as follows:

**Group**  
This is the highest level in the hierarchy and is identified by a GroupId. It consists of one or more messages that contain the same GroupId. These messages can be stored anywhere on the queue.

**Note:** The term “message” is used here to denote one item on a queue, such as would be returned by a single MQGET that does not specify MQGMO_COMPLETE_MSG.

Figure 3 shows a group of logical messages:

![Figure 3. Group of logical messages](image)

**Logical message**
Logical messages within a group are identified by the GroupId and MsgSeqNumber fields. The MsgSeqNumber starts at 1 for the first message within a group, and if a message is not in a group, the value of the field is 1.

Logical messages within a group can be used to:
- Ensure ordering (if this is not guaranteed under the circumstances in which the message is transmitted).
- Allow applications to group together similar messages (for example, those that must all be processed by the same server instance).

Each message within a group consists of one physical message, unless it is split into segments. Each message is logically a separate message, and only the GroupId and MsgSeqNumber fields in the MQMD need bear any relationship to other messages in the group. Other fields in the MQMD are independent; some may be identical for all messages in the group whereas others may be different. For example, messages in a group may have different format names, CCSIDs, encodings, and so on.

**Segment**
Segments are used to handle messages that are too large for either the putting or getting application or the queue manager (including intervening queue managers through which the message passes). For more information about this, see “Message segmentation” on page 134.

A segment of a message is identified by the GroupId, MsgSeqNumber, and Offset fields. The Offset field starts at zero for the first segment within a message.

Each segment consists of one physical message that may or may not belong to a group (Figure 4 on page 30 shows an example of messages within a group). A segment is logically part of a single message, so only
Message groups

the MsgId, Offset, and SegmentFlag fields in the MQMD should differ between separate segments of the same message. Figure 4 shows a group of logical messages, some of which are segmented:

![Diagram of logical messages]

For a description of logical and physical messages, see “Logical and physical ordering” on page 124. For further information about segmenting messages, see “Message segmentation” on page 134.

Message persistence

Persistent messages are written out to logs and queue data files. If a queue manager is restarted after a failure, it recovers these persistent messages as necessary from the logged data. Messages that are not persistent are discarded if a queue manager stops, whether the stoppage is as a result of an operator command or because of the failure of some part of your system. Non-persistent messages for WebSphere MQ for z/OS stored in a coupling facility (CF) are an exception to this. They persist as long as the CF remains available.

When you create a message, if you initialize the message descriptor (MQMD) using the defaults, the persistence for the message will be taken from the DefPersistence attribute of the queue specified in the MQOPEN command. Alternatively, you may set the persistence of the message using the Persistence field of the MQMD structure to define the message as persistent or not persistent.

The performance of your application is affected when you use persistent messages; the extent of the effect depends on the performance characteristics of the machine’s I/O subsystem and how you use the syncpoint options on each platform:

- A persistent message, outside the current unit of work, is written to disk on every put and get operation. See Chapter 13, “Committing and backing out units of work”, on page 173.
- In WebSphere MQ on UNIX systems, MQSeries for Compaq OpenVMS Alpha, WebSphere MQ for z/OS, MQSeries for OS/2 Warp, MQSeries for VSE/ESA, and WebSphere MQ for Windows, a persistent message within the current unit of work is logged only when the unit of work is committed (and the unit of work could contain many queue operations).

Nonpersistent messages can be used for fast messaging. See WebSphere MQ Application Programming Reference and WebSphere MQ Intercommunication for further information about fast messages.
Selecting messages from queues

To get a particular message from a queue, you need to use the *MsgId* and *CorrelId* fields of the message descriptor. If you specify Version 2 of the MQMD, the *GroupId* can also be used. (See “Getting a particular message” on page 131.)

The message identifier is usually generated by the queue manager when the message is put on a queue. The queue manager tries to ensure that message identifiers are unique. However, a WebSphere MQ application can specify a particular value for the message identifier.

You can use the correlation identifier in any way you like. However, an intended use of this field is for applications to copy the message identifier of a request message into the *CorrelId* field of a reply message.

The group identifier is usually generated by the queue manager when the first message of a group is put onto a queue. The *MsgSeqNumber* field identifies the position of the message within the group and the *Offset* field identifies the segments within the message.

Where more than one message meets the combined selection criteria, the *MsgDeliverySequence* attribute of the queue determines whether messages are selected in FIFO (first in, first out) or priority order. When messages have equal priority, they are selected in FIFO order. For more information, see “The order in which messages are retrieved from a queue” on page 124.

For an example of an application that uses correlation identifiers, see “The Credit Check sample” on page 501.

Messages that fail to be delivered

When a queue manager is unable to put a message on a queue, you have various options. You can:

- Attempt to put the message on the queue again.
- Request that the message is returned to the sender.
- Put the message on the dead-letter queue.

See Chapter 5, “Handling program errors”, on page 49 for more information.

Messages that are backed out

When processing messages from a queue under the control of a unit of work, the unit of work could consist of one or more messages. If a backout occurs, the messages which were retrieved from the queue are reinstated on the queue, and they can be processed again in another unit of work. If the processing of a particular message is causing the problem, the unit of work is backed out again. This could cause a processing loop. Messages which were put to a queue are removed from the queue.

An application can detect messages that are caught up in such a loop by testing the *BackoutCount* field of MQMD. The application can either correct the situation, or issue a warning to an operator.

In WebSphere MQ for z/OS, to ensure that the back-out count survives restarts of the queue manager, set the *HardenGetBackout* attribute to MQQA_BACKOUT_HARDENED; otherwise, if the queue manager has to restart, it
Message backout

does not maintain an accurate back-out count for each message. Setting the attribute this way adds the penalty of extra processing.

In WebSphere MQ for iSeries, MQSeries for OS/2 Warp, WebSphere MQ for Windows, MQSeries for Compaq OpenVMS Alpha, and WebSphere MQ on UNIX systems, the back-out count always survives restarts of the queue manager. Any change to the *HardenGetBackout* attribute is ignored.

For more information on committing and backing out messages, see Chapter 13, “Committing and backing out units of work”, on page 175.

Reply-to queue and queue manager

There are occasions when you may receive messages in response to a message you send:

* A reply message in response to a request message
* A report message about an unexpected event or expiry
* A report message about a COA (Confirmation Of Arrival) or a COD (Confirmation Of Delivery) event
* A report message about a PAN (Positive Action Notification) or a NAN (Negative Action Notification) event

Using the MQMD structure, specify the name of the queue to which you want reply and report messages sent, in the *ReplyToQ* field. Specify the name of the queue manager that owns the reply-to queue in the *ReplyToQMgr* field.

If you leave the *ReplyToQMgr* field blank, the queue manager sets the contents of the following fields in the message descriptor on the queue:

*ReplyToQ*

If *ReplyToQ* is a local definition of a remote queue, the *ReplyToQ* field is set to the name of the remote queue; otherwise this field is not changed.

*ReplyToQMgr*

If *ReplyToQ* is a local definition of a remote queue, the *ReplyToQMgr* field is set to the name of the queue manager that owns the remote queue; otherwise the *ReplyToQMgr* field is set to the name of the queue manager to which your application is connected.

**Note:** You can request that a queue manager makes more than one attempt to deliver a message, and you can request that the message is discarded if it fails. If the message, after failing to be delivered, is not to be discarded, the remote queue manager puts the message on its dead-letter (undelivered message) queue (see “Using the dead-letter (undelivered message) queue” on page 53).

Message context

*Message context* information allows the application that retrieves the message to find out about the originator of the message. The retrieving application may want to:

* Check that the sending application has the correct level of authority
* Perform some accounting function so that it can charge the sending application for any work it has to perform
* Keep an audit trail of all the messages it has worked with
When you use the MQPUT or MQPUT1 call to put a message on a queue, you can specify that the queue manager is to add some default context information to the message descriptor. Applications that have the appropriate level of authority can add extra context information. For more information on how to specify context information, see “Controlling context information” on page 110.

All context information is stored in the eight context fields of the message descriptor. The type of information falls into two categories: identity and origin context information.

**Identity context**

Identity context information identifies the user of the application that first put the message on a queue:

- The queue manager fills the `UserIdentifier` field with a name that identifies the user—the way that the queue manager can do this depends on the environment in which the application is running.
- The queue manager fills the `AccountingToken` field with a token or number that it determined from the application that put the message.
- Applications can use the `ApplIdentityData` field for any extra information that they want to include about the user (for example, an encrypted password).

Suitably authorized applications may set the above fields.

A Windows systems security identifier (SID) is stored in the `AccountingToken` field when a message is created under WebSphere MQ for Windows. The SID can be used to supplement the `UserIdentifier` field and to establish the credentials of a user.

For information on how the queue manager fills the `UserIdentifier` and `AccountingToken` fields, see the descriptions of these fields in [WebSphere MQ Application Programming Reference](#). Applications that pass messages from one queue manager to another should also pass on the identity context information so that other applications know the identity of the originator of the message.

**Origin context**

Origin context information describes the application that put the message on the queue on which the message is currently stored. The message descriptor contains the following fields for origin context information:

- `PutApplType`: The type of application that put the message (for example, a CICS transaction).
- `PutApplName`: The name of the application that put the message (for example, the name of a job or transaction).
- `PutDate`: The date on which the message was put on the queue.
- `PutTime`: The time at which the message was put on the queue.
- `ApplOriginData`: Any extra information that an application may want to include about the
Message context

origin of the message. For example, it could be set by suitably authorized applications to indicate whether the identity data is trusted.

Origin context information is usually supplied by the queue manager. Greenwich Mean Time (GMT) is used for the PutDate and PutTime fields. See the descriptions of these fields in [WebSphere MQ Application Programming Reference](#).

An application with enough authority can provide its own context. This allows accounting information to be preserved when a single user has a different user ID on each of the systems that process a message they have originated.
Chapter 4. WebSphere MQ objects

The WebSphere MQ objects are:

- Queue managers
- Queue-sharing groups (WebSphere MQ for z/OS only), although these are not strictly objects.
- Queues
- Namelists
- Process definitions
- AUTHINFO objects
- Channels
- Storage classes (WebSphere MQ for z/OS only)

Queue managers define the properties (known as attributes) of these objects. The values of these attributes affect the way in which these objects are processed by WebSphere MQ. From your applications, you use the Message Queue Interface (MQI) to control these objects. Objects are identified by an object descriptor (MQOD) when addressed from a program.

When you use WebSphere MQ commands to define, alter, or delete objects, for example, the queue manager checks that you have the required level of authority to perform these operations. Similarly, when an application uses the MQOPEN call to open an object, the queue manager checks that the application has the required level of authority before it allows access to that object. The checks are made on the name of the object being opened.

This chapter introduces WebSphere MQ objects, under these headings:

- “Queue managers” on page 35
- “Queue-sharing groups” on page 36
- “Queues” on page 37
- “Namelists” on page 44
- “Process definitions” on page 45
- “AUTHINFO objects” on page 45
- “Channels” on page 45
- “Storage classes” on page 45
- “Rules for naming WebSphere MQ objects” on page 46

Queue managers

A queue manager supplies an application with WebSphere MQ services. A program must have a connection to a queue manager before it can use the services of that queue manager. A program can make this connection explicitly (using the MQCONN or MQCONNX call), or the connection might be made implicitly (this depends on the platform and the environment in which the program is running).

Queues belong to queue managers, but programs can send messages to queues that belong to any queue manager.

Attributes of queue managers

Associated with each queue manager is a set of attributes (or properties) that define its characteristics. Some of the attributes of a queue manager are fixed when it is created; you can change others using the WebSphere MQ commands. You can inquire about the values of all the attributes, except those used for Secure Sockets
Queue managers

Layer (SSL) encryption, using the MQINQ call.

The fixed attributes include:

- The name of the queue manager
- The platform on which the queue manager runs (for example, z/OS)
- The level of system control commands that the queue manager supports
- The maximum priority that you can assign to messages processed by the queue manager
- The name of the queue to which programs can send WebSphere MQ commands
- The maximum length of messages the queue manager can process (Fixed only in WebSphere MQ for z/OS)
- Whether the queue manager supports syncpointing when programs put and get messages

The changeable attributes include:

- A text description of the queue manager
- The identifier of the character set the queue manager uses for character strings when it processes MQI calls
- The time interval that the queue manager uses to restrict the number of trigger messages
- The time interval that the queue manager uses to determine how often queues are to be scanned for expired messages (WebSphere MQ for z/OS only)
- The name of the queue manager’s dead-letter (undelivered message) queue
- The name of the queue manager’s default transmission queue
- The maximum number of open handles for any one connection
- The enabling and disabling of various categories of event reporting
- The maximum number of uncommitted messages within a unit of work

For a full description of all the attributes, see WebSphere MQ Application Programming Reference.

Queue managers and workload management

You can set up a cluster of queue managers that has more than one definition for the same queue (for example, the queue managers in the cluster could be clones of each other). Messages for a particular queue can be handled by any queue manager which hosts an instance of the queue. A workload-management algorithm decides which queue manager handles the message and so spreads the workload between your queue managers. See WebSphere MQ Queue Manager Clusters for further information.

Queue-sharing groups

Only supported in WebSphere MQ for z/OS.

Queue-sharing groups are not strictly objects, but are mentioned here for convenience.

Queue managers that can access the same set of shared queues form a group called a queue-sharing group (QSG), and they communicate with each other by means of a coupling facility (CF) that stores the shared queues. A shared queue is a type of local queue whose messages can be accessed by one or more queue managers that are in
Queue-sharing groups

A queue-sharing group is a group of queues that share a single queue manager. Each queue in the group is owned by the same queue manager, and applications can access any queue within the group. This is different from a queue being shared by more than one application, via the same queue manager. See WebSphere MQ for z/OS Concepts and Planning Guide for a full discussion of shared queues and queue-sharing groups.

Queues

A WebSphere MQ queue is a named object on which applications can put messages, and from which applications can get messages. Messages are stored on a queue, so if the putting application is expecting a reply to its message, it is free to do other work while waiting for that reply. Applications access a queue by using the Message Queue Interface (MQI), described in Chapter 6, “Introducing the Message Queue Interface”, on page 61.

Before a message can be put on a queue, the queue must have already been created. A queue is owned by a queue manager, and that queue manager can own many queues. However, each queue must have a name that is unique within that queue manager.

A queue is maintained through a queue manager. In most cases, each queue is physically managed by its queue manager but this is transparent to an application program. WebSphere MQ for z/OS shared queues can be managed by any queue manager in the queue-sharing group.

To create a queue you can use WebSphere MQ commands (MQSC), PCF commands, or platform-specific interfaces such as the WebSphere MQ for z/OS operations and control panels.

On all platforms except MQSeries for VSE/ESA™, you can create local queues for temporary jobs “dynamically” from your application. For example, you can create reply-to queues (which are not needed after an application ends). For more information, see “Dynamic queues” on page 41.

Before using a queue, you must open the queue, specifying what you want to do with it. For example, you can open a queue:

- For browsing messages only (not retrieving them)
- For retrieving messages (and either sharing the access with other programs, or with exclusive access)
- For putting messages on the queue
- For inquiring about the attributes of the queue
- For setting the attributes of the queue

For a complete list of the options you can specify when you open a queue, see the description of the MQOPEN call in WebSphere MQ Application Programming Reference.

Types of queue

The types of queue that WebSphere MQ supports for applications to use are:

**Local and remote queues**

A queue is known to a program as local if it is owned by the queue manager to which the program is connected; the queue is known as remote if it is owned by a different queue manager. The important difference between these two types of queue is that you can get messages only from local queues. (You can put messages on both types of queue.)
The queue definition object, created when you define a local queue, will hold the definition information of the queue as well as the physical messages put on the queue. The queue definition object, created when you ‘define’ a remote queue, will only hold the information necessary for the local queue manager to be able to locate the queue to which you want your message to go. This object is known as the local definition of a remote queue. All the attributes of the remote queue are held by the queue manager that owns it, because it is a local queue to that queue manager.

Shared queues

Shared queues are only available on WebSphere MQ for z/OS.

A shared queue is a type of local queue whose messages can be accessed by one or more queue managers that are in a queue-sharing group. (This is not the same as a queue being "shared" by more than one application, via the same queue manager.) Shared queues are held by a coupling facility (CF), and are accessible by any queue manager in the queue-sharing group. Each shared queue in a queue-sharing group must have a name that is unique within that group. See [WebSphere MQ for z/OS Concepts and Planning Guide](#) for a full discussion of shared queues and queue-sharing groups.

Alias queues

To your program, an alias queue appears to be a queue, but it is really a WebSphere MQ object that you can use to access another queue. This means that more than one program can work with the same queue, accessing it using different names.

Model and dynamic queues

A model queue is a template of a queue definition used only when you want to create a dynamic local queue.

You can create a local queue dynamically from a WebSphere MQ program, naming the model queue you wish to use as the template for the queue attributes. You may now, if you wish, change some attributes of the new queue. However, you cannot change the DefinitionType. If, for example, you require a permanent queue, you must select a model queue with the definition type set to permanent. Some conversational applications could make use of dynamic queues to hold replies to their queries because they probably would not need to maintain these queues after they have processed the replies.

Cluster queues

A cluster queue is a queue that is hosted by a cluster queue manager and made available to other queue managers in the cluster.

The cluster queue manager makes a local queue definition for the queue specifying the name of the cluster that the queue is to be available in. This definition has the effect of advertising the queue to the other queue managers in the cluster. The other queue managers in the cluster can put messages to a cluster queue without needing a corresponding remote-queue definition. A cluster queue can be advertised in more than one cluster. See "What is a cluster?" on page 5 and [WebSphere MQ Queue Manager Clusters](#) for further information.

Types of local queue

Each queue manager can have some local queues that it uses for special purposes:

Transmission queues

A transmission queue is a local queue which holds messages destined for a
remote queue. The messages are forwarded to their destination queue by WebSphere MQ when a communication program and link are available.

Initiation queues
An initiation queue is a local queue on which the queue manager puts a message for the purpose of automatically starting an application when certain conditions (such as more than 10 messages arriving, for example) are met on a local queue.

Dead-letter (undelivered message) queue
The dead-letter queue is a local queue on which the queue manager and applications put messages they cannot deliver. You should plan to process any messages that arrive on this queue.

System command queue
The system command queue is a queue to which suitably authorized applications can send WebSphere MQ commands.

System default queues
When you create a queue (other than a dynamic queue), WebSphere MQ uses the queue definitions stored in the system default queues.

Channel queues
Channel queues are used for distributed queue management.

Event queues
Event queues hold event messages. These messages are reported by the queue manager or a channel.

These special queues are described in greater detail in the following sections.

Attributes of queues
Some of the attributes of a queue are specified when the queue is defined, and may not be changed afterwards (for example, the type of the queue). Other attributes of queues can be grouped into those that can be changed:

- By the queue manager during the processing of the queue (for example, the current depth of a queue)
- Only by commands (for example, the text description of the queue)
- By applications, using the MQSET call (for example, whether or not put operations are allowed on the queue)

You can find the values of all the attributes using the MQINQ call.

The attributes that are common to more than one type of queue are:

- **QName** Name of the queue
- **QType** Type of the queue
- **QDesc** Text description of the queue
- **InhibitGet** Whether or not programs are allowed to get messages from the queue (although you can never get messages from remote queues)
- **InhibitPut** Whether or not programs are allowed to put messages on the queue
- **DefPriority** Default priority for messages put on the queue
**DefPersistence**
Default persistence for messages put on the queue

**Scope** *(not supported on z/OS or VSE/ESA)*
Controls whether an entry for this queue also exists in a name service

For a full description of these attributes, see [WebSphere MQ Application Programming Reference](#).

### Remote queues

To a program, a queue is *remote* if it is owned by a different queue manager to the one to which the program is connected. Where a communication link has been established, it is possible for a program to send a message to a remote queue. A program can never get a message from a remote queue.

When opening a remote queue, to identify the queue you must specify either:
- The name of the local definition that defines the remote queue.
  To create a local definition of a remote queue use the `DEFINE QREMOTE` command; in WebSphere MQ for iSeries, alternatively use the `CRTMQMQM` command; in MQSeries for Compaq NonStop Kernel, you can use the MQM screen-based interface; in MQSeries for VSE/ESA, you can use the MQMT transaction.
  From the viewpoint of an application, this is the same as opening a local queue. An application does not need to know if a queue is local or remote.
- The name of the remote queue manager and the name of the queue as it is known to that remote queue manager.

Local definitions of remote queues have three attributes in addition to the common attributes described in "Attributes of queues" on page 39. These are `RemoteQName` (the name that the queue’s owning queue manager knows it by), `RemoteQMgrName` (the name of the owning queue manager), and `XmitQName` (the name of the local transmission queue that is used when forwarding messages to other queue managers). For a fuller description of these attributes, see [WebSphere MQ Application Programming Reference](#).

If you use the `MQINQ` call against the local definition of a remote queue, the queue manager returns the attributes of the local definition only, that is the remote queue name, the remote queue manager name and the transmission queue name, not the attributes of the matching local queue in the remote system.

See also "Transmission queues" on page 43

### Alias queues

An *alias queue* is a WebSphere MQ object that you can use to access another queue. The queue resulting from the resolution of an alias name (known as the base queue) can be a local queue, the local definition of a remote queue, or a shared queue (a type of local queue only available on WebSphere MQ for z/OS). It can also be either a predefined queue or a dynamic queue, as supported by the platform.

**Note:** An alias cannot resolve to another alias.

An example of the use of alias queues is for a system administrator to give different access authorities to the base queue name (that is, the queue to which the
alias resolves) and to the alias queue name. This would mean that a program or user could be authorized to use the alias queue, but not the base queue.

Alternatively, authorization can be set to inhibit put operations for the alias name, but allow them for the base queue.

In some applications, the use of alias queues means that system administrators can easily change the definition of an alias queue object without having to get the application changed.

WebSphere MQ makes authorization checks against the alias name when programs try to use that name. It does not check that the program is authorized to access the name to which the alias resolves. A program can therefore be authorized to access an alias queue name, but not the resolved queue name.

In addition to the general queue attributes described in “Attributes of queues” on page 39, alias queues have a **BaseQName** attribute. This is the name of the base queue to which the alias name resolves. For a fuller description of this attribute, see WebSphere MQ Application Programming Reference.

The **InhibitGet** and **InhibitPut** attributes (see “Attributes of queues” on page 39) of alias queues belong to the alias name. For example, if the alias-queue name ALIAS1 resolves to the base-queue name BASE, inhibitions on ALIAS1 affect ALIAS1 only and BASE is not inhibited. However, inhibitions on BASE also affect ALIAS1.

The **DefPriority** and **DefPersistence** attributes also belong to the alias name. So, for example, you can assign different default priorities to different aliases of the same base queue. Also, you can change these priorities without having to change the applications that use the aliases.

**Model queues**

A model queue is a template of a queue definition that you use when creating a dynamic queue. You specify the name of a model queue in the object descriptor (MQOD) of your MQOPEN call. Using the attributes of the model queue, the queue manager dynamically creates a local queue for you.

You can specify a name (in full) for the dynamic queue, or the stem of a name (for example, ABC) and let the queue manager add a unique part to this, or you can let the queue manager assign a complete unique name for you. If the queue manager assigns the name, it puts it in the MQOD structure.

You can not issue an MQPUT1 call directly to a model queue, but you can issue an MQPUT1 to the dynamic queue that has been created by opening a model queue.

The attributes of a model queue are a subset of those of a local queue. For a fuller description, see WebSphere MQ Application Programming Reference.

**Dynamic queues**

On all platforms except for MQSeries for VSE/ESA, when an application program issues an MQOPEN call to open a model queue, the queue manager dynamically creates an instance of a local queue with the same attributes as the model queue. Depending on the value of the **DefinitionType** field of the model queue, the queue manager creates either a temporary or permanent dynamic queue (See “Creating dynamic queues” on page 102).
Properties of temporary dynamic queues
Temporary dynamic queues have the following properties:

- They cannot be shared queues, accessible from queue managers in a queue-sharing group (only available on WebSphere MQ for z/OS).
- They hold nonpersistent messages only.
- They are non-recoverable.
- They are deleted when the queue manager is started.
- They are deleted when the application that issued the MQOPEN call which resulted in the creation of the queue closes the queue or terminates.
  - If there are any committed messages on the queue, they will be deleted.
  - If there are any uncommitted MQGET, MQPUT, or MQPUT1 calls outstanding against the queue at this time, the queue is marked as being logically deleted, and is only physically deleted (after these calls have been committed) as part of close processing, or when the application terminates.
  - If the queue happens to be in use at this time (by the creating, or another application), the queue is marked as being logically deleted, and is only physically deleted when closed by the last application using the queue.
  - Attempts to access a logically deleted queue (other than to close it) fail with reason code MQRC_Q_DELETED.
  - MQCO_NONE, MQCO_DELETE and MQCO_DELETE_PURGE are all treated as MQCO_NONE when specified on an MQCLOSE call for the corresponding MQOPEN call that created the queue.

Properties of permanent dynamic queues
Permanent dynamic queues have the following properties:

- They hold persistent or nonpersistent messages.
- They are recoverable in the event of system failures.
- They are deleted when an application (not necessarily the one that issued the MQOPEN call which resulted in the creation of the queue) successfully closes the queue using the MQCO_DELETE, or the MQCO_DELETE_PURGE option.
  - A close request with the MQCO_DELETE option fails if there are any messages (committed or uncommitted) still on the queue. A close request with the MQCO_DELETE_PURGE option succeeds even if there are committed messages on the queue (the messages being deleted as part of the close), but fails if there are any uncommitted MQGET, MQPUT, or MQPUT1 calls outstanding against the queue.
  - If the delete request is successful, but the queue happens to be in use (by the creating, or another application), the queue is marked as being logically deleted and is only physically deleted when closed by the last application using the queue.
- They are not deleted if closed by an application which is not authorized to delete the queue, unless the closing application issued the MQOPEN call which caused the creation of the queue. Authorization checks are performed against the user identifier (or alternate user identifier if MQOO_ALTERNATE_USER_AUTHORITY was specified) which was used to validate the corresponding MQOPEN call.
- They can be deleted in the same way as a normal queue.

Uses of dynamic queues
You can use dynamic queues for:

- Applications that do not require queues to be retained after the application has terminated.
• Applications that require replies to messages to be processed by another application can dynamically create a reply-to queue by opening a model queue. For example, a client application could:
  1. Create a dynamic queue.
  2. Supply its name in the ReplyToQ field of the message descriptor structure of the request message.
  3. Place the request on a queue being processed by a server.

The server could then place the reply message on the reply-to queue. Finally, the client could process the reply, and close the reply-to queue with the delete option.

**Recommendations for uses of dynamic queues**

You should consider the following points when using dynamic queues:

• In a client-server model, each client should create and use its own dynamic reply-to queue. If a dynamic reply-to queue is shared between more than one client, the deletion of the reply-to queue may be delayed because there is uncommitted activity outstanding against the queue, or because the queue is in use by another client. Additionally, the queue might be marked as being logically deleted, and hence inaccessible for subsequent API requests (other than MQCLOSE).

• If your application environment requires that dynamic queues must be shared between applications, you should ensure that the queue is only closed (with the delete option) when all activity against the queue has been committed. This should be by the last user preferably. This ensures that deletion of the queue is not delayed, and should minimize the period that the queue is inaccessible because it has been marked as being logically deleted.

**Transmission queues**

When an application sends a message to a remote queue, the local queue manager stores the message in a special local queue, called a transmission queue.

A *message channel agent* (channel program), or *intra-group queuing agent* when using intra-group queuing on WebSphere MQ for z/OS, will be associated with the transmission queue and the remote queue manager, and this delivers the message. When the message has been delivered, it is deleted from the transmission queue.

The message may have to pass through many queue managers (or nodes) on its journey to its final destination. There must be a transmission queue defined at each queue manager along the route, each holding messages waiting to be transmitted to the next node. (A shared transmission queue is used when using intra-group queuing on WebSphere MQ for z/OS.) There can be several transmission queues defined at a particular queue manager. A given transmission queue holds messages whose next destination is the same queue manager, although the messages may have different eventual destinations. There may also be several transmission queues for the same remote queue manager, with each one being used for a different type of service, for example.

Transmission queues can be used to trigger a message channel agent to send messages onward. For information about this, see Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191. These attributes are defined in the transmission queue definition (for triggered channels) or the process definition object (see “Process definitions” on page 45).
Initiation queues

An *initiation queue* is a local queue on which the queue manager puts a trigger message when a trigger event occurs on an application queue. A trigger event is an event (for example, more than 10 messages arriving) that an application designer intends the queue manager to use as a cue, or trigger, to start a program that will process the queue. For more information on how triggering works, see Chapter 14, "Starting WebSphere MQ applications using triggers", on page 191.

Dead-letter (undelivered message) queues

A *dead-letter (undelivered message) queue* is a local queue on which the queue manager puts messages it cannot deliver.

When the queue manager puts a message on the dead-letter queue, it adds a header to the message. This includes such information as the intended destination of the original message, the reason the queue manager put the message on the dead-letter queue, and the date and time it did this.

Applications can also use the queue for messages they cannot deliver. For more information, see "Using the dead-letter (undelivered message) queue" on page 53.

System command queues

Not supported in MQSeries for VSE/ESA.

These queues receive the PCE, MQSC, and CL commands, as supported on your platform, in readiness for the queue manager to action them. In WebSphere MQ for z/OS the queue is known as the SYSTEM.COMMAND.INPUT.QUEUE and accepts MQSC commands. On other platforms it is known as the SYSTEM.ADMIN.COMMAND.QUEUE and the commands accepted vary by platform. See [WebSphere MQ Programmable Command Formats and Administration Interface](#) for details.

System default queues

The *system default queues* contain the initial definitions of the queues for your system. When you create a new queue, the queue manager copies the definition from the appropriate system default queue.

Namelists

A *namelist* is a WebSphere MQ object that contains a list of cluster names, queue names or AUTHINFO object names. In a cluster, it can be used to identify a list of clusters for which the queue manager holds the repositories.

You can only define and modify namelists using the operations and control panels of WebSphere MQ for z/OS or MQSC commands.

Programs can use the MQI to find out which queues are included in these namelists. The organization of the namelists is the responsibility of the application designer and system administrator.

For a full description of the attributes of namelists, see [WebSphere MQ Application Programming Reference](#).
Process definitions

Not supported in MQSeries for VSE/ESA.

To allow an application to be started without the need for operator intervention (described in Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191), the attributes of the application must be known to the queue manager. These attributes are defined in a process definition object.

The ProcessName attribute is fixed when the object is created; you can change the others using the WebSphere MQ commands or the WebSphere MQ for z/OS operations and control panels. You can inquire about the values of all the attributes using the MQINQ call.

For a full description of the attributes of process definitions, see WebSphere MQ Application Programming Reference.

AUTHINFO objects

An AUTHINFO object contains authentication information used in Secure Sockets Layer (SSL) encrypted transport of information. An AUTHINFO object of AUTHTYPE CRL LDAP provides the definitions required to perform Certificate Revocation List (CRL) checking using LDAP servers. CRLs allow Certification Authorities to revoke certificates which can no longer be trusted.

For a full description of the attributes of AUTHINFO objects, see WebSphere MQ Application Programming Reference. For more information about SSL, see WebSphere MQ Security.

Channels

A channel is a communication link used by distributed queue managers. There are two categories of channel in WebSphere MQ:

- Message channels, which are unidirectional, and transfer messages from one queue manager to another.
- MQI channels, which are bidirectional, and transfer MQI calls from a WebSphere MQ client to a queue manager, and responses from a queue manager to a WebSphere MQ client.

These need to be considered when designing your application, but a program will be unaware of WebSphere MQ channel objects. For more information, see WebSphere MQ Intercommunication and WebSphere MQ Clients.

Storage classes

Only supported in WebSphere MQ for z/OS.

A storage class maps one or more queues to a page set. This means that messages for that queue are stored (subject to buffering) on that page set.

For further information about storage classes, see WebSphere MQ for z/OS Concepts and Planning Guide.
Rules for naming WebSphere MQ objects

A WebSphere MQ queue, process definition, namelist, and channel can all have the same name. However, a WebSphere MQ object cannot have the same name as any other object of the same type. Names in WebSphere MQ are case sensitive.

The character set that can be used for naming all WebSphere MQ objects is as follows:

- Uppercase A–Z
- Lowercase a–z (but there are restrictions on the use of lowercase letters for z/OS console support)
  - On systems using EBCDIC Katakana you cannot use lowercase characters.
- Numerics 0–9
- Period (.)
- Forward slash (/)
- Underscore (_)
- Percent sign (%)

Notes:

1. Leading or embedded blanks are not allowed.
2. You should also avoid using names with leading or trailing underscores, because they cannot be handled by the WebSphere MQ for z/OS operations and control panels.
3. Any name that is less than the full field length can be padded to the right with blanks. All short names that are returned by the queue manager are always padded to the right with blanks.
4. Any structure to the names (for example, the use of the period or underscore) is not significant to the queue manager.
5. On OS/400 systems, within CL, lowercase a-z, forward slash (/), and percent (%) are special characters. If you use any of these characters in a name, the name must be enclosed in quotation marks. Lowercase a-z characters are changed to uppercase if the name is not enclosed in quotation marks.
6. On Windows systems, the first character of a queue manager name cannot be a forward slash (/).

Queue names

The name of a queue has two parts:
- The name of a queue manager
- The local name of the queue as it is known to that queue manager

Each part of the queue name is 48 characters long.

To refer to a local queue, you can omit the name of the queue manager (by replacing it with blank characters or using a leading null character). However, all queue names returned to a program by WebSphere MQ contain the name of the queue manager.

Note that a shared queue, accessible to any queue manager in its queue-sharing group, cannot have the same name as any non-shared local queue in the same queue-sharing group. This restriction avoids the possibility of an application
mistakenly opening a shared queue when it intended to open a local queue, or vice versa. Shared queues and queue-sharing groups are only available on WebSphere MQ for z/OS.

To refer to a remote queue, a program must include the name of the queue manager in the full queue name, or there must be a local definition of the remote queue.

Note that when an application uses a queue name, that name can be either the name of a local queue (or an alias to one) or the name of a local definition of a remote queue, but the application does not need to know which, unless it needs to get a message from the queue (when the queue must be local). When the application opens the queue object, the MQOPEN call performs a name resolution function to determine on which queue to perform subsequent operations. The significance of this is that the application has no built-in dependency on particular queues being defined at particular locations in a network of queue managers. Therefore, if a system administrator relocates queues in the network, and changes their definitions, the applications that use those queues do not need to be changed.

### Process definition, AUTHINFO and namelist names

Process definitions, AUTHINFO objects, and namelists can have names up to 48 characters long.

### Channel names

Channels can have names up to 20 characters long. See [WebSphere MQ Intercommunication](#) for further information on channels.

### Reserved object names

Names that start with SYSTEM. are reserved for objects defined by the queue manager.
Chapter 5. Handling program errors

Your application may encounter errors associated with its MQI calls either when it makes a call or when its message is delivered to its final destination:

- Whenever possible, the queue manager returns any errors as soon as an MQI call is made. These are locally determined errors.
- When sending messages to a remote queue, errors may not be apparent when the MQI call is made. In this case, the queue manager that identifies the errors reports them by sending another message to the originating program. These are remotely determined errors.

This chapter gives advice on how to handle both types of error, under these headings:

- "Locally determined errors"
- “Using report messages for problem determination” on page 52
- “Remotely determined errors” on page 53

Locally determined errors

The three most common causes of errors that the queue manager can report immediately are:

- Failure of an MQI call; for example, because a queue is full
- An interruption to the running of some part of the system on which your application is dependent; for example, the queue manager
- Messages containing data that cannot be processed successfully

Failure of an MQI call

The queue manager can report immediately any errors in the coding of an MQI call. It does this using a set of predefined return codes. These are divided into completion codes and reason codes.

To show whether or not a call is successful, the queue manager returns a completion code when the call completes. There are three completion codes, indicating success, partial completion, and failure of the call. The queue manager also returns a reason code which indicates the reason for the partial completion or the failure of the call.

The completion and reason codes for each call are listed with the description of that call in [WebSphere MQ Application Programming Reference]. You will also find further information (including some ideas for corrective action) for each completion and reason code in [WebSphere MQ Application Programming Reference]. You should design your programs to handle all the return codes that could arise from each call.
System interruptions

Your application may be unaware of any interruption if the queue manager to which it is connected has to recover from a system failure. However, you must design your application to ensure that your data is not lost if such an interruption occurs.

The methods you can use to make sure that your data remains consistent depends on the platform on which your queue manager is running:

**z/OS**
In the CICS and IMS environments, you can make MQPUT and MQGET calls within units of work that are managed by CICS or IMS. In the batch environment, you can make MQPUT and MQGET calls in the same way, but you must declare syncpoints by using the WebSphere MQ for z/OS MQCMIT and MQBACK calls (see Chapter 13, “Committing and backing out units of work”, on page 175), or you can use the z/OS Transaction Management and Recoverable Resource Manager Services (RRS) to provide two-phase syncpoint support. RRS allows you to update both WebSphere MQ and other RRS-enabled product resources, such as DB2 stored procedure resources, within a single logical unit of work. For information on RRS syncpoint support see “Transaction management and recoverable resource manager services” on page 179.

**OS/400**
You can make your MQPUT and MQGET calls within global units of work that are managed by OS/400 commitment control. You can declare syncpoints by using the native OS/400 COMMIT and ROLLBACK commands or the language-specific commands. Local units of work are managed by WebSphere MQ via the MQCMIT and MQBACK calls.

**Compaq OpenVMS Alpha, UNIX systems and Windows systems**
In these environments, you can make your MQPUT and MQGET calls in the normal way, but you must declare syncpoints by using the MQCMIT and MQBACK calls (see Chapter 13, “Committing and backing out units of work”, on page 175). In the CICS environment, MQCMIT and MQBACK commands are disabled as you can make your MQPUT and MQGET calls within units of work that are managed by CICS.

**Compaq NonStop Kernel**
You can make your MQPUT and MQGET calls within units of work that are managed by the Compaq NonStop Kernel TM/MP product.

**VSE/ESA**
CICS controls the unit of work in the VSE/ESA environment. If the system fails and is restarted, the logical unit of work rollback occurs automatically.

You should use persistent messages for carrying all data you cannot afford to lose. Persistent messages are reinstated on queues if the queue manager has to recover from a failure. With WebSphere MQ on UNIX systems, MQSeries for OS/2 Warp, and WebSphere MQ for Windows, note that an MQGET or MQPUT call within your application will fail at the point of filling up all the log files, with the message MQRC_RESOURCE_PROBLEM. For more information on log files on AIX, HP-UX, Linux, OS/2, Solaris, and Windows systems, see WebSphere MQ System Administration Guide for z/OS, see WebSphere MQ for z/OS Concepts and Planning Guide for other platforms, see the appropriate System Management Guide.

If the queue manager is stopped by an operator while an application is running, the quiesce option is normally used. The queue manager enters a quiescing state in which applications can continue to do work, but they should terminate as soon as
it is convenient. Small, quick applications can probably ignore the quiescing state and continue until they terminate as normal. Longer running applications, or ones that wait for messages to arrive, should use the fail if quiescing option when they use the MQOPEN, MQPUT, MQPUT1, and MQGET calls. These options mean that the calls fail when the queue manager quiesces, but the application may still have time to terminate cleanly by issuing calls that ignore the quiescing state. Such applications could also commit, or back out, changes they have made, and then terminate.

If the queue manager is forced to stop (that is, stop without quiescing), applications will receive the MQRC_CONNECTION_BROKEN reason code when they make MQI calls. At this point you must exit the application or, alternatively, on WebSphere MQ for iSeries™, WebSphere MQ on UNIX systems, MQSeries for OS/2 Warp, and WebSphere MQ for Windows, you can issue an MQDISC call.

**Messages containing incorrect data**

Note: In MQSeries for VSE/ESA, BackoutCount is a reserved field. It cannot be used as described in this section.

When you use units of work in your application, if a program cannot successfully process a message that it retrieves from a queue, the MQGET call is backed out. The queue manager maintains a count (in the BackoutCount field of the message descriptor) of the number of times this happens. It maintains this count in the descriptor of each message that is affected. This count can provide valuable information about the efficiency of an application. Messages whose backout counts are increasing over time are being repeatedly rejected—you should design your application so that it analyzes the reasons for this and handles such messages accordingly.

In WebSphere MQ for z/OS, to make the backout count survive restarts of the queue manager, set the HardenGetBackout attribute to MQQA_BACKOUT_HARDENED; otherwise, if the queue manager has to restart, it does not maintain an accurate backout count for each message. Setting the attribute this way adds the penalty of extra processing.

In WebSphere MQ for iSeries, MQSeries for OS/2 Warp, WebSphere MQ for Windows, and WebSphere MQ on UNIX systems, the backout count always survives restarts of the queue manager.

Also, in WebSphere MQ for z/OS, when you remove messages from a queue within a unit of work, you can mark one message so that it is not made available again if the unit of work is backed out by the application. The marked message is treated as if it has been retrieved under a new unit of work. You mark the message that is to skip backout using the MQGMO_MARK_SKIP_BACKOUT option (in the MQGMO structure) when you use the MQGET call. See “Skipping backout” on page 142 for more information about this technique.
Report messages for error handling

Using report messages for problem determination

The remote queue manager cannot report errors such as failing to put a message on a queue when you make your MQI call, but it can send you a report message to say how it has processed your message.

Within your application you can create (MQPUT) report messages as well as select the option to receive them (in which case they will be sent by either another application or by a queue manager).

Creating report messages

Report messages provide a mechanism for an application to inform another application that it is unable to deal with the message that was sent. However, the Report field must initially be analyzed to determine whether or not the application that sent the message is interested in being informed of any problems. Having determined that a report message is required, you have to decide:

- Whether you want to include the entire original message, just the first 100 bytes of data, or none of the original message.
- What to do with the original message. You can discard it or let it go to the dead-letter queue.
- Whether the content of the MsgId and CorrelId fields are needed as well.

Use the Feedback field to indicate the reason for the report message being generated. Put your report messages on an application’s reply-to queue. Refer to WebSphere MQ Application Programming Reference for further information.

Requesting and receiving (MQGET) report messages

When you send a message to another application, you will not be informed of any problems unless you complete the Report field to indicate the feedback you require. The options available to you are in WebSphere MQ Application Programming Reference.

Queue managers always put report messages on an application’s reply-to queue and it is recommended that your own applications do the same. When you use the report message facility you must specify the name of your reply-to queue in the message descriptor of your message; otherwise, the MQPUT call fails.

Your application should contain procedures that monitor your reply-to queue and process any messages that arrive on it. Remember that a report message can contain all the original message, the first 100 bytes of the original message, or none of the original message.

The queue manager sets the Feedback field of the report message to indicate the reason for the error; for example, the target queue does not exist. Your programs should do the same.

For more information on report messages, see “Report messages” on page 21.
Remotely determined errors

When you send messages to a remote queue, even when the local queue manager has processed your MQI call without finding an error, other factors can influence how your message is handled by a remote queue manager. For example, the queue you are targeting may be full, or may not even exist. If your message has to be handled by other intermediate queue managers on the route to the target queue, any of these could find an error.

Problems delivering a message

When an MQPUT call fails, you have the choice of attempting to put the message on the queue again, returning it to the sender, or putting it on the dead-letter queue.

Each option has its own merits, but you may not want to retry putting a message if the reason that the MQPUT failed was because the destination queue was full. In this instance, putting it on the dead-letter queue allows you to deliver it to the correct destination queue later on.

Retry message delivery

Before the message is put on a dead-letter queue, a remote queue manager attempts to put the message on the queue again if the attributes `MsgRetryCount` and `MsgRetryInterval` have been set for the channel, or if there is a retry exit program for it to use (the name of which is held in the channel attribute `MsgRetryExitId` field).

If the `MsgRetryExitId` field is blank, the values in the attributes `MsgRetryCount` and `MsgRetryInterval` are used.

If the `MsgRetryExitId` field is not blank, the exit program of this name runs. For more information on using your own exit programs, see WebSphere MQ Intercommunication.

Return message to sender

You return a message to the sender by requesting a report message to be generated to include all of the original message. See "Report messages" on page 21 for details on report message options.

Using the dead-letter (undelivered message) queue

When a queue manager cannot deliver a message, it attempts to put the message on its dead-letter queue. This queue should be defined when the queue manager is installed.

Your programs can use the dead-letter queue in the same way that the queue manager uses it. You can find the name of the dead-letter queue by opening the queue manager object (using the MQOPEN call) and inquiring about the `DeadLetterQName` attribute (using the MQINQ call).

When the queue manager puts a message on this queue, it adds a header to the message, the format of which is described by the dead-letter header (MQDLH) structure, in WebSphere MQ Application Programming Reference. This header includes the name of the target queue and the reason the message was put on the dead-letter queue. It must be removed and the problem must be resolved before
the message is put on the intended queue. Also, the queue manager changes the
Format field of the message descriptor (MQMD) to indicate that the message
contains an MQDLH structure.

MQDLH structure

You are recommended to add an MQDLH structure to all messages that you
put on the dead-letter queue; however, if you intend to use the dead-letter
handler provided by certain WebSphere MQ products, you must add an
MQDLH structure to your messages.

The addition of the header to a message may make the message too long for the
dead-letter queue, so you should always make sure that your messages are shorter
than the maximum size allowed for the dead-letter queue, by at least the value of
the MQ_MSG_HEADER_LENGTH constant. The maximum size of messages
allowed on a queue is determined by the value of the MaxMsgLength attribute of the
queue. For the dead-letter queue, you should make sure that this attribute is set to
the maximum allowed by the queue manager. If your application cannot deliver a
message, and the message is too long to be put on the dead-letter queue, follow
the advice given in the description of the MQDLH structure.

You need to ensure that the dead-letter queue is monitored, and that any messages
arriving on it get processed. A dead-letter queue handler is provided by
WebSphere MQ on all platforms except VSE/ESA. It runs as a batch utility and can
be used to perform various actions on selected messages on the dead-letter queue.
If you have a queue manager on one of the platforms that does not provide a
dead-letter queue handler, you will need to provide your own. The program could
be triggered, or run at regular intervals. For further details, see
WebSphere MQ System Administration Guide for WebSphere MQ for AIX, HP-UX, Linux, OS/2,
Solaris, and Windows systems; for WebSphere MQ for z/OS see WebSphere MQ for
z/OS System Administration Guide; for other platforms, see the appropriate System
Management Guide.

If data conversion is necessary, the queue manager converts the header information
when you use the MQGMO_CONVERT option on the MQGET call. If the process
putting the message is an MCA, the header is followed by all the text of the
original message.

You should be aware that messages put on the dead-letter queue may be truncated
if they are too long for this queue. A possible indication of this situation is the
messages on the dead-letter queue being the same length as the value of the
MaxMsgLength attribute of the queue.

Dead-letter queue processing

The rest of this chapter contains general-use programming interface information.

Dead-letter queue processing is dependent on local system requirements, but you
should consider the following when you draw up the specification:

• The message can be identified as having a dead-letter queue header because the
  value of the format field in the MQMD, is MQFMT_DEAD_LETTER_HEADER.
• In WebSphere MQ for z/OS using CICS, if an MCA puts this message to the
dead-letter queue, the PutApplType field is MQAT_CICS, and the PutAppName
  field is the ApplId of the CICS system followed by the transaction name of the
  MCA.
Remote determined errors

- The reason for the message to be routed to the dead-letter queue is contained in the Reason field of the dead-letter queue header.
- The dead-letter queue header contains details of the destination queue name and queue manager name.
- The dead-letter queue header contains fields that have to be reinstated in the message descriptor before the message is put to the destination queue. These are:
  1. Encoding
  2. CodedCharSetId
  3. Format
- The message descriptor is the same as PUT by the original application, except for the three fields shown above.

Your dead-letter queue application should do one or more of the following:
- Examine the Reason field. A message may have been put by an MCA for the following reasons:
  - The message was longer than the maximum message size for the channel
    The reason will be MQRC_MSG_TOO_BIG_FOR_CHANNEL (or MQRC_MSG_TOO_BIG_FOR_Q_MGR if you are using CICS for distributed queuing on WebSphere MQ for z/OS)
  - The message could not be put to its destination queue
    The reason will be any MQRC_* reason code that can be returned by an MQPUT operation
  - A user exit has requested this action
    The reason code will be that supplied by the user exit, or the default MQRC_SUPPRESSED_BY_EXIT
- Try to forward the message to its intended destination, where this is possible.
- Retain the message for a certain length of time before discarding when the reason for the diversion is determined, but not immediately correctable.
- Give instructions to administrators for the correction of problems where these have been determined.
- Discard messages that are corrupted or otherwise not processible.

There are two ways that you deal with the messages you have recovered from the dead-letter queue:

1. If the message is for a local queue, you should:
   - Carry out any code translations required to extract the application data
   - Carry out code conversions on that data if this is a local function
   - Put the resulting message on the local queue with all the detail of the message descriptor restored
2. If the message is for a remote queue, put the message on the queue.

For information on how undelivered messages are handled in a distributed queuing environment, see [WebSphere MQ Intercommunication](#)
Part 2. Writing a WebSphere MQ application

Chapter 6. Introducing the Message Queue Interface

What is in the MQI? ............................................. 61
Calls. ...................................................... 63
Syncpoint calls ........................................... 63
WebSphere MQ for z/OS calls ......................... 63
OS/400 calls ........................................... 64
MQSeries for Compaq NonStop Kernel calls .... 64
MQSeries for VSE/ESA calls ......................... 64
WebSphere MQ calls on other platforms .......... 64
Data conversion ......................................... 64
Structures .............................................. 65
Elementary data types ................................ 65
WebSphere MQ data definitions ................... 65
WebSphere MQ stub programs and library files 65
WebSphere MQ for z/OS ................................ 65
WebSphere MQ for iSeries ............................ 66
MQSeries for OS/2 Warp ................................ 67
WebSphere MQ for Windows ......................... 67
WebSphere MQ for AIX ................................ 67
MQSeries for AT&T GIS UNIX ....................... 68
MQSeries for Compaq OpenVMS Alpha ........... 68
MQSeries for Compaq Tru64 UNIX .................. 68
WebSphere MQ for HP-UX ............................. 69
WebSphere MQ for Linux .............................. 69
MQSeries for SINIX and DC/OSx ................. 70
WebSphere MQ for Solaris ............................ 70
MQSeries for VSE/ESA ................................. 70
MQSeries for Compaq NonStop Kernel .......... 71
Parameters common to all the calls ............... 71
Using connection and object handles ............. 71
Understanding return codes ....................... 71
Specifying buffers ..................................... 72
Programming language considerations .......... 72
Coding in C .............................................. 73
Parameters of the MQI calls .......................... 73
Parameters with undefined data type ............. 73
Data types .............................................. 73
Manipulating binary strings ......................... 73
Manipulating character strings .................... 74
Initial values for structures ......................... 74
Initial values for dynamic structures .......... 74
Use from C++ ........................................... 75
Coding in COBOL ........................................ 75
Named constants ........................................ 75
Coding in System/390® assembler language .... 76
Names .................................................... 76
Using the MQI calls ................................... 76
 Declaring constants ................................. 76
Specifying the name of a structure ............... 77
Specifying the form of a structure ............... 77
Controlling the listing ................................ 77
Specifying initial values for fields .......... 77
Writing reenterable programs ..................... 78
Using CEDF ............................................ 78
Coding in RPG .......................................... 78
Coding in PL/I .......................................... 79
Structures .............................................. 79
Named constants ....................................... 79
Coding in TAL .......................................... 80
Coding in Visual Basic ................................ 80
z/OS batch considerations ......................... 80
UNIX signal handling .................................. 81
Signal handling before MQSeries version 5.2 .... 82
Signals in the non-threaded environment ........ 82
Signals in the threaded environment ............. 82
Additional considerations .......................... 83
Signal handling in version 5.2 and later releases 84
Unthreaded applications ............................. 84
Threaded applications ................................ 84
Additional considerations .......................... 85

Chapter 7. Connecting to and disconnecting from a queue manager ............................................. 87
Connecting to a queue manager using the MQCONN call .............................................. 88
Scope of MQCONN or MQCONNX .......................... 89
Connecting to a queue manager using the MQCONNX call ...................................... 90
Restrictions for trusted applications .............. 91
Shared (thread independent) connections with MQCONNX ......................................... 92
 Shared connection usage notes .......................... 93
MQCONNX environment variable ...................... 93
Disconnecting programs from a queue manager using MQDISC ..................................... 94
When no MQDISC is issued ............................ 94
Authority checking ..................................... 94

Chapter 8. Opening and closing objects ............................................. 95
Opening objects using the MQOPEN call .............. 96
Scope of an object handle ............................. 96
Identifying objects (the MQOD structure) .................. 96
Name resolution ......................................... 97
Using the options of the MQOPEN call .......... 100
MQOPEN option for cluster queue .................. 100
MQOPEN option for putting messages .............. 100
MQOPEN option for browsing messages .......... 100
MQOPEN options for removing messages ........... 100
MQOPEN options for setting and inquiring about attributes .................. 101
MQOPEN options relating to message context ........ 101
MQOPEN option for alternate user authority ........ 102
MQOPEN option for queue manager quiescing .......... 102
Creating dynamic queues ............................. 102
Opening remote queues ................................ 103
Closing objects using the MQCLOSE call ............ 103

Chapter 9. Putting messages on a queue ............................................. 105
<table>
<thead>
<tr>
<th>Chapter 10. Getting messages from a queue</th>
<th>119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting messages from a queue using the MQGET call</td>
<td>119</td>
</tr>
<tr>
<td>Specifying connection handles</td>
<td>120</td>
</tr>
<tr>
<td>Describing messages using the MQMD structure and the MQGET call</td>
<td>120</td>
</tr>
<tr>
<td>Specifying MQGET options using the MQGMO structure</td>
<td>120</td>
</tr>
<tr>
<td>Specifying the size of the buffer area</td>
<td>123</td>
</tr>
<tr>
<td>The order in which messages are retrieved from a queue</td>
<td>124</td>
</tr>
<tr>
<td>Priority</td>
<td>124</td>
</tr>
<tr>
<td>Logical and physical ordering</td>
<td>124</td>
</tr>
<tr>
<td>Grouping logical messages</td>
<td>127</td>
</tr>
<tr>
<td>Putting and getting a group that spans units of work</td>
<td>128</td>
</tr>
<tr>
<td>Getting a particular message</td>
<td>131</td>
</tr>
<tr>
<td>Type of index</td>
<td>132</td>
</tr>
<tr>
<td>Handling messages greater than 4 MB long</td>
<td>133</td>
</tr>
<tr>
<td>Increasing the maximum message length</td>
<td>134</td>
</tr>
<tr>
<td>Message segmentation</td>
<td>134</td>
</tr>
<tr>
<td>Segmentation and reassembly by queue manager</td>
<td>135</td>
</tr>
<tr>
<td>Application segmentation</td>
<td>135</td>
</tr>
<tr>
<td>Application segmentation of logical messages</td>
<td>136</td>
</tr>
<tr>
<td>Putting and getting a segmented message that spans units of work</td>
<td>137</td>
</tr>
<tr>
<td>Reference messages</td>
<td>137</td>
</tr>
<tr>
<td>Using the MQRMH and MQMD structures</td>
<td>138</td>
</tr>
<tr>
<td>Waiting for messages</td>
<td>139</td>
</tr>
<tr>
<td>Signaling</td>
<td>140</td>
</tr>
<tr>
<td>To set a signal</td>
<td>140</td>
</tr>
<tr>
<td>When the message arrives</td>
<td>141</td>
</tr>
<tr>
<td>Skipping backout</td>
<td>142</td>
</tr>
<tr>
<td>Application data conversion</td>
<td>145</td>
</tr>
<tr>
<td>Conversion of EBCDIC newline characters</td>
<td>146</td>
</tr>
<tr>
<td>Browsing messages on a queue</td>
<td>147</td>
</tr>
<tr>
<td>The browse cursor</td>
<td>147</td>
</tr>
<tr>
<td>Queues in FIFO (first in, first out) sequence</td>
<td>147</td>
</tr>
<tr>
<td>Queues in priority sequence</td>
<td>148</td>
</tr>
<tr>
<td>Uncommitted messages</td>
<td>148</td>
</tr>
<tr>
<td>Change to queue sequence</td>
<td>148</td>
</tr>
<tr>
<td>Use of the queue's index</td>
<td>148</td>
</tr>
<tr>
<td>Browsing messages when message length unknown</td>
<td>149</td>
</tr>
<tr>
<td>Removing a message you have browsed</td>
<td>149</td>
</tr>
<tr>
<td>Browsing messages in logical order</td>
<td>150</td>
</tr>
<tr>
<td>Browsing messages in groups</td>
<td>150</td>
</tr>
<tr>
<td>Browsing and retrieving destructively</td>
<td>151</td>
</tr>
<tr>
<td>Some cases where the MQGET call fails</td>
<td>152</td>
</tr>
</tbody>
</table>

Chapter 11. Writing data-conversion exits | 153 |
| Invoking the data-conversion exit | 154 |
| Data conversion on z/OS | 155 |
| Writing a data-conversion exit program | 155 |
| Skeleton source file | 156 |
| Convert characters call | 156 |
| Utility for creating conversion-exit code | 156 |
| Invoking the CSQUCVX utility on z/OS | 157 |
| z/OS data definition statements | 157 |
| Error messages in OS/2, Windows systems, and UNIX systems | 157 |
| Valid syntax | 157 |
| Example of valid syntax for the input data set | 158 |
| Writing a data-conversion exit program for WebSphere MQ for iSeries | 159 |
| Writing a data-conversion exit for MQSeries for OS/2 Warp | 160 |
| Writing a data-conversion exit program for WebSphere MQ for z/OS | 162 |
| Writing a data-conversion exit for MQSeries for Compaq NonStop Kernel | 163 |
| Reusing data-conversion exit programs | 164 |
| Writing a data-conversion exit for WebSphere MQ on UNIX systems and Compaq OpenVMS Alpha | 164 |
| UNIX environment | 165 |
| Non-threaded environment | 165 |
| Threaded environment | 165 |
| Compiling data-conversion exits on Compaq OpenVMS Alpha | 166 |
| Compiling data-conversion exits on UNIX | 166 |
| On AIX 4.3 | 167 |
| On AT&T G3 UNIX | 167 |
| On Compaq Tru64 UNIX Version 4.0 | 167 |
| On Compaq Tru64 UNIX Version 5.0 | 167 |
| On HP-UX Version 11.00 | 167 |
| On Linux | 168 |
| On S/NIX | 168 |
| On DC/OSx | 168 |
| On Solaris | 168 |
| Writing a data-conversion exit for WebSphere MQ for Windows | 169 |

Chapter 12. Inquiring about and setting object attributes | 171 |
| Inquiring about the attributes of an object | 172 |
Chapter 13. Committing and backing out units of work

- Syncpoint considerations in WebSphere MQ applications
- Syncpoints in WebSphere MQ for z/OS applications
  - Syncpoints in CICS Transaction Server for z/OS and CICS for MVS/ESA applications
  - Syncpoints in IMS applications
  - Syncpoints in z/OS batch applications
  - Committing changes using the MQCMIT call
  - Backing out changes using the MQBACK call
  - Transaction management and recoverable resource manager services
- Syncpoints in CICS for iSeries applications
- Syncpoints in MQSeries for OS/2 Warp, WebSphere MQ for Windows, WebSphere MQ for iSeries, and WebSphere MQ on UNIX systems
  - Local units of work
  - Global units of work
  - Internal syncpoint coordination
  - External syncpoint coordination
- Interfaces to external syncpoint managers
- Interfaces to the OS/400 external syncpoint manager
- Syncpoints in MQSeries for Compaq NonStop Kernel applications
  - Using MQGET wait interval and channel
  - DISCINT and HBINT
  - General XA support
- WebSphere MQ XA support and Tuxedo

Chapter 14. Starting WebSphere MQ applications using triggers

- What is triggering?
- Prerequisites for triggering
- Conditions for a trigger event
- Controlling trigger events
  - Example of the use of trigger type EVERY
  - Example of the use of trigger type FIRST
  - Special case of trigger type FIRST
- Designing an application that uses triggered queues
  - Trigger messages and units of work
  - Getting messages from a triggered queue
- Trigger monitors
  - Trigger monitors on z/OS
  - Trigger monitors on OS/2, Compaq OpenVMS Alpha, Compaq NonStop Kernel, UNIX systems, OS/400, and Windows systems
  - For CICS
  - WebSphere MQ for iSeries trigger monitors
- Properties of trigger messages
  - Persistence and priority of trigger messages
  - Queue manager restart and trigger messages
  - Trigger messages and changes to object attributes

Chapter 15. Using and writing API exits

- Introducing API exits
- Why use API exits
  - How you use API exits
  - How to configure WebSphere MQ for API exits
  - How to write an API exit
  - What happens when an API exit runs
- Compiling API exits
  - On Solaris
  - On AIX
  - On HP-UX
  - On Linux
  - On Windows systems
  - On OS/400
- Reference information
  - External control blocks
    - WebSphere MQ API exit parameter structure (MQAXP)
    - WebSphere MQ API exit context structure (MQAXC)
- The exit chain area and exit chain area header (MQACH)
- External constants
- C language typedefs
- The exit entry point registration call (MQXEP)
  - MQXEP C language invocation
  - MQXEP C language typedefs
  - MQXEP C function prototype
- Invoking exit functions
  - General rules for API exit routines
  - The API exit functions
  - General information on invoking exit functions
    - What happens when exits fail
    - What if the ExitResponse fields are incorrectly set

Chapter 16. Using and writing applications on WebSphere MQ for z/OS

- Environment-dependent WebSphere MQ for z/OS functions
- Program debugging facilities
- Syncpoint support
- Recovery support
- The WebSphere MQ for z/OS interface with the application environment
  - The batch adapter
  - RRS batch adapter
  - Migration
  - The CICS adapter
Chapter 6. Introducing the Message Queue Interface

This chapter introduces the features of the Message Queue Interface (MQI).

The remaining chapters in this part of the book describe how to use these features. Detailed descriptions of the calls, structures, data types, return codes, and constants are given in the WebSphere MQ Application Programming Reference.

The MQI is introduced under these headings:
- “What is in the MQI?”
- “Parameters common to all the calls” on page 71
- “Specifying buffers” on page 72
- “Programming language considerations” on page 72
- “z/OS batch considerations” on page 80
- “UNIX signal handling” on page 81

Note
The Application Messaging Interface (AMI) provides a simpler and higher-level programming interface than the MQI. Although it has some limitations compared with the MQI, its function should be sufficient for the majority of users. The AMI supports both point-to-point and publish/subscribe messaging models, and includes support for both WebSphere MQ Integrator Version 1 and WebSphere MQ Integrator Version 2. The AMI eliminates the need for application programmers to understand all of the options and functions available in the MQI. The Application Messaging Interface for C, C++, and Java runs on the following operating systems or environments: OS/400, AIX, HP-UX, Solaris, Microsoft Windows, and z/OS. The Application Messaging Interface for COBOL runs on the z/OS operating system. Further information about the AMI is outside the scope of this book. For full details, refer to WebSphere MQ Application Messaging Interface.

What is in the MQI?

The Message Queue Interface consists of the following:
- Calls through which programs can access the queue manager and its facilities
- Structures that programs use to pass data to, and get data from, the queue manager
- Elementary data types for passing data to, and getting data from, the queue manager

WebSphere MQ for z/OS also supplies:
- Two extra calls through which z/OS batch programs can commit and back out changes.
- Data definition files (sometimes known as copy files, macros, include files, and header files) that define the values of constants supplied with WebSphere MQ for z/OS.
- Stub programs to link-edit to your applications.
MQI contents

- A suite of sample programs that demonstrate how to use the MQI on the z/OS platform. For further information about these samples, see Chapter 36, “Sample programs for WebSphere MQ for z/OS”, on page 471.

WebSphere MQ for iSeries also supplies:
- *Data definition files* (sometimes known as copy files, macros, include files, and header files) that define the values of constants supplied with WebSphere MQ for iSeries.
- Three stub programs to link-edit to your ILE C, ILE COBOL, and ILE RPG applications.
- A suite of sample programs that demonstrate how to use the MQI on the iSeries platform. For further information about these samples, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

MQSeries for OS/2 Warp, WebSphere MQ for Windows, MQSeries for Compaq OpenVMS Alpha, and WebSphere MQ on UNIX systems also supply:
- Calls through which MQSeries for OS/2 Warp, WebSphere MQ for Windows, WebSphere MQ for iSeries, and WebSphere MQ on UNIX systems programs can commit and back out changes.
- *Include files* that define the values of constants supplied on these platforms.
- *Library files* to link your applications.
- A suite of sample programs that demonstrate how to use the MQI on these platforms.
- Sample source and executable code for bindings to external transaction managers.

MQSeries for Compaq NonStop Kernel also supplies:
- *Include files* that define the values of constants supplied with MQSeries for Compaq NonStop Kernel.
- *Library files* to link your applications.
- A suite of sample programs that demonstrate how to use the MQI on the Compaq NonStop Kernel platform.

MQSeries for VSE/ESA also supplies:
- *Include files* that define the values of constants supplied with MQSeries for VSE/ESA.
- A suite of sample programs that demonstrate how to use the MQI on the VSE/ESA platform.
Calls

The calls in the MQI can be grouped as follows:

**MQCONN, MQCONNX, and MQDISC**
Use these calls to connect a program to (with or without options), and disconnect a program from, a queue manager. If you write CICS programs for z/OS, or VSE/ESA, you do not need to use these calls. However, you are recommended to use them if you want your application to be portable to other platforms.

**MQOPEN and MQCLOSE**
Use these calls to open and close an object, such as a queue.

**MQPUT and MQPUT1**
Use these calls to put a message on a queue.

**MQGET**
Use these calls to browse messages on a queue, or to remove messages from a queue.

**MQINQ**
Use this call to inquire about the attributes of an object.

**MQSET**
Use this call to set some of the attributes of a queue. You cannot set the attributes of other types of object.

**MQBEGIN, MQCMIT, and MQBACK**
Use these calls when WebSphere MQ is the coordinator of a unit of work. MQBEGIN starts the unit of work. MQCMIT and MQBACK end the unit of work, either committing or rolling back the updates made during the unit of work. OS/400 commitment controller is used to coordinate global units of work on iSeries. Native start commitment control, commit, and rollback commands are used.

The MQI calls are described fully in *WebSphere MQ Application Programming Reference*.

Syncpoint calls

Syncpoint calls are available as follows:

**WebSphere MQ for z/OS calls**
WebSphere MQ for z/OS provides the MQCMIT and MQBACK calls. Use these calls in z/OS batch programs to tell the queue manager that all the MQGET and MQPUT operations since the last syncpoint are to be made permanent (committed) or are to be backed out. To commit and back out changes in other environments:

- **CICS** Use commands such as EXEC CICS SYNCPOINT and EXEC CICS SYNCPOINT ROLLBACK.
- **IMS** Use the IMS syncpoint facilities, such as the GU (get unique) to the IOPCB, CHKP (checkpoint), and ROLB (rollback) calls.
- **RRS** Use MQCMIT and MQBACK or SRRCMIT and SRRBACK as appropriate. (See “Transaction management and recoverable resource manager services” on page 179.)

**Note:** SRRCMIT and SRRBACK are “native’ RRS commands, they are not MQI calls.”
MQI contents

For backward compatibility, the CSQBCMT and CSQBBAK calls are available as synonyms for MQCMIT and MQBACK. These are described fully in WebSphere MQ Application Programming Reference.

OS/400 calls

WebSphere MQ for iSeries provides the MQCMIT and MQBACK commands. You can also use the OS/400 COMMIT and ROLLBACK commands, or any other commands or calls that initiate the OS/400 commitment control facilities (for example, EXEC CICS SYNCPOINT).

MQSeries for Compaq NonStop Kernel calls

The default SYNCPOINT option for the MQPUT and MQGET calls is SYNCPOINT, rather than NO_SYNCPOINT. To use the default (SYNCPOINT) option for MQPUT, MQGET and MQPUT1 operations, the application must have an active TM/MP Transaction that defines the unit of work to be committed.

MQSeries for VSE/ESA calls

Use CICS commands such as EXEC CICS SYNCPOINT and EXEC CICS SYNCPOINT ROLLBACK. The batch interface and server support the MQCMIT and MQBACK calls which are translated into the CICS commands EXEC CICS SYNCPOINT and EXEC CICS SYNCPOINT ROLLBACK respectively. Use these calls in programs to tell the queue manager that all the MQGET and MQPUT operations since the last syncpoint are to be made permanent (committed) or are to be backed out.

WebSphere MQ calls on other platforms

The following products provide the MQCMIT and MQBACK calls:

- MQSeries for OS/2 Warp
- WebSphere MQ for Windows
- MQSeries for Compaq OpenVMS Alpha
- WebSphere MQ on UNIX systems

Use syncpoint calls in programs to tell the queue manager that all the MQGET and MQPUT operations since the last syncpoint are to be made permanent (committed) or are to be backed out. To commit and back out changes in the CICS environment, use commands such as EXEC CICS SYNCPOINT and EXEC CICS SYNCPOINT ROLLBACK.

Data conversion

The MQXCNVC - convert characters call converts message character data from one character set to another. Except on WebSphere MQ for z/OS, this call is used only from a data-conversion exit.

See the WebSphere MQ Application Programming Reference manual for the syntax used with the MQXCNVC call, and Chapter 11, “Writing data-conversion exits”, on page 153 for guidance on writing and invoking data conversion exits.
Structures

Structures, used with the MQI calls listed in “Calls” on page 63, are supplied in data definition files for each of the supported programming languages. WebSphere MQ for z/OS and WebSphere MQ for iSeries supply files that contain constants for you to use when filling in some of the fields of these structures. For more information on these, see “WebSphere MQ data definitions”.

All the structures are described fully in the WebSphere MQ Application Programming Reference.

Elementary data types

For the supported programming languages, the MQI provides elementary data types or unstructured fields. These data types are described fully in the WebSphere MQ Application Programming Reference.

WebSphere MQ data definitions

WebSphere MQ for z/OS supplies data definitions in the form of COBOL copy files, assembler-language macros, a single PL/I include file, a single C language include file, and C++ language include files.

WebSphere MQ for iSeries supplies data definitions in the form of COBOL copy files, RPG copy files, C language include files, and C++ language include files.

MQSeries for VSE/ESA supplies data definitions in the form of a C language include file, COBOL copy files, and PL/I include files.

The data definition files supplied with WebSphere MQ contain:

- Definitions of all the WebSphere MQ constants and return codes
- Definitions of the WebSphere MQ structures and data types
- Constant definitions for initializing the structures
- Function prototypes for each of the calls (for PL/I and the C language only)

For a full description of WebSphere MQ data definition files, see Appendix F, “WebSphere MQ data definition files”, on page 591.

WebSphere MQ stub programs and library files

The stub programs and library files provided are listed here, for each platform.

For more information about how to use stub programs and library files when you build an executable application, see Part 3, “Building a WebSphere MQ application”, on page 329. For information about linking to C++ library files, see WebSphere MQ Using C++.

WebSphere MQ for z/OS

Before you can run a program written with WebSphere MQ for z/OS, you must link-edit it to the stub program supplied with WebSphere MQ for z/OS for the environment in which you are running the application. The stub program provides the first stage of the processing of your calls into requests that WebSphere MQ for z/OS can process.

WebSphere MQ for z/OS supplies the following stub programs:

- **CSQBSTUB**: Stub program for z/OS batch programs
- **CSQBRRSI**: Stub program for z/OS batch programs using RRS via the MQI
CSQBRSTB  Stub program for z/OS batch programs using RRS directly
CSQCSTUB  Stub program for CICS programs
CSQQSTUB  Stub program for IMS programs
CSQXSTUB  Stub program for distributed queuing non-CICS exits
CSQASTUB  Stub program for data-conversion exits

Note: If you use the CSQBRSTB stub program you must link-edit with ATRSCSS from SYS1.CSSLIB. (SYS1.CSSLIB is also known as the “Callable Services Library”). For more information about RRS see “Transaction management and recoverable resource manager services” on page 179.

Alternatively, you can dynamically call the stub from within your program. This technique is described in “Dynamically calling the WebSphere MQ stub” on page 387.

In IMS, you may also need to use a special language interface module that is supplied by WebSphere MQ.

WebSphere MQ for iSeries
In WebSphere MQ for iSeries, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system.

For non-threaded applications:

| AMQZSTUB   | Server service program provided for compatibility with releases before V5R1M0 |
| AMQVSTUB   | Data conversion service program provided for compatibility with releases before V5R1M0 |
| LIBMQM     | Server service program |
| LIBMQIC    | Client service program |
| IMQB23I4   | C++ base service program |
| IMQS23I4   | C++ server service program |
| LIBMQMZF   | Installable exits for C |

In a threaded application:

| LIBMQM_R  | Server service program |
| IMQB23I4_R| C++ base service program |
| IMQS23I4_R| C++ server service program |
| LIBMQMZF_R| Installable exits for C |

If you are using WebSphere MQ for iSeries you can write your applications in C++. To see how to link your C++ applications, and for full details of all aspects of using C++, see WebSphere MQ Using C++.
MQSeries for OS/2 Warp
In MQSeries for OS/2 Warp, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system:

- MQM.LIB: Server for 32-bit C
- MQIC.LIB: Client for C
- MQMXA.LIB: Static XA interface for C
- MQMCICS.LIB: CICS for OS/2 V2 exits for C
- MQMCICS3.LIB: CICS Transaction Server for OS/2, V4 exits
- MQMZELIB: Installable services exits for C
- MQICCCB16.LIB: Client for 16-bit Micro Focus COBOL
- MQMCB16.LIB: Server for 16-bit Micro Focus COBOL
- MQMCBB.LIB: Server for 32-bit IBM VisualAge® COBOL
- MQMCB32.LIB: Server for 32-bit Micro Focus COBOL
- MQICCCB32.LIB: Client for 32-bit Micro Focus COBOL
- IMQ*.LIB: Server for C++

WebSphere MQ for Windows
In WebSphere MQ for Windows, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system:

- MQM.LIB: Server for 32-bit C
- MQIC.LIB: Client for 16-bit C
- MQIC32.LIB: Client for 32-bit C
- MQMXA.LIB: Static XA interface for C
- MQMCICS.LIB: CICS for Windows NT V2 exits for C
- MQMCICS4.LIB: TXSeries for Windows NT, V4 exits for C
- MQMZE.LIB: Installable services exits for C
- MQMCBB.LIB: Server for 32-bit IBM COBOL
- MQMCB32: Server for 32-bit Micro Focus COBOL
- MQICCB.BLIB: Client for 32-bit IBM COBOL
- MQICCBB.LIB: Client for 32-bit Micro Focus COBOL
- IMQ*.LIB: Server for C++
- MQMENC.LIB: Dynamic XA interface in C for Encina
- MQMTUX.LIB: Dynamic XA interface in C for Tuxedo

WebSphere MQ for AIX
In WebSphere MQ for AIX, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system.

In a non-threaded application:

- libmqm.a: Server for C
- libmqic.a: Client for C
- libmqmzf.a: Installable service exits for C
- libmqmx.a: XA interface for C
- libmqmcbrt.o: WebSphere MQ run-time library for Micro Focus COBOL support
- libmqmcb.a: Server for COBOL
- libmqicb.a: Client for COBOL
- libimqC23ia.a: Client for C++
- libimqs23ia.a: Server for C++
MQI contents

In a threaded application:

- libmqm_r.a Server for C
- libmqic_r.a Client for C
- libmqmzf_r.a Installable service exits for C
- libmqmxa_r.a XA interface for C
- libimqc23ia_r.a Client for C++
- libimqs23ia_r.a Server for C++
- libmqmxa_r.a For Encina

MQSeries for AT&T GIS UNIX

In MQSeries for AT&T GIS UNIX, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system.

- libmqm.so Server for C
- libmqmzse.so For C
- libmqic.so Client for C
- libmqmces.so Client for C
- libmqmzf.so Installable service exits for C
- libmqmxa.a XA interface for C

MQSeries for Compaq OpenVMS Alpha

In MQSeries for Compaq OpenVMS Alpha, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system:

- mqm.exe Server for C
- mqic.exe Client for C
- mqmzf.exe Installable service exits for C
- mqmxa.exe XA interface for C
- mqcbrt.exe WebSphere MQ COBOL run-time
- mqmcb.exe Server for COBOL
- mqicb.exe Client for COBOL

MQSeries for Compaq Tru64 UNIX

In MQSeries for Compaq Tru64 UNIX, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system. The files listed are for DIGITAL UNIX Version 4.0D or Version 4.0E, and Compaq Tru64 UNIX Version 4.0F or Version 5.0, except where stated.

In a non-threaded application on V4.0 or any application on V5.0:

- libmqm.so Server for C
- libmqic.so Client for C
- libimqs23ff.so Server for C++
- libimqc23ff.so Client for C++
- libmqmcb.so Server for COBOL
- libmqmecb.so Client for COBOL
- libmqmzf.so Installable service exits (not Compaq Tru64 UNIX Version 5.0)
In a threaded application on V4.0:

libmqm_r.so  Server for C
libmqic_r.so  Client for C
libimqs23ff_r.so  Server for C++
libimqc23ff_r.so  Client for C++
libmqmcb_r.so  COBOL
libmqmzf.so  Installable service exits (not Compaq Tru64 UNIX Version 5.0)

WebSphere MQ for HP-UX
In WebSphere MQ for HP-UX, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system.

In a non-threaded application:

libmqm.sl  Server for C
libmqic.sl  Client for C
libmqmzf.sl  Installable service exits for C
libmqmxa.sl  XA interface for C
libimqi23ah.sl  C++
libmqmcbrt.o  WebSphere MQ run-time library for Micro Focus COBOL support
libmqmcb.sl  Server for COBOL
libmqicb.sl  Client for COBOL

In a threaded application:

libmqm_r.sl  Server for C
libmqmzf_r.sl  Installable service exits for C
libmqmxa_r.sl  XA interface for C
libimqi23ah_r.sl  C++

WebSphere MQ for Linux
In WebSphere MQ for Linux, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system.

In a non-threaded application:

libmqm.so  Server for C
libmqic.so  Client for C
libmqmzf.so  Installable service exits for C
libmqmxa.so  XA interface for C
libimqc23gl.so  Client for C++
libimqs23gl.so  Server for C++

In a threaded application:

libmqm_r.so  Server for C
libmqic_r.so  Client for C
libmqmzf_r.so  Installable service exits for C
libmqmxa_r.so  XA interface for C
libimqc23gl_r.so  Client for C++
libimqs23gl_r.so  Server for C++
MQI contents

**MQSeries for SINIX and DC/OSx**
In MQSeries for SINIX and DC/OSx, you must link your program to the MQI library files supplied for the environment in which you are running your application, in addition to those provided by the operating system.

In a non-threaded application:

- `libmqm.so`: Server for C
- `libmqmzse.so`: For C
- `libmqic.so`: Client for C
- `libmqmcs.so`: Client for C
- `libmqmzf.so`: Installable service exits for C
- `libmqmxa.a`: XA interface for C
- `libmqmcbt.o`: WebSphere MQ COBOL run-time
- `libmqmcb.so`: Server for COBOL
- `libmqicb.so`: Client for COBOL

In a threaded application:

- `libmqm_r.so`: For C
- `libmqmcs_r.so`: For C
- `libmqmcics_r.so`: For CICS
- `libmqmxa_r.a`: For XA interface in C

**WebSphere MQ for Solaris**
In WebSphere MQ for Solaris, you must link your program to the MQI library files supplied for the environment in which you are running your application in addition to those provided by the operating system.

- `libmqm.so`: Server for C
- `libmqmzse.so`: For C
- `libmqic.so`: Client for C
- `libmqmcs.so`: Client for C
- `libmqmzf.so`: Installable service exits for C
- `libmqmxa.a`: XA interface for C
- `libimqc23as.a`: Client for C++
- `libimq23as.a`: Server for C++

**MQSeries for VSE/ESA**
In MQSeries for VSE/ESA you must link your program to the install sublibrary PRD2.MQSERIES (this is its default name). This sublibrary contains all the required object decks.
MQSeries for Compaq NonStop Kernel

In MQSeries for Compaq NonStop Kernel, you must link your program to the MQI library files supplied for the environment in which you are running your application in addition to those provided by the operating system.

mqmlib For static build of non-native C, COBOL, and TAL
mqmlibn For static build of native C, C++, and COBOL
mqsrllib For dynamic build of native C, C++, and COBOL

Parameters common to all the calls

There are two types of parameter common to all the calls: handles and return codes.

Using connection and object handles

For a program to communicate with a queue manager, the program must have a unique identifier by which it knows that queue manager. This identifier is called a connection handle, sometimes referred to as an Hconn. For CICS programs, the connection handle is always zero. For all other platforms or styles of programs, the connection handle is returned by the MQCONN or MQCONNX call when the program connects to the queue manager. Programs pass the connection handle as an input parameter when they use the other calls.

For a program to work with a WebSphere MQ object, the program must have a unique identifier by which it knows that object. This identifier is called an object handle, sometimes referred to as an Hobj. The handle is returned by the MQOPEN call when the program opens the object to work with it. Programs pass the object handle as an input parameter when they use subsequent MQPUT, MQGET, MQINQ, MQSET, or MQCLOSE calls.

Understanding return codes

A completion code and a reason code are returned as output parameters by each call. These are known collectively as return codes.

To show whether or not a call is successful, each call returns a completion code when the call is complete. The completion code is usually either MQCC_OK or MQCC_FAILED, showing success and failure, respectively. Some calls can return an intermediate state, MQCC_WARNING, indicating partial success.

Each call also returns a reason code that shows the reason for the failure, or partial success, of the call. There are many reason codes, covering such circumstances as a queue being full, get operations not being allowed for a queue, and a particular queue not being defined for the queue manager. Programs can use the reason code to decide how to proceed. For example, they could prompt the user of the program to make changes to his input data, then make the call again, or they could return an error message to the user.

When the completion code is MQCC_OK, the reason code is always MQRC_NONE.

The completion and reason codes for each call are listed with the description of that call in WebSphere MQ Application Programming Reference. This also contains further information (including some ideas for corrective action) for each completion and reason code.
Specifying buffers

The queue manager refers to buffers only if they are required. If you do not require a buffer on a call or the buffer is zero in length, you can use a null pointer to a buffer.

Always use datalength when specifying the size of the buffer you require.

When you use a buffer to hold the output from a call (for example, to hold the message data for an MQGET call, or the values of attributes queried by the MQINQ call), the queue manager attempts to return a reason code if the buffer you specify is not valid or is in read-only storage. However, it may not be able to return a reason code in some situations.

Programming language considerations

WebSphere MQ provides support for the following programming languages:
- C
- C++ (not on all platforms; see WebSphere MQ Using C++ for information about coding WebSphere MQ programs in C++)
- Visual Basic (Windows systems only)
- COBOL
- Assembler language (WebSphere MQ for z/OS only)
- RPG (WebSphere MQ for iSeries only)
- PL/I (WebSphere MQ for z/OS, OS/2 Warp, VSE/ESA, and Windows systems only)
- TAL (MQSeries for Compaq NonStop Kernel only)

The call interface, and how you can code the calls in each of these languages, is described in WebSphere MQ Application Programming Reference.

WebSphere MQ provides data definition files to assist you with the writing of your applications. For a full description, see Appendix F, “WebSphere MQ data definition files”, on page 591.

If you can choose which language to code your programs in, you should consider the maximum length of the messages that your programs will process. If your programs will process only messages of a known maximum length, you can code them in any of the supported programming languages. But if you do not know the maximum length of the messages the programs will have to process, the language you choose will depend on whether you are writing a CICS, IMS, or batch application:

**IMS and batch**

Code the programs in C, PL/I, or assembler language to use the facilities these languages offer for obtaining and releasing arbitrary amounts of memory. Alternatively, you could code your programs in COBOL, but use assembler language, PL/I, or C subroutines to get and release storage.

**CICS**

Code the programs in any language supported by CICS. The EXEC CICS interface provides the calls for managing memory, if necessary.
Coding in C

See Appendix A, “Language compilers and assemblers”, on page 521 for the compilers that you can use to process your C programs.

Note the information in the following sections when coding WebSphere MQ programs in C.

Parameters of the MQI calls
Parameters that are input-only and of type MQHCONN, MQHOBJ, or MQLONG are passed by value; for all other parameters, the address of the parameter is passed by value.

Not all parameters that are passed by address need to be specified every time a function is invoked. Where a particular parameter is not required, a null pointer can be specified as the parameter on the function invocation, in place of the address of the parameter data. Parameters for which this is possible are identified in the call descriptions.

No parameter is returned as the value of the function; in C terminology, this means that all functions return void.

The attributes of the function are defined by the MQENTRY macro variable; the value of this macro variable depends on the environment.

Parameters with undefined data type
The MQGET, MQPUT, and MQPUT1 functions each have one parameter that has an undefined data type, namely the Buffer parameter. This parameter is used to send and receive the application's message data.

Parameters of this sort are shown in the C examples as arrays of MQBYTE. It is valid to declare the parameters in this way, but it is usually more convenient to declare them as the particular structure that describes the layout of the data in the message. The function parameter is declared as a pointer-to-void, and so the address of any sort of data can be specified as the parameter on the function invocation.

Data types
All data types are defined by means of the typedef statement. For each data type, the corresponding pointer data type is also defined. The name of the pointer data type is the name of the elementary or structure data type prefixed with the letter “P” to denote a pointer. The attributes of the pointer are defined by the MQPOINTER macro variable; the value of this macro variable depends on the environment. The following illustrates how pointer data types are declared:

```c
#define MQPOINTER /* depends on environment */
...
typedef MQLONG MQPOINTER PMQLONG; /* pointer to MQLONG */
typedef MQMD MQPOINTER PMQMD; /* pointer to MQMD */
```

Manipulating binary strings
Strings of binary data are declared as one of the MQBYTEn data types. Whenever you copy, compare, or set fields of this type, use the C functions memcpy, memcmp, or memset:

```c
#include <string.h>
#include "cmqc.h"

MQMD MyMsgDesc;
```
memcpy(MyMsgDesc.MsgId, /* set "MsgId" field to nulls */ MQMI_NONE, /* ...using named constant */ sizeof(MyMsgDesc.MsgId));

memset(MyMsgDesc.CorrelId, /* set "CorrelId" field to nulls */ 0x00, /* ...using a different method */ sizeof(MQBYTE24));

Do not use the string functions strcpy, strcmp, strncpy, or strncmp because these do not work correctly with data declared as MQBYTE24.

Manipulating character strings
When the queue manager returns character data to the application, the queue manager always pads the character data with blanks to the defined length of the field. The queue manager does not return null-terminated strings, but you can use them in your input. Therefore, when copying, comparing, or concatenating such strings, use the string functions strncpy, strncmp, or strncat.

Do not use the string functions that require the string to be terminated by a null (strcpy, strcmp, and strcat). Also, do not use the function strlen to determine the length of the string; use instead the sizeof function to determine the length of the field.

Initial values for structures
The include file <cmqc.h> defines various macro variables that may be used to provide initial values for the structures when instances of those structures are declared. These macro variables have names of the form MQxxx_DEFAULT, where MQxxx represents the name of the structure. Use them like this:

MQMD MyMsgDesc = {MQMD_DEFAULT};
MQPMO MyPutOpts = {MQPMO_DEFAULT};

For some character fields, the MQI defines particular values that are valid (for example, for the StrucId fields or for the Format field in MQMD). For each of the valid values, two macro variables are provided:

• One macro variable defines the value as a string whose length, excluding the implied null, matches exactly the defined length of the field. For example, (the symbol b represents a blank character):

#define MQMD_STRUC_ID "MD\b\b"
#define MQFMT_STRING "MQSTR\b\b\b"

Use this form with the memcpy and memcmp functions.

• The other macro variable defines the value as an array of char; the name of this macro variable is the name of the string form suffixed with “_ARRAY”. For example:

#define MQMD_STRUC_ID_ARRAY 'M','D','b','b'
#define MQFMT_STRING_ARRAY 'M','Q','S','T','R','b','b','b'

Use this form to initialize the field when an instance of the structure is declared with values different from those provided by the MQMD_DEFAULT macro variable.

Initial values for dynamic structures
When a variable number of instances of a structure are required, the instances are usually created in main storage obtained dynamically using the calloc or malloc functions.

To initialize the fields in such structures, the following technique is recommended:
Programming language considerations

1. Declare an instance of the structure using the appropriate MQxxx_DEFAULT macro variable to initialize the structure. This instance becomes the “model” for other instances:

   MQMD ModelMsgDesc = (MQMD_DEFAULT);
   /* declare model instance */

   The static or auto keywords can be coded on the declaration in order to give the model instance static or dynamic lifetime, as required.

2. Use the calloc or malloc functions to obtain storage for a dynamic instance of the structure:

   PMQMD InstancePtr;
   InstancePtr = malloc(sizeof(MQMD));
   /* get storage for dynamic instance */

3. Use the memcpy function to copy the model instance to the dynamic instance:

   memcpy(InstancePtr, &ModelMsgDesc, sizeof(MQMD));
   /* initialize dynamic instance */

Use from C++

For the C++ programming language, the header files contain the following additional statements that are included only when a C++ compiler is used:

   #ifdef __cplusplus
   extern "C" {
   #endif
   /* rest of header file */

   #ifdef __cplusplus
   }
   #endif

Coding in COBOL

See Appendix A, “Language compilers and assemblers”, on page 521 for the compilers that you can use to process your COBOL programs.

Note the information in the following sections when coding WebSphere MQ programs in COBOL.

Named constants

In this book, the names of constants are shown containing the underscore character (_) as part of the name. In COBOL, you must use the hyphen character (-) in place of the underscore.

Constants that have character-string values use the single quotation mark character (‘) as the string delimiter. To make the compiler accept this character, use the compiler option APOST.

The copy file CMQV contains declarations of the named constants as level-10 items. To use the constants, declare the level-01 item explicitly, then use the COPY statement to copy in the declarations of the constants:

   WORKING-STORAGE SECTION.
   01 MQM-CONSTANTS.
       COPY CMQV.

However, this method causes the constants to occupy storage in the program even if they are not referred to. If the constants are included in many separate programs within the same run unit, multiple copies of the constants will exist—this may...
result in a significant amount of main storage being used. You can avoid this situation by adding the GLOBAL clause to the level-01 declaration:

* Declare a global structure to hold the constants
  01 MQM-CONSTANTS GLOBAL.
  COPY CMQV.

This causes storage to be allocated for only one set of constants within the run unit; the constants, however, can be referred to by any program within the run unit, not just the program that contains the level-01 declaration.

**Coding in System/390® assembler language**

Not supported in WebSphere MQ for z/OS.

See Appendix A, “Language compilers and assemblers”, on page 521 for the assemblers that you can use to process your assembler-language programs.

Note the information in the following sections when coding WebSphere MQ for z/OS programs in assembler language.

**Names**

In this book, the names of parameters in the descriptions of calls, and the names of fields in the descriptions of structures are shown in mixed case. In the assembler-language macros supplied with WebSphere MQ, all names are in uppercase.

**Using the MQI calls**

The MQI is a call interface, so assembler-language programs must observe the OS linkage convention. In particular, before they issue an MQI call, assembler-language programs must point register R13 at a save area of at least 18 full words. This save area is to provide storage for the called program. It stores the registers of the caller before their contents are destroyed, and restores the contents of the caller’s registers on return.

**Note:** This is of particular importance for CICS assembler-language programs that use the DFHEIENT macro to set up their dynamic storage, but that choose to override the default DATAREG from R13 to other registers. When the CICS Resource Manager Interface receives control from the stub, it saves the current contents of the registers at the address to which R13 is pointing. Failing to reserve a proper save area for this purpose gives unpredictable results, and will probably cause an abend in CICS.

**Declaring constants**

Most constants are declared as equates in macro CMQA. However, the following constants cannot be defined as equates, and these are not included when you call the macro using default options:

- MQACT_NONE
- MQCI_NONE
- MQFMT_NONE
- MQFMT_ADMIN
- MQFMT_COMMAND_1
- MQFMT_COMMAND_2
- MQFMT_DEAD_LETTER_HEADER
- MQFMT_EVENT
- MQFMT_IMS
- MQFMT_IMS_VAR_STRING
- MQFMT_PCF
To include them, add the keyword EQUONLY=NO when you call the macro.

CMQA is protected against multiple declaration, so you can include it many times. However, the keyword EQUONLY takes effect only the first time the macro is included.

### Specifying the name of a structure
To allow more than one instance of a structure to be declared, the macro that generates the structure prefixes the name of each field with a user-specifiable string and an underscore character (_). Specify the string when you invoke the macro. If you do not specify a string, the macro uses the name of the structure to construct the prefix:

* Declare two object descriptors

  **CMQODA**  
  Prefix used="MQOD_" (the default)  
  **MY_MQOD**  
  CMQODA  
  Prefix used="MY_MQOD_"

The structure declarations in [WebSphere MQ Application Programming Reference](#) show the default prefix.

### Specifying the form of a structure
The macros can generate structure declarations in one of two forms, controlled by the DSECT parameter:

**DSECT=YES**  
An assembler-language DSECT instruction is used to start a new data section; the structure definition immediately follows the DSECT statement. No storage is allocated, so no initialization is possible. The label on the macro invocation is used as the name of the data section; if no label is specified, the name of the structure is used.

**DSECT=NO**  
Assembler-language DC instructions are used to define the structure at the current position in the routine. The fields are initialized with values, which you can specify by coding the relevant parameters on the macro invocation. Fields for which no values are specified on the macro invocation are initialized with default values.

DSECT=NO is assumed if the DSECT parameter is not specified.

### Controlling the listing
You can control the appearance of the structure declaration in the assembler-language listing by means of the LIST parameter:

**LIST=YES**  
The structure declaration appears in the assembler-language listing.

**LIST=NO**  
The structure declaration does not appear in the assembler-language listing. This is assumed if the LIST parameter is not specified.

### Specifying initial values for fields
You can specify the value to be used to initialize a field in a structure by coding the name of that field (without the prefix) as a parameter on the macro invocation, accompanied by the value required.
Programming language considerations

For example, to declare a message descriptor structure with the `MsgType` field initialized with `MQMT_REQUEST`, and the `ReplyToQ` field initialized with the string `MY_REPLY_TO_QUEUE`, you could use the following code:

```
MY_MQMD CMQMDA MSGTYPE=MQMT_REQUEST, X
REPLYTOQ=MY_REPLY_TO_QUEUE
```

If you specify a named constant (or equate) as a value on the macro invocation, you must use the CMQA macro to define the named constant. You must not enclose in single quotation marks (`'`) values that are character strings.

Writing reentrant programs

WebSphere MQ uses its structures for both input and output. If you want your program to remain reentrant, you should:

1. Define working storage versions of the structures as DSECTs, or define the structures inline within an already-defined DSECT. Then copy the DSECT to storage that is obtained using:
   - For batch and TSO programs, the STORAGE or GETMAIN z/OS assembler macros
   - For CICS, the working storage DSECT (DFHEISTG) or the EXEC CICS GETMAIN command

   To correctly initialize these working storage structures, copy a constant version of the corresponding structure to the working storage version.

   **Note:** The MQMD and MQXQH structures are each more than 256 bytes long. To copy these structures to storage, you will have to use the MVCL assembler instruction.

2. Reserve space in storage by using the LIST form (`MF=L`) of the CALL macro. When you use the CALL macro to make an MQI call, use the EXECUTE form (`MF=E`) of the macro, using the storage reserved earlier, as shown in the example under “Using CEDF.” For more examples of how to do this, see the assembler language sample programs as shipped with WebSphere MQ.

   Use the assembler language RENT option to help you determine if your program is reentrant.

   For information on writing reentrant programs, see *MVS/ESA Application Development Guide: Assembler Language Programs*, GC28-1644.

Using CEDF

If you want to use the CICS-supplied transaction, CEDF (CICS Execution Diagnostic Facility) to help you to debug your program, you must add the ,VL keyword to each CALL statement, for example:

```
CALL MQCONN,(NAME,HCONN,COMPCODE,REASON),MF=(E,PARMAREA),VL
```

The above example is reentrant assembler-language code where PARMAREA is an area in the working storage you specified.

Coding in RPG

Only supported in WebSphere MQ for iSeries.

See Appendix A, “Language compilers and assemblers”, on page 521 for the compilers that you can use to process your RPG programs.
In this book, the parameters of calls, the names of data types, the fields of structures, and the names of constants are described using their long names. In RPG, these names are abbreviated to six or fewer uppercase characters. For example, the field MsgType becomes MDMT in RPG. For more information, see WebSphere MQ for iSeries V5.3 Application Programming Reference (ILE RPG).

Coding in PL/I

PL/I is supported on z/OS, OS/2, VSE/ESA, and Windows systems only.

See Appendix A, “Language compilers and assemblers”, on page 521 for the compilers that you can use to process your PL/I programs.

Note the information in the following sections when coding WebSphere MQ for z/OS programs in PL/I.

Structures

Structures are declared with the BASED attribute, and so do not occupy any storage unless the program declares one or more instances of a structure.

An instance of a structure can be declared by using the like attribute, for example:

dcl my_mqmd like MQMD; /* one instance */
dcl my_other_mqmd like MQMD; /* another one */

The structure fields are declared with the INITIAL attribute; when the like attribute is used to declare an instance of a structure, that instance inherits the initial values defined for that structure. Thus it is necessary to set only those fields where the value required is different from the initial value.

PL/I is not sensitive to case, and so the names of calls, structure fields, and constants can be coded in lowercase, uppercase, or mixed case.

Named constants

The named constants are declared as macro variables; as a result, named constants which are not referenced by the program do not occupy any storage in the compiled procedure. However, the compiler option which causes the source to be processed by the macro preprocessor must be specified when the program is compiled.

All of the macro variables are character variables, even the ones which represent numeric values. Although this may seem counter intuitive, it does not result in any data-type conflict after the macro variables have been substituted by the macro processor, for example:

```
%dcl MQMD_STRUC_ID char;
%MQMD_STRUC_ID = '''MD''';

%dcl MQMD_VERSION_1 char;
%MQMD_VERSION_1 = '1';
```
Programming language considerations

Coding in TAL

TAL is supported on Compaq NonStop Kernel only.

See Appendix A, “Language compilers and assemblers”, on page 521 for the compilers that you can use to process your TAL programs.

Note the following when coding MQSeries for Compaq NonStop Kernel programs in TAL:

- The MQI library (bound into the application process) does not open $RECEIVE and does not open $TMP (TM/MP transaction pseudo-file) itself, so you may code your application to use these features.
- The MQI library uses a SERVERCLASS_SEND_() call in initial communication with the queue manager. While connected, it maintains two process file opens (with the LINKMON process and a local queue manager agent) and a small number of disk file opens (fewer than 10).

Coding in Visual Basic

Visual Basic is only supported on Windows.

To avoid unintended translation of binary data passing between Visual Basic and WebSphere MQ, use an MQBYTE definition instead of MQSTRING. CMQB.BAS defines several new MQBYTE types which are equivalent to a C “byte” definition and uses these within WebSphere MQ structures. For example, for the MQMD (message descriptor) structure, MsgId (message identifier) is defined as MQBYTE24.

Visual Basic does not have a pointer datatype, so references to other WebSphere MQ data structures are by offset rather than pointer. You must declare a compound structure consisting of the two component structures, and specify the compound structure on the call. WebSphere MQ support for Visual Basic provides an MQCONNXAny call to make this possible and allow client applications to specify the channel properties on a client connection. It accepts an untyped structure (MQCNOCD) in place of the usual MQCNO structure.

The MQCNOCD structure is a compound structure consisting of an MQCNO followed by an MQCD. This structure is declared in the exits header file CMQXB. Use the routine MQCNOCD_DEFAULTS to initialize an MQCNOCD structure. A sample making MQCONNX calls is provided (amqscnxb.vbp).

MQCONNXAny has the same parameters as MQCONNX, except that the Connect0pts parameter is declared as being of “Any” datatype rather than of “MQCNO” datatype. This allows the function to accept either the MQCNO or the MQCNOCD structure. This function is declared in the main header file CMQB.

z/OS batch considerations

z/OS batch programs that call the MQI can be in either supervisor or problem state. However, they must meet the following conditions:

- They must be in task mode, not service request block (SRB) mode.
- They must be in Primary address space control (ASC) mode (not Access Register ASC mode).
- They must not be in cross-memory mode. The primary address space number (ASN) must be equal to the secondary ASN and the home ASN.
They must not be used as MPF exit programs.
- No z/OS locks can be held.
- There can be no function recovery routines (FRRs) on the FRR stack.
- Any program status word (PSW) key can be in force for the MQCONN or MQCONNX call (provided the key is compatible with using storage that is in the TCB key), but subsequent calls that use the connection handle returned by MQCONN or MQCONNX:
  - Must have the same PSW key that was used on the MQCONN or MQCONNX call
  - Must have parameters accessible (for write, where appropriate) under the same PSW key
  - Must be issued under the same task (TCB), but not in any subtask of the task
- They can be in either 24-bit or 31-bit addressing mode. However, if 24-bit addressing mode is in force, parameter addresses must be interpreted as valid 31-bit addresses.

If any of these conditions is not met, a program check may occur. In some cases the call will fail and a reason code will be returned.

**UNIX signal handling**

This section does not apply to WebSphere MQ for z/OS or WebSphere MQ for Windows.

In general, UNIX and iSeries systems have moved from a nonthreaded (process) environment to a multithreaded environment. In the nonthreaded environment, some functions could be implemented only by using signals, though most applications did not need to be aware of signals and signal handling. In the multithreaded environment, thread-based primitives support some of the functions that used to be implemented in the nonthreaded environments using signals.

In many instances, signals and signal handling, although supported, do not fit well into the multithreaded environment and various restrictions exist. This can be particularly problematic when you are integrating application code with different middleware libraries (running as part of the application) in a multithreaded environment where each is trying to handle signals. The traditional approach of saving and restoring signal handlers (defined per process), which worked when there was only one thread of execution within a process, does not work in a multithreaded environment. This is because many threads of execution could be trying to save and restore a process-wide resource, with unpredictable results.
UNIX signal handling

Signal handling before MQSeries version 5.2

Signals in the non-threaded environment
Each MQI function sets up its own signal handler for the signals:
   - SIGALRM
   - SIGBUS
   - SIGFPE
   - SIGSEGV

Users’ handlers for these are replaced for the duration of the MQI function call. Other signals can be caught in the normal way by user-written handlers. If you do not install a handler, the default actions (for example, ignore, core dump, or exit) are left in place.

Note: On Solaris all applications are threaded even if they use a single thread.

Signals in the threaded environment
A thread is considered to be connected to MQSeries from MQCONN (or MQCONNX) until MQDISC.

Synchronous signals: Synchronous signals arise in a specific thread. UNIX safely allows the setting up of a signal handler for such signals for the whole process. However, MQSeries sets up its own handler for the following signals, in the application process, while any thread is connected to WebSphere MQ:
   - SIGBUS
   - SIGFPE
   - SIGSEGV

If you are writing multithreaded applications, you should note that there is only one process-wide signal handler for each signal. MQSeries alters this signal handler when the application is connected to MQSeries. If one of these signals occurs while not on a thread connected to MQSeries, MQSeries attempts to call the signal handler that was in effect at the time of the first MQSeries connection within the process. Application threads must not establish signal handlers for these signals while there is any possibility that another thread of the same process is also connected to MQSeries.

Because signal handlers are saved and restored by WebSphere MQ, application threads ideally should not establish signal handlers for these signals while there is any possibility that another thread of the same process is also connected to WebSphere MQ.

Asynchronous signals: Asynchronous signals arise outside the whole process. UNIX does not guarantee predictable behavior for handling asynchronous signals, in certain situations, when running multithreaded. MQSeries must perform clean-up of thread and process resources as part of the termination from these asynchronous signals:
   - SIGCHLD
   - SIGHUP
   - SIGINT
   - SIGQUIT
   - SIGTERM

MQSeries establishes a sigwait thread in the application process to intercept these signals.
These signals must not be used by the application when running multithreaded and when any thread is within an MQSeries connection. These signals should not be unmasked within any application thread; be aware of the default status of the signal mask for threads that do not make MQSeries calls.

**Additional considerations**

**Fastpath (trusted) applications:** Fastpath applications run in the same process as MQSeries and so are running in the multithreaded environment. In this environment the application should not use any signals or timer interrupts. If a Fastpath application intercepts such an event, the queue manager must be stopped and restarted, or it may be left in an undefined state. For a full list of the restrictions for Fastpath applications under MQCONNX see "Connecting to a queue manager using the MQCONNX call" on page 90.

**MQI function calls within signal handlers:** While you are in a signal handler, you cannot call an MQI function. If you call an MQI function, while another MQI function is active, MQRC_CALL_IN_PROGRESS is returned. If you call an MQI function, while no other MQI function is active, it is likely to fail because of the operating system restrictions on which calls can be issued from within a handler.

In the case of C++ destructor methods, which may be called automatically during program exit, you may not be able to stop the MQI functions from being called. Therefore, ignore any errors about MQRC_CALL_IN_PROGRESS. If a signal handler calls exit(), MQSeries backs out uncommitted messages in syncpoint as normal and closes any open queues.

**Signals during MQI calls:** MQI functions do not return the code EINTR or any equivalent to application programs. If a signal occurs during an MQI call, and the handler calls “return”, the call continues to run as if the signal had not happened. In particular, MQGET cannot be interrupted by a signal to return control immediately to the application. If you want to break out of an MQGET, set the queue to GET_DISABLED; alternatively, use a loop around a call to MQGET with a finite time expiry (MQGMO_WAIT with gmo.WaitInterval set), and use your signal handler (in a nonthreaded environment) or equivalent function in a threaded environment to set a flag which breaks the loop.

**User exits and installable services:** User exits and installable services that run as part of an MQSeries process in a multithreaded environment have the same restrictions as for Fastpath applications. They should be considered as permanently connected to MQSeries and so not use signals or non-threadsafe operating system calls.

**MQSeries use of SIGALRM:** For communication purposes, MQSeries needs a signal for its internal use. The SIGALRM signal should not be used by an application while any thread is within an MQSeries connection.
Additional considerations for threaded client applications: MQSeries handles the following signals during I/O to a server. These signals are defined by the communications stack. An application should not establish a signal handler for these signals while a thread of the process is making an MQSeries call:

- SIGPIPE (for TCP/IP)
- SIGUSR1 (for LU 6.2)

Signal handling in version 5.2 and later releases

Unthreaded applications
(Not applicable on Solaris as all applications are considered threaded even if they only use a single thread.)

Each MQI function sets up its own signal handler for the signals:
- SIGALRM
- SIGBUS
- SIGFPE
- SIGSEGV
- SIGILL

Users’ handlers for these are replaced for the duration of the MQI function call. Other signals can be caught in the normal way by user-written handlers. If you do not install a handler, the default actions (for example, ignore, core dump, or exit) are left in place.

Following the handling of a synchronous signal (SIGSEGV, SIGBUS, SIGFPE, SIGILL) by WebSphere MQ, it will attempt to pass the signal on to any signal handler registered before making the MQI function call.

Threaded applications
A thread is considered to be connected to WebSphere MQ from MQCONN (or MQCONNX) until MQDISC.

Synchronous signals: Synchronous signals arise in a specific thread. UNIX safely allows the setting up of a signal handler for such signals for the whole process. However, WebSphere MQ sets up its own handler for the following signals, in the application process, while any thread is connected to WebSphere MQ:
- SIGBUS
- SIGFPE
- SIGSEGV
- SIGILL

If you are writing multithreaded applications, you should note that there is only one process-wide signal handler for each signal. When WebSphere MQ sets up its own synchronous signal handlers it saves any previously registered handlers for each signal. Following the handling by WebSphere MQ of one of the signals listed above, WebSphere MQ attempts to call the signal handler that was in effect at the time of the first WebSphere MQ connection within the process. The previously registered handlers are restored when all application threads have disconnected from WebSphere MQ.

Because signal handlers are saved and restored by WebSphere MQ, application threads ideally should not establish signal handlers for these signals while there is any possibility that another thread of the same process is also connected to WebSphere MQ.
Note: When an application, or a middleware library (running as part of an application), does establish a signal handler while a thread is connected to WebSphere MQ, the application’s signal handler must call the corresponding WebSphere MQ handler during the processing of that signal.

When establishing and restoring signal handlers, the general principle is that the last signal handler to be saved must be the first to be restored:

• When an application establishes a signal handler after connecting to WebSphere MQ, the previous signal handler must be restored before the application disconnects from WebSphere MQ.

• When an application establishes a signal handler before connecting to WebSphere MQ, the application must disconnect from WebSphere MQ before restoring its signal handler.

Note: Failure to observe the general principle that the last signal handler to be saved must be the first to be restored can result in unexpected signal handling in the application and, potentially, the loss of signals by the application.

Asynchronous signals: WebSphere MQ does not make use of any asynchronous signals in threaded applications unless they are client applications.

Additional considerations for threaded client applications: WebSphere MQ handles the following signals during I/O to a server. These signals are defined by the communications stack. The application should not establish a signal handler for these signals while a thread is connected to a queue manager:

- SIGPIPE (for TCP/IP)

Additional considerations

Fastpath (trusted) applications: Fastpath applications run in the same process as WebSphere MQ and so are running in the multithreaded environment. In this environment WebSphere MQ handles the synchronous signals SIGSEGV, SIGBUS, SIGFPE, and SIGILL. All other signals must not be delivered to the Fastpath application whilst it is connected to WebSphere MQ. Instead they must be blocked or handled by the application. If a Fastpath application intercepts such an event the queue manager must be stopped and restarted, or it may be left in an undefined state. For a full list of the restrictions for Fastpath applications under MQCONNX see “Connecting to a queue manager using the MQCONNX call” on page 90.

MQI function calls within signal handlers: While you are in a signal handler, you cannot call an MQI function. If you call an MQI function, while another MQI function is active, MQRC_CALL_IN_PROGRESS is returned. If you call an MQI function, while no other MQI function is active, it is likely to fail because of the operating system restrictions on which calls can be issued from within a handler.

In the case of C++ destructor methods, which may be called automatically during program exit, you may not be able to stop the MQI functions from being called. Therefore, ignore any errors about MQRC_CALL_IN_PROGRESS. If a signal handler calls exit(), WebSphere MQ backs out uncommitted messages in syncpoint as normal and closes any open queues.
Signals during MQI calls: MQI functions do not return the code EINTR or any equivalent to application programs. If a signal occurs during an MQI call, and the handler calls “return”, the call continues to run as if the signal had not happened. In particular, MQGET cannot be interrupted by a signal to return control immediately to the application. If you want to break out of an MQGET, set the queue to GET_DISABLED; alternatively, use a loop around a call to MQGET with a finite time expiry (MQGMO_WAIT with gmo.WaitInterval set), and use your signal handler (in a nonthreaded environment) or equivalent function in a threaded environment to set a flag which breaks the loop.

In the AIX environment, WebSphere MQ requires that system calls interrupted by signals are restarted. When establishing your own signal handler with sigaction(2) you must set the SA_RESTART flag in the sa_flags field of the new action structure otherwise WebSphere MQ may be unable to complete any call interrupted by a signal.

User exits and installable services: User exits and installable services that run as part of an WebSphere MQ process in a multithreaded environment have the same restrictions as for Fastpath applications. They should be considered as permanently connected to WebSphere MQ and so not use signals or non-threadsafe operating system calls.
Chapter 7. Connecting to and disconnecting from a queue manager

To use WebSphere MQ programming services, a program must have a connection to a queue manager. The way this connection is made depends on the platform and the environment in which the program is operating:

**z/OS batch, WebSphere MQ for iSeries, MQSeries for OS/2 Warp, MQSeries for Compaq NonStop Kernel, WebSphere MQ on UNIX systems and WebSphere MQ for Windows**

Programs that run in these environments can use the MQCONN MQI call to connect to, and the MQDISC call to disconnect from, a queue manager. Alternatively, on all but MQSeries for Compaq NonStop Kernel, programs can use the MQCONNX call. This chapter describes how writers of such programs should use these calls.

z/OS batch programs can connect, consecutively or concurrently, to multiple queue managers on the same TCB.

**IMS**

The IMS control region is connected to one or more queue managers when it starts. This connection is controlled by IMS commands. (For information on how to control the IMS adapter of WebSphere MQ for z/OS, see WebSphere MQ for z/OS System Administration Guide.) However, writers of message queuing IMS programs must use the MQCONN MQI call to specify the queue manager to which they want to connect. They can use the MQDISC call to disconnect from that queue manager. This chapter describes how writers of such programs should use these calls. Before the IMS adapter processes a message for another user following a Get Unique call from the IOPCB, or one implied by a checkpoint call, the adapter ensures that the application closes handles and disconnects from the queue manager.

IMS programs can connect, consecutively or concurrently, to multiple queue managers on the same TCB.

**CICS Transaction Server for z/OS and CICS for MVS/ESA**

CICS programs do not need to do any work to connect to a queue manager because the CICS system itself is connected. This connection is usually made automatically at initialization, but you can also use the CKQC transaction, which is supplied with WebSphere MQ for z/OS. CKQC is discussed in WebSphere MQ for z/OS System Administration Guide.

CICS tasks can connect only to the queue manager to which the CICS region, itself, is connected.

**Note:** CICS programs can also use the MQI connect and disconnect calls (MQCONN and MQDISC). You may want to do this so that you can port these applications to non-CICS environments with a minimum of recoding. Be warned, though, that these calls always complete successfully in a CICS environment. This means that the return code may not reflect the true state of the connection to the queue manager.
Connecting and disconnecting

TXSeries for Windows NT and Open Systems
These programs do not need to do any work to connect to a queue manager because the CICS system itself is connected. Therefore, only one connection at a time is supported. CICS applications must issue an MQCONN call to obtain a connection handle, and should issue an MQDISC call before they exit.

MQSeries for VSE/ESA
In your VSE/ESA application, make an explicit call to MQCONN to establish a connection to the VSE/ESA queue manager. Ensure that your application issues an MQDISC call to disconnect. The performance of your application is better if you connect and disconnect as infrequently as possible.

This chapter introduces connecting to and disconnecting from a queue manager, under these headings:
- “Connecting to a queue manager using the MQCONN call”
- “Connecting to a queue manager using the MQCONNX call” on page 90
- “Disconnecting programs from a queue manager using MQDISC” on page 94

Connecting to a queue manager using the MQCONN call

In general, you can connect either to a specific queue manager, or to the default queue manager:
- For WebSphere MQ for z/OS, in the batch environment, the default queue manager is specified in the CSQBDEFV module.
- For WebSphere MQ for iSeries, MQSeries for Compaq OpenVMS Alpha, MQSeries for OS/2 Warp, MQSeries for Compaq NonStop Kernel, and WebSphere MQ on UNIX systems, the default queue manager is specified in the mqs.ini file.
- For MQSeries for Compaq NonStop Kernel, the default queue manager is specified in the MQSINI file, resident in the ZMQSSYS subvolume.
- For WebSphere MQ for Windows, the default queue manager is specified in the registry.
- MQSeries for VSE/ESA allows only one queue manager to run at a time; its name is specified in the Global System Definition of the System Management Facility (SMF). Your application can specify the name or use the default value.

Alternatively, in the z/OS MVS™ batch, TSO, and RRS environments you may connect to any one queue manager within a queue-sharing group. The MQCONN or MQCONNX request will select any one of the active members of the group.

The queue manager you connect to must be local to the task. This means that it must belong to the same system as the WebSphere MQ application.

In the IMS environment, the queue manager must be connected to the IMS control region and to the dependent region that the program uses. The default queue manager is specified in the CSQQQDEFV module when WebSphere MQ for z/OS is installed.

With the CICS on Open Systems environment, and TXSeries for Windows NT and AIX, the queue manager must be defined as an XA resource to CICS.

To connect to the default queue manager, call MQCONN, specifying a name consisting entirely of blanks or starting with a null (X’00’) character.
Within WebSphere MQ on UNIX systems, an application must be authorized for it to successfully connect to a queue manager. For more information, see the WebSphere MQ System Administration Guide for WebSphere MQ for AIX, HP-UX, and Solaris; for other platforms, see the appropriate System Management Guide.

The output from MQCONN is:
- A connection handle (Hconn)
- A completion code
- A reason code

You will need to use the connection handle on subsequent MQI calls.

If the reason code indicates that the application is already connected to that queue manager, the connection handle that is returned is the same as the one that was returned when the application first connected. So the application probably should not issue the MQDISC call in this situation because the calling application will expect to remain connected.

The scope of the connection handle is the same as that of the object handle (see “Opening objects using the MQOPEN call” on page 96).

Descriptions of the parameters are given in the description of the MQCONN call in WebSphere MQ Application Programming Reference.

The MQCONN call fails if the queue manager is in a quiescing state when you issue the call, or if the queue manager is shutting down.

Scope of MQCONN or MQCONNX

Within WebSphere MQ for iSeries, MQSeries for Compaq OpenVMS Alpha, MQSeries for OS/2 Warp, WebSphere MQ on UNIX systems and WebSphere MQ for Windows, the scope of an MQCONN or MQCONNX call is usually the thread that issued it. That is, the connection handle returned from the call is valid only within the thread that issued the call. Only one call may be made at any one time using the handle. If it is used from a different thread, it will be rejected as invalid. If you have multiple threads in your application and each wishes to use WebSphere MQ calls, each one must individually issue MQCONN or MQCONNX.

Alternatively, consider “Shared (thread independent) connections with MQCONNX” on page 92.

Each thread can connect to a different queue manager using MQCONN or MQCONNX on OS/2 and Windows systems, but not on OS/400 or UNIX.

If your application is running as a client, it may connect to more than one queue manager within a thread.

OS/2 has a limit of 4095 active threads in a system. However, the default is 64. This value may be controlled by the THREADS=xxxx parameter in CONFIG.SYS. Limitations on the number of concurrent MQCONN calls that can be made within a system are dependent on this value, although other factors to consider are disk space availability for the swapper.dat file and shared memory availability.

On MQSeries for VSE/ESA, there is a maximum of 1000 concurrently-connected tasks. The connection handle is unique to the ID of the transaction that is executing and only valid for the duration of that transaction.
Using MQCONNX

Connecting to a queue manager using the MQCONNX call

MQCONNX is not supported on VSE/ESA.

The MQCONNX call is similar to the MQCONN call, but includes options to control the way that the call actually works.

As input to MQCONNX, you can supply a queue manager name, or a queue-sharing group name on z/OS shared queue systems. The output from MQCONNX is:
- A connection handle (Hconn)
- A completion code
- A reason code

You use the connection handle on subsequent MQI calls.

A description of all of the parameters of MQCONNX is given in WebSphere MQ Application Programming Reference. The Options field allows you to set MQCNO_STANDARD_BINDING or FASTPATH_BINDING for Version 1 and Version 2 MQCONNX. You can also make shared (thread independent) connections using a MQCONNX call. See “Shared (thread independent) connections with MQCONNX” on page 92 for more information about these.

MQCNO_STANDARD_BINDING

By default, MQCONNX (like MQCONN) implies two logical threads where the WebSphere MQ application and the local queue manager agent run in separate processes. The WebSphere MQ application requests the WebSphere MQ operation and the local queue manager agent services the request. This is defined by the MQCNO_STANDARD_BINDING option on the MQCONNX call.

Note: This default maintains the integrity of the queue manager (that is, it makes the queue manager immune to errant programs), but impairs the performance of the MQI calls.

MQCNO_FASTPATH_BINDING

Trusted applications imply that the WebSphere MQ application and the local queue manager agent become the same process. Since the agent process no longer needs to use an interface to access the queue manager, these applications become an extension of the queue manager. This is defined by the MQCNO_FASTPATH_BINDING option on the MQCONNX call.

You need to link trusted applications to the threaded WebSphere MQ libraries. For instructions on how to set up a WebSphere MQ application to run as trusted, see WebSphere MQ Application Programming Reference.

Note: This option compromises the integrity of the queue manager as there is no protection from overwriting its storage. This also applies if the application contains errors which can be exposed to messages and other data in the queue manager too. These issues must be considered before using this option.
For z/OS these two options are tolerated, but only a standard bound connection is performed. MQCNO Version 3, for z/OS, allows four new options:

**MQCNO_SERIALIZE_CONN_TAG_QSG**

This allows an application to request that only one instance of an application may be running at any one time in a queue-sharing group. This is achieved by registering the use of a connection tag, whose value is specified or derived by the application. The tag is a 128 byte character string specified in the Version 3 MQCNO.

**MQCNO_RESTRICT_CONN_TAG_QSG**

This is used where an application consists of more than one process (or a TCB on z/OS), each of which can connect to a queue manager. Connection is permitted only if there is no current use of the tag, or the requesting application is within the same processing scope. For z/OS this is MVS address space within the same queue-sharing group as the tag owner.

**MQCNO_SERIALIZE_CONN_TAG_Q_MGR**

This is similar to MQCNO_SERIALIZE_CONN_TAG_QSG, but only the local queue manager is interrogated to see if the requested tag is already in use.

**MQCNO_RESTRICT_CONN_TAG_Q_MGR**

This is similar to MQCNO_RESTRICT_CONN_TAG_QSG, but only the local queue manager is interrogated to see if the requested tag is already in use.

**Restrictions for trusted applications**

The following restrictions apply to trusted applications:

- You must explicitly disconnect trusted applications from the queue manager.
- You must stop trusted applications before ending the queue manager with the endmqm command.
- You must not use asynchronous signals and timer interrupts (such as `sigkill`) with MQCNO_FASTPATH_BINDING.
- On WebSphere MQ on UNIX systems you must use `mqm` as the effective user ID and group ID for all MQI calls. You may change these IDs before making a non-MQI call requiring authentication (for example, opening a file), but you *must* change it back to `mqm` before making the next MQI call.
- On WebSphere MQ for iSeries:
  1. trusted applications must be run under the QMQM user profile. It is not sufficient that the user profile be member of the QMQM group or that the program adopt QMQM authority. It may not be possible, or desirable, for the QMQM user profile to be used to sign on to interactive jobs, or be specified in the job description for jobs running trusted applications. In this case one approach is to use the OS/400 profile swapping API functions, QSYGETPH, QWTSETTP and QSYRLSPH to temporarily change the current user of the job to QMQM while the MQ programs run. Details of these functions together with an example of their use is provided in the Security APIs section of *iSeries System API Reference*.
  2. trusted applications must not be canceled through the use of System-Request Option 2, or by the jobs in which they are running being ended using ENDJOB.
On all platforms, a thread within a trusted application cannot connect to a queue manager while another thread in the same process is connected to a different queue manager.

On WebSphere MQ for AIX:
1. trusted applications cannot be compiled using the PL/I programming language.
2. trusted applications must have the environment variable EXTSHM set to ON in their environment before the application starts, otherwise the connection will be downgraded to a standard connection.

Shared (thread independent) connections with MQCONNX

Not supported in WebSphere MQ for z/OS.

On WebSphere MQ platforms other than WebSphere MQ for z/OS, a connection made with MQCONN is only available to the thread that made the connection. Options on the MQCONNX call allow you to create a connection that can be shared by all the threads in a process.

Use one of the following options to make a thread independent or shared connection:

- **MQCNO_HANDLE_SHARE_BLOCK**
  Creates a shared connection on which, if the connection is currently in use by another thread, an MQI call will wait until the current MQI call has completed.

- **MQCNO_HANDLE_SHARE_NO_BLOCK**
  Creates a shared connection on which, if the connection is currently in use by another thread, an MQI call will fail immediately with a reason of MQRC_CALL_IN_PROGRESS.

- **MQCNO_HANDLE_SHARE_NONE**
  Creates a standard non-shared connection.

In the normal MQI environment the default value is MQCNO_HANDLE_SHARE_NONE. In the MTS environment the default value is MQCNO_HANDLE_SHARE_BLOCK.

A connection handle (Hconn) is returned from the MQCONNX call in the usual way. This can be used by subsequent MQI calls from any thread in the process, associating those calls with the Hconn returned from the MQCONNX. MQI calls using a single shared Hconn are serialized across threads.

For example, the following sequence of activity is possible with a shared Hconn:
1. Thread 1 issues MQCONNX and gets a shared Hconn h1
2. Thread 1 opens a queue and issues a get request using h1
3. Thread 2 issues a put request using h1
4. Thread 3 issues a put request using h1
5. Thread 2 issues MQDISC using h1

While the Hconn is in use by any thread, access to the connection is unavailable to other threads. In circumstances where it is acceptable that a thread waits for any previous call from another thread to complete, use MQCONNX with the option MQCNO_HANDLE_SHARE_BLOCK.
However this can cause difficulties. Suppose that in step 2 above, the thread issued a get request that waits for messages that may not have yet arrived (a get with wait). In this case, threads 2 and 3 will also be left waiting (blocked) for as long as the get request takes. If you prefer that your application is notified of calls that are already running on the Hconn, use MQCONNX with the option MQCNO_HANDLE_SHARE_NO_BLOCK.

**Shared connection usage notes**

1. Any object handles (Hobj) created by opening an object are associated with an Hconn; so for a shared Hconn, the Hobjs are also shared and usable by any thread using the Hconn. Similarly, any unit of work started under an Hconn is associated with that Hconn; so this too is shared across threads with the shared Hconn.

2. *Any* thread can call MQDISC to disconnect a shared Hconn, not just the thread that called the corresponding MQCONNX. The MQDISC will terminate the Hconn making it unavailable to all threads.

3. A single thread can use multiple shared Hconns serially, for example MQPUT one message under one shared Hconn then MQPUT another message using another shared Hconn, with each operation being under a different local unit of work.

4. Shared Hconns cannot be used within a global unit of work.

**MQCONNX environment variable**

On WebSphere MQ for iSeries, WebSphere MQ for Windows, and WebSphere MQ on UNIX systems, and on MQSeries for OS/2 Warp and MQSeries for Compaq NonStop Kernel, you can use the environment variable, MQ_CONNECT_TYPE (MQCONNECTTYPE on MQSeries for Compaq NonStop Kernel) in combination with the type of binding specified in the *Options* field. This environment variable allows you to execute the application with the STANDARD_BINDING if any problems occur with the FASTPATH_BINDING. If the environment variable is specified, it should have the value FASTPATH or STANDARD to select the type of binding required. However, the FASTPATH binding is used only if the connect option is appropriately specified as shown in [Table 1](#).

<table>
<thead>
<tr>
<th>MQCONNX call option</th>
<th>MQ_CONNECT_TYPE environment variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARD</td>
<td>UNDEFINED</td>
<td>STANDARD</td>
</tr>
<tr>
<td>FASTPATH</td>
<td>UNDEFINED</td>
<td>FASTPATH</td>
</tr>
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<td>STANDARD</td>
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So, to run a trusted application, either:

1. Specify the MQCNO_FASTPATH_BINDING option on the MQCONNX call and the FASTPATH environment variable,

or

2. Specify the MQCNO_FASTPATH_BINDING option on the MQCONNX call and leave the environment variable undefined.
Using MQCONNX

If neither MQCNO_STANDARD_BINDING nor MQCNO_FASTPATH_BINDING is specified, you can use MQCNO_NONE, which defaults to MQCNO_STANDARD_BINDING.

Disconnecting programs from a queue manager using MQDISC

When a program that has connected to a queue manager using the MQCONN or MQCONNX call has finished all interaction with the queue manager, it should break the connection using the MQDISC call. However, note that

- On CICS Transaction Server for z/OS applications, the call is optional unless MQCONNX was used and you want to drop the connection tag before the application ends.
- On WebSphere MQ for iSeries, when you sign off from the operating system, an implicit MQDISC call is made.
- On MQSeries for VSE/ESA, if your application does not issue the MQDISC call explicitly, the MQSeries for VSE/ESA housekeeping routine issues the MQDISC call on its behalf and unwanted messages appear in the SYSTEM.LOG queue.

As input to the MQDISC call, you must supply the connection handle (Hconn) that was returned by MQCONN or MQCONNX when you connected to the queue manager.

Except on CICS on z/OS, after MQDISC is called the connection handle (Hconn) is no longer valid, and you cannot issue any further MQI calls until you call MQCONN or MQCONNX again. MQDISC does an implicit MQCLOSE for any objects that are still open using this handle.

If MQCONNX was used to connect on WebSphere MQ for z/OS, MQDISC also ends the scope of the connection tag established by the MQCONNX. However, in a CICS, IMS, or RRS application, if there is an active unit of recovery associated with a connection tag, then the MQDISC is rejected with a reason code of MQRC_CONN_TAG_NOT_RELEASED.

Descriptions of the parameters are given in the description of the MQDISC call in WebSphere MQ Application Programming Reference.

When no MQDISC is issued

A standard, non-shared connection (Hconn) is cleaned up when the creating thread terminates. A shared connection will only be implicitly backed out and disconnected when the whole process terminates. If the thread that created the shared Hconn terminates whilst the Hconn still exists the Hconn is still usable.

Authority checking

The MQCLOSE and MQDISC calls usually perform no authority checking. In the normal course of events a job which has the authority to open or connect to a WebSphere MQ object will close or disconnect from that object. Even if the authority of a job that has connected to, or opened a WebSphere MQ object is revoked, the MQCLOSE and MQDISC calls are accepted.
Chapter 8. Opening and closing objects

To perform any of the following operations, you must first open the relevant WebSphere MQ object:

- Put messages on a queue
- Get (browse or retrieve) messages from a queue
- Set the attributes of an object
- Inquire about the attributes of any object

Use the MQOPEN call to open the object, using the options of the call to specify what you want to do with the object. The only exception is if you want to put a single message on a queue, then close the queue immediately. In this case, you can bypass the “opening” stage by using the MQPUT1 call (see “Putting one message on a queue using the MQPUT1 call” on page 111).

Before you open an object using the MQOPEN call, you must connect your program to a queue manager. This is explained in detail, for all environments, in Chapter 7, “Connecting to and disconnecting from a queue manager”, on page 87.

There are four types of WebSphere MQ object that can be opened:

- Queue
- Namelist
- Process definition
- Queue manager

You open all of these objects in a similar way using the MQOPEN call. For more information about WebSphere MQ objects, see Chapter 4, “WebSphere MQ objects”, on page 35.

You can open the same object more than once, and each time you get a new object handle. You might want to browse messages on a queue using one handle, and remove messages from the same queue using another handle. This saves using up resources to close and reopen the same object. You can also open a queue for browsing and removing messages at the same time.

Moreover, you can open multiple objects with a single MQOPEN and close them using MQCLOSE. See “Distribution lists” on page 113 for information about how to do this.

When you attempt to open an object, the queue manager checks that you are authorized to open that object for the options you specify in the MQOPEN call.

Objects are closed automatically when a program disconnects from the queue manager. In the IMS environment, disconnection is forced when a program starts processing for a new user following a GU (get unique) IMS call. On the iSeries platform, objects are closed automatically when a job ends.

It is good programming practice to close objects you have opened. Use the MQCLOSE call to do this.

This chapter introduces opening and closing WebSphere MQ objects, under these headings:

- “Opening objects using the MQOPEN call” on page 96
Opening and closing

- “Creating dynamic queues” on page 102
- “Opening remote queues” on page 103
- “Closing objects using the MQCLOSE call” on page 103

Opening objects using the MQOPEN call

As input to the MQOPEN call, you must supply:

- A connection handle. For CICS applications on z/OS, you can specify the constant MQHC_DEF_HCONN (which has the value zero), or use the connection handle returned by the MQCONN or MQCONNX call. For other programs, always use the connection handle returned by the MQCONN or MQCONNX call.
- A description of the object you want to open, using the object descriptor structure (MQOD).
- One or more options that control the action of the call.

The output from MQOPEN is:

- An object handle that represents your access to the object. Use this on input to any subsequent MQI calls.
- A modified object-descriptor structure, if you are creating a dynamic queue (and it is supported on your platform).
- A completion code.
- A reason code.

Scope of an object handle

The scope of an object handle (Hobj) is the same as the scope of a connection handle (Hconn). This is covered in “Scope of MQCONN or MQCONNX” on page 89 and “Shared (thread independent) connections with MQCONNX” on page 92, however there are additional considerations in some environments:

- CICS In a CICS program, you can use the handle only within the same CICS task from which you made the MQOPEN call.
- IMS and z/OS batch In the IMS and batch environments, you can use the handle within the same task, but not within any subtasks.
- MQSeries for VSE/ESA In the VSE/ESA environment, you can use the handle only within the same application transaction from which you made the MQOPEN call.

Descriptions of the parameters of the MQOPEN call are given in WebSphere MQ Application Programming Reference.

The following sections describe the information you must supply as input to MQOPEN.

Identifying objects (the MQOD structure)

Use the MQOD structure to identify the object you want to open. This structure is an input parameter for the MQOPEN call. (The structure is modified by the queue manager when you use the MQOPEN call to create a dynamic queue.)

For full details of the MQOD structure see WebSphere MQ Application Programming Reference.
For information about using the MQOD structure for distribution lists, see [Using the MQOD structure under “Distribution lists” on page 113](#).

# Name resolution

**Note:** A Queue manager alias is a remote queue definition without an `RNAME` field.

When you open a WebSphere MQ queue, the MQOPEN call performs a name resolution function on the queue name you specify. This determines on which queue the queue manager performs subsequent operations. This means that when you specify the name of an alias queue or a remote queue in your object descriptor (MQOD), the call resolves the name either to a local queue or to a transmission queue. If a queue is opened for any type of input, browse, or set, it resolves to a local queue if there is one, and fails otherwise. It resolves to a nonlocal queue only if it is opened for output only, inquire only, or output and inquire only. See [Table 2](#) for an overview of the name resolution process. Note that the name you supply in `ObjectQMgrName` is resolved before that in `ObjectName`.

[Table 2](#) also shows how you can use a local definition of a remote queue to define an alias for the name of a queue manager. This allows you to select which transmission queue is used when you put messages on a remote queue, so you could, for example, use a single transmission queue for messages destined for many remote queue managers.

To use the following table, first read down the two left-hand columns, under the heading “Input to MQOD”, and select the appropriate case. Then read across the corresponding row, following any instructions. Following the instructions in the “Resolved names” columns, you can either return to the “Input to MQOD” columns and insert values as directed, or you can exit the table with the results supplied. For example, you may be required to input `ObjectName`.

### Table 2. Resolving queue names when using MQOPEN

<table>
<thead>
<tr>
<th>Input to MQOD</th>
<th>Resolved names</th>
<th>Transmission queue</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ObjectQMgrName</code></td>
<td><code>ObjectName</code></td>
<td><code>ObjectQMgrName</code></td>
</tr>
<tr>
<td>Blank or local queue manager</td>
<td>Local queue with no CLUSTER attribute</td>
<td>Local queue manager</td>
</tr>
<tr>
<td>Blank queue manager</td>
<td>Local queue with CLUSTER attribute</td>
<td>Workload management selected cluster queue manager or specific cluster queue manager selected on PUT</td>
</tr>
<tr>
<td>Local queue manager</td>
<td>Local queue with CLUSTER attribute</td>
<td>Local queue manager</td>
</tr>
<tr>
<td>Blank or local queue manager</td>
<td>Model queue</td>
<td>Local queue manager</td>
</tr>
</tbody>
</table>
Table 2. Resolving queue names when using MQOPEN (continued)

<table>
<thead>
<tr>
<th>Input to MQOD</th>
<th>Resolved names</th>
<th>Transmission queue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ObjectQMgrName</strong></td>
<td><strong>ObjectName</strong></td>
<td><strong>ObjectQMgrName</strong></td>
</tr>
<tr>
<td>Blank or local queue manager</td>
<td>Alias queue with or without CLUSTER attribute</td>
<td>Perform name resolution again with ObjectQMgrName unchanged, and input ObjectName set to the BaseQName in the alias queue definition object. Must not resolve to an alias queue</td>
</tr>
<tr>
<td>Blank or local queue manager</td>
<td>Local definition of a remote queue with or without CLUSTER attribute</td>
<td>Perform name resolution again with RemoteQMgrName set to RemoteQMgrName, and ObjectName set to RemoteQName. Must not resolve remote queues</td>
</tr>
<tr>
<td>Blank queue manager</td>
<td>No matching local object; cluster queue found</td>
<td>Workload management selected cluster queue manager or specific cluster queue manager selected on PUT</td>
</tr>
<tr>
<td>Blank or local queue manager</td>
<td>No matching local object; cluster queue not found</td>
<td>Error, queue not found</td>
</tr>
<tr>
<td>Name of a local transmission queue</td>
<td>(Not resolved)</td>
<td>Input ObjectQMgrName</td>
</tr>
<tr>
<td>Queue manager alias definition</td>
<td>(Not resolved, remote queue)</td>
<td>Perform name resolution again with ObjectQMgrName set to RemoteQMgrName. Must not resolve to remote queues</td>
</tr>
<tr>
<td>Queue manager is not the name of any local object; cluster queue managers or queue manager alias found</td>
<td>(Not resolved)</td>
<td>ObjectQMgrName or specific cluster queue manager selected on PUT</td>
</tr>
<tr>
<td><strong>Transmission queue</strong></td>
<td></td>
<td>SYSTEM.QSG. TRANSMIT.QUEUE (see note)</td>
</tr>
</tbody>
</table>

- NAME OF XMITQNAME attribute, IF NON-BLANK; OTHERWISE RemoteQMgrName IN THE REMOTE QUEUE DEFINITION OBJECT.
- SYSTEM.QSG. TRANSMIT.QUEUE (SEE NOTE)
### Table 2. Resolving queue names when using MQOPEN (continued)

<table>
<thead>
<tr>
<th>Input to MQOD</th>
<th>Resolved names</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ObjectQMgrName</strong></td>
<td><strong>ObjectName</strong></td>
</tr>
<tr>
<td>Queue manager is not the name of any local object; no cluster objects found</td>
<td>(Not resolved)</td>
</tr>
</tbody>
</table>

**Note:** The SYSTEM.QSG.TRANSMIT.QUEUE is used if local and remote queue managers are in the same queue-sharing group, intra-group queuing is enabled, and small messages are being put.

---

**Notes:**

1. **BaseQName** is the name of the base queue from the definition of the alias queue.
2. **RemoteQName** is the name of the remote queue from the local definition of the remote queue.
3. **RemoteQMgrName** is the name of the remote queue manager from the local definition of the remote queue.
4. **XmitQName** is the name of the transmission queue from the local definition of the remote queue.
5. When using WebSphere MQ for z/OS queue managers that are part of a queue-sharing group (QSG), the name of the QSG can be used instead of the local queue manager name in Table 2 on page 97.

Opening an alias queue also opens the base queue to which the alias resolves, and opening a remote queue also opens the transmission queue. Therefore you cannot delete either the queue you specify or the queue to which it resolves while the other one is open.

The resolved queue name and the resolved queue manager name are stored in the **ResolvedQName** and **ResolvedQMgrName** fields in the MQOD.

For more information about name resolution in a distributed queuing environment see [WebSphere MQ Intercommunication](#).
Using the options of the MQOPEN call

In the Options parameter of the MQOPEN call, you must choose one or more options to control the access you are given to the object you are opening. With these options you can:

- Open a queue and specify that all messages put to that queue must be directed to the same instance of it
- Open a queue to allow you to put messages on it
- Open a queue to allow you to browse messages on it
- Open a queue to allow you to remove messages from it
- Open an object to allow you to inquire about and set its attributes (but you can set the attributes of queues only)
- Associate context information with a message
- Nominate an alternate user identifier to be used for security checks
- Control the call if the queue manager is in a quiescing state

MQOPEN option for cluster queue

To specify that all messages MQPUT to a queue are to be routed to the same queue manager by the same route use the MQOO_BIND_ON_OPEN option on the MQOPEN call. To specify that a destination is to be selected at MQPUT time, that is, on a message-by-message basis, use the MQOO_BIND_NOT_FIXED option on the MQOPEN call. If you specify neither of these options the default, MQOO_BIND_AS_Q_DEF, is used. In this case the binding used for the queue handle is taken from the DefBind queue attribute, which can take the value MQBND_BIND_ON_OPEN or MQBND_BIND_NOT_FIXED. If the queue you open is not a cluster queue the MQOO_BIND_* options are ignored. If you specify the name of the local queue manager in the MQOD the local instance of the cluster queue is selected. If the queue manager name is blank, any instance can be selected. See WebSphere MQ Queue Manager Clusters for more information.

MQOPEN option for putting messages

To open a queue in order to put messages on it, use the MQOO_OUTPUT option.

MQOPEN option for browsing messages

To open a queue so that you can browse the messages on it, use the MQOPEN call with the MQOO_BROWSE option. This creates a browse cursor that the queue manager uses to identify the next message on the queue. For more information, see “Browsing messages on a queue” on page 147.

Notes:

1. You cannot browse messages on a remote queue. Therefore you cannot open a remote queue using the MQOO_BROWSE option.
2. You cannot specify this option when opening a distribution list. For further information about distribution lists, see “Distribution lists” on page 113.

MQOPEN options for removing messages

There are three options that control the opening of a queue in order to remove messages from it. You can use only one of them in any MQOPEN call. These options define whether your program has exclusive or shared access to the queue. Exclusive access means that, until you close the queue, only you can remove messages from it. If another program attempts to open the queue to remove messages, its MQOPEN call fails. Shared access means that more than one program can remove messages from the queue.
The most advisable approach is to accept the type of access that was intended for the queue when the queue was defined. The queue definition involved the setting of the Shareability and the DefInputOpenOption attributes. To accept this access, use the MQOO_INPUT_AS_Q_DEF option. Refer to Table 3 to see how the setting of these attributes affects the type of access you will be given when you use this option.

Table 3. How queue attributes and options of the MQOPEN call affect access to queues

<table>
<thead>
<tr>
<th>Queue attributes</th>
<th>DefInputOpenOption</th>
<th>AS_Q_DEF</th>
<th>SHARED</th>
<th>EXCLUSIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHAREABLE</td>
<td>SHARED</td>
<td>shared</td>
<td>shared</td>
<td>exclusive</td>
</tr>
<tr>
<td>SHAREABLE</td>
<td>EXCLUSIVE</td>
<td>exclusive</td>
<td>shared</td>
<td>exclusive</td>
</tr>
<tr>
<td>NOT_SHAREABLE*</td>
<td>SHARED*</td>
<td>exclusive</td>
<td>exclusive</td>
<td>exclusive</td>
</tr>
<tr>
<td>NOT_SHAREABLE</td>
<td>EXCLUSIVE</td>
<td>exclusive</td>
<td>exclusive</td>
<td>exclusive</td>
</tr>
</tbody>
</table>

Note: * Although you can define a queue to have this combination of attributes, the default input open option is overridden by the shareability attribute.

Alternatively:

- If you know that your application can work successfully even if other programs can remove messages from the queue at the same time, use the MQOO_INPUT_SHARED option. Table 3 shows how, in some cases you will be given exclusive access to the queue, even with this option.
- If you know that your application can work successfully only if other programs are prevented from removing messages from the queue at the same time, use the MQOO_INPUT_EXCLUSIVE option.

Notes:

1. You cannot remove messages from a remote queue. Therefore you cannot open a remote queue using any of the MQOO_INPUT_* options.
2. You cannot specify this option when opening a distribution list. For further information, see “Distribution lists” on page 113.

MQOPEN options for setting and inquiring about attributes

To open a queue so that you can set its attributes, use the MQOO_SET option. You cannot set the attributes of any other type of object (see Chapter 12, “Inquiring about and setting object attributes”, on page 171).

To open an object so that you can inquire about its attributes, use the MQOO_INQUIRE option.

Note: You cannot specify this option when opening a distribution list.

MQOPEN options relating to message context

If you want to be able to associate context information with a message when you put it on a queue, you must use one of the message context options when you open the queue.

The options allow you to differentiate between context information that relates to the user who originated the message, and that which relates to the application that originated the message. Also, you can opt to set the context information when you put the message on the queue, or you can opt to have the context taken automatically from another queue handle.
MQOPEN option for alternate user authority
When you attempt to open an object using the MQOPEN call, the queue manager checks that you have the authority to open that object. If you are not authorized, the call fails.

However, server programs may want the queue manager to check the authorization of the user on whose behalf they are working, rather than the server’s own authorization. To do this, they must use the MQOO_ALTERNATE_USER_AUTHORITY option of the MQOPEN call, and specify the alternate user ID in the AlternateUserId field of the MQOD structure. Typically, the server would get the user ID from the context information in the message it is processing.

MQOPEN option for queue manager quiescing
In the CICS environment on z/OS, if you use the MQOPEN call when the queue manager is in a quiescing state, the call always fails. In other z/OS environments, OS/400, OS/2, Windows systems and in UNIX systems environments, the call fails when the queue manager is quiescing only if you use the MQOO_FAIL_IF_QUIESCING option of the MQOPEN call.

Creating dynamic queues
You should use a dynamic queue for those cases where you do not need the queue after your application ends. For example, you may want to use a dynamic queue for your “reply-to” queue. You specify the name of the reply-to queue in the ReplyToQ field of the MQMD structure when you put a message on a queue (see “Defining messages using the MQMD structure” on page 106).

To create a dynamic queue, you use a template known as a model queue, together with the MQOPEN call. You create a model queue using the WebSphere MQ commands or the operations and control panels. The dynamic queue you create takes the attributes of the model queue.

When you call MQOPEN, specify the name of the model queue in the ObjectName field of the MQOD structure. When the call completes, the ObjectName field is set to the name of the dynamic queue that is created. Also, the ObjectQMgrName field is set to the name of the local queue manager.

There are three ways to specify the name of the dynamic queue you create:
• Give the full name you want in the DynamicQName field of the MQOD structure.
• Specify a prefix (fewer than 33 characters) for the name, and allow the queue manager to generate the rest of the name. This means that the queue manager generates a unique name, but you still have some control (for example, you may want each user to use a certain prefix, or you may want to give a special security classification to queues with a certain prefix in their name). To use this method, specify an asterisk (*) for the last non-blank character of the DynamicQName field. Do not specify a single asterisk (*) for the dynamic queue name.
• Allow the queue manager to generate the full name. To use this method, specify an asterisk (*) in the first character position of the DynamicQName field.

For more information about these methods, see the description of the DynamicQName field in WebSphere MQ Application Programming Reference.
Opening remote queues

A remote queue is a queue owned by a queue manager other than the one to which the application is connected.

To open a remote queue, use the MQOPEN call as for a local queue. There are different ways you can specify the name of the queue:

1. In the ObjectName field of the MQOD structure, specify the name of the remote queue as known to the local queue manager.

   Note: The ObjectQMgrName field must be left blank in this case.

2. In the ObjectName field of the MQOD structure, specify the name of the remote queue, as known to the remote queue manager. In the ObjectQMgrName field, specify either:
   - The name of the transmission queue that has the same name as the remote queue manager. Note that the name and case (capitals, lower case or a mixture) must match exactly.
   - The name of a queue manager alias object that resolves to the destination queue manager or the transmission queue.

   This tells the queue manager the destination of the message as well as the transmission queue it needs to be put on to get there.

3. If DefXmitQname is supported, in the ObjectName field of the MQOD structure, specify the name of the remote queue as known by the remote queue manager.

   Note: The ObjectQMgrName field must be set to the name of the remote queue manager (it cannot be left blank in this case).

Only local names are validated when you call MQOPEN; the last check is for the existence of the transmission queue to be used.

These methods are summarized in Table 2 on page 97.

Closing objects using the MQCLOSE call

To close an object, you use the MQCLOSE call. If the object is a queue, you should note the following:

- There is no need to empty a temporary dynamic queue before you close it. When you close a temporary dynamic queue, the queue is deleted, along with any messages that may still be on it. This is true even if there are uncommitted MQGET, MQPUT, or MQPUT1 calls outstanding against the queue.
- In WebSphere MQ for z/OS, if you have any MQGET requests with an MQGMO_SET_SIGNAL option outstanding for that queue, they are canceled.
- If you opened the queue using the MQOO_BROWSE option, your browse cursor is destroyed.

Namelists can be closed only on AIX, HP-UX, OS/2, Linux, z/OS, OS/400, Solaris, Compaq Tru64 UNIX, and Windows systems.

In MQSeries for VSE/ESA, ensure that your application issues a matching MQCLOSE call for each MQOPEN call. If your application does not issue the
MQCLOSE call, the MQSeries for VSE/ESA housekeeping routine issues the MQCLOSE call on its behalf and unwanted messages appear in the SYSTEM.LOG queue.

Closure is unrelated to syncpoint, so you can close queues before or after syncpoint.

As input to the MQCLOSE call, you must supply:

- A connection handle. Use the same connection handle used to open it, or alternatively, for CICS applications on z/OS, you can specify the constant MQHC_DEF_HCONN (which has the value zero).
- The handle of the object you want to close. Get this from the output of the MQOPEN call.
- MQCO_NONE in the Options field (unless you are closing a permanent dynamic queue).
- The control option to determine whether the queue manager should delete the queue even if there are still messages on it (when closing a permanent dynamic queue).

The output from MQCLOSE is:

- A completion code
- A reason code
- The object handle, reset to the value MQHO_UNUSABLE_HOBJ

Descriptions of the parameters of the MQCLOSE call are given in WebSphere MQ Application Programming Reference.
Chapter 9. Putting messages on a queue

Use the MQPUT call to put messages on the queue. You can use MQPUT repeatedly to put many messages on the same queue, following the initial MQOPEN call. Call MQCLOSE when you have finished putting all your messages on the queue.

If you want to put a single message on a queue and close the queue immediately afterwards, you can use the MQPUT1 call. MQPUT1 performs the same functions as the following sequence of calls:

- MQOPEN
- MQPUT
- MQCLOSE

Generally however, if you have more than one message to put on the queue, it is more efficient to use the MQPUT call. This depends on the size of the message and the platform you are working on.

This chapter introduces putting messages to a queue, under these headings:

- “Putting messages on a local queue using the MQPUT call” on page 109
- “Putting messages on a remote queue” on page 110
- “Controlling context information” on page 110
- “Putting one message on a queue using the MQPUT1 call” on page 111
- “Distribution lists” on page 113
- “Some cases where the put calls fail” on page 118

Putting messages on a local queue using the MQPUT call

As input to the MQPUT call, you must supply:

- A connection handle (Hconn).
- A queue handle (Hobj).
- A description of the message you want to put on the queue. This is in the form of a message descriptor structure (MQMD).
- Control information, in the form of a put-message options structure (MQPMO).
- The length of the data contained within the message (MQLONG).
- The message data itself.

The output from the MQPUT call is

- A reason code (MQLONG)
- A completion code (MQLONG)

If the call completes successfully, it also returns your options structure and your message descriptor structure. The call modifies your options structure to show the name of the queue and the queue manager to which the message was sent. If you request that the queue manager generates a unique value for the identifier of the message you are putting (by specifying binary zero in the MsgId field of the MQMD structure), the call inserts the value in the MsgId field before returning this structure to you. This value must be reset before you issue another MQPUT.

There is a description of the MQPUT call in WebSphere MQ Application Programming Reference.
MQPUT to local queue

The following sections describe the information you must supply as input to the MQPUT call.

Specifying handles

For the connection handle (Hconn) in CICS on z/OS applications, you can specify the constant MQHC_DEF_HCONN (which has the value zero), or you can use the connection handle returned by the MQCONN or MQCONNX call. For other applications, always use the connection handle returned by the MQCONN or MQCONNX call.

Whatever environment you are working in, use the same queue handle (Hobj) that is returned by the MQOPEN call.

Defining messages using the MQMD structure

The message descriptor structure (MQMD) is an input/output parameter for the MQPUT and MQPUT1 calls. You use it to define the message you are putting on a queue.

If MQPRI_PRIORITY_AS_Q_DEF or MQPER_PERSISTENCE_AS_Q_DEF is specified for the message and the queue is a cluster queue the values used will be those of the queue the MQPUT resolves to. If that queue is disabled for MQPUT the call will fail. See WebSphere MQ Queue Manager Clusters for more information.

Note: You should use MQPMO_NEW_MSG_ID and MQPMO_NEW_CORREL_ID before putting a new message to ensure the MsgId and CorrelId are unique. The values in these fields are returned on a successful MQPUT.

There is an introduction to the message properties that MQMD describes in Chapter 3, “WebSphere MQ messages”, on page 19, and there is a description of the structure itself in WebSphere MQ Application Programming Reference.

Specifying options using the MQPMO structure

You use the MQPMO (Put Message Option) structure to pass options to the MQPUT and MQPUT1 calls.

The following sections give you help on filling in the fields of this structure. There is a description of the structure itself in WebSphere MQ Application Programming Reference.

The fields of the structure include:

- **StrucId**
- **Version**
- **Options**
- **Context**
- **ResolvedQName**
- **ResolvedQMgrName**

These fields are described below.

**StrucId**
This identifies the structure as a put-message options structure. This is a 4-character field. Always specify MQPMO_STRUC_ID.

**Version**
This describes the version number of the structure. The default is MQPMO_VERSION_1. If you enter MQPMO_VERSION_2, you can use
distribution lists (see “Distribution lists” on page 113). If you enter MQPMO_CURRENT_VERSION, your application is set always to use the most recent level.

Options

This controls the following:

- Whether the put operation is included in a unit of work
- How much context information is associated with a message
- Where the context information is taken from
- Whether the call fails if the queue manager is in a quiescing state
- Whether grouping and, or segmentation is allowed
- Generation of a new message identifier and correlation identifier
- The order in which messages and segments are put on a queue

If you leave the Options field set to the default value (MQPMO_NONE), the message you put has default context information associated with it.

Also, the way that the call operates with syncpoints is determined by the platform. The syncpoint control default is ‘yes’ in z/OS; for other platforms, it is ‘no’.

Context

This states the name of the queue handle that you want context information to be copied from (if requested in the Options field).

For an introduction to message context, see “Message context” on page 32.
For information about using the MQPMO structure to control the context information in a message, see “Controlling context information” on page 110.

ResolvedQName

This contains the name (after resolution of any alias name) of the queue that was opened to receive the message. This is an output field.

ResolvedQMgrName

This contains the name (after resolution of any alias name) of the queue manager that owns the queue in ResolvedQName. This is an output field.

The MQPMO can also accommodate fields required for distribution lists (see “Distribution lists” on page 113). If you wish to use this facility, Version 2 of the MQPMO structure is used. This includes the following fields:

Version

This field describes the version number of the structure. For distribution lists, you are required to specify MQPMO_VERSION_2.

RecsPresent

This field contains the number queues in the distribution list. That is the number of Put Message Records (MQPMR) and corresponding Response Records (MQRR) present.

The value you enter can be the same as the number of Object Records provided at MQOPEN. However, if the value is less than the number of Object Records provided on the MQOPEN call (or if no Put Message Records are provided), the values of the queues that are not defined are taken from the default values provided by the message descriptor. Also, if the value is greater than the number of Object Records provided, the excess Put Message Records are ignored.

You are recommended to do one of the following:
MQPUT to local queue

- If you want to receive a report or reply from each destination, enter the same value as appears in the MQOR structure and use MQPMRs containing \textit{MsgId} fields. Either initialize these \textit{MsgId} fields to zeros or specify MQPMO\_NEW\_MSG\_ID.

When you have put the message to the queue, \textit{MsgId} values that the queue manager has created become available in the MQPMRs; you can use these to identify which destination is associated with each report or reply.

- If you do not want to receive reports or replies, choose one of the following:
  1. If you want to identify destinations that fail immediately, you may still want to enter the same value in the \textit{RecsPresent} field as appears in the MQOR structure and provide MQRRs to identify these destinations. Do not specify any MQPMRs.
  2. If you do not want to identify failed destinations, enter zero in the \textit{RecsPresent} field and do not provide MQPMRs nor MQRRs.

\textbf{Note:} If you are using MQPUT1, the number of Response Record Pointers and Response Record Offsets must be zero.

For a full description of Put Message Records (MQPMR) and Response Records (MQRR), see \cite{WebSphereMQApplicationProgrammingReference}.

\textbf{PutMsgRecFields}

This indicates which fields are present in each Put Message Record (MQPMR). For a list of these fields, see \cite{Using the MQPMR structure on page 117}.

\textbf{PutMsgRecOffset and PutMsgRecPtr}

Pointers (typically in C) and offsets (typically in COBOL) are used to address the Put Message Records (see \cite{Using the MQPMR structure on page 117} for an overview of the MQPMR structure).

Use the \texttt{PutMsgRecPtr} field to specify a pointer to the first Put Message Record, or the \texttt{PutMsgRecOffset} field to specify the offset of the first Put Message Record. This is the offset from the start of the MQPMO. Depending on the \texttt{PutMsgRecFields} field, enter a nonnull value for either \texttt{PutMsgRecOffset} or \texttt{PutMsgRecPtr}.

\textbf{ResponseRecOffset and ResponseRecPtr}

You also use pointers and offsets to address the Response Records (see \cite{Using the MQRR structure on page 116} for further information about Response Records).

Use the \texttt{ResponseRecPtr} field to specify a pointer to the first Response Record, or the \texttt{ResponseRecOffset} field to specify the offset of the first Response Record. This is the offset from the start of the MQPMO structure. Enter a nonnull value for either \texttt{ResponseRecOffset} or \texttt{ResponseRecPtr}.

\textbf{Note:} If you are using MQPUT1 to put messages to a distribution list, \texttt{ResponseRecPtr} must be null or zero and \texttt{ResponseRecOffset} must be zero.

Additional information for putting to a distribution list (see \cite{Distribution lists on page 113}) is provided in Version 2 of the Put Message Option structure (MQPMR). This is described in \cite{WebSphereMQApplicationProgrammingReference}.

108 WebSphere MQ Application Programming Guide
The data in your message

Give the address of the buffer that contains your data in the Buffer parameter of the MQPUT call. You can include anything in the data in your messages. The amount of data in the messages, however, affects the performance of the application that is processing them.

The maximum size of the data is determined by:

- The MaxMsgLength attribute of the queue manager
- The MaxMsgLength attribute of the queue on which you are putting the message
- The size of any message header added by WebSphere MQ (including the Dead-letter header, MQDLH and the Distribution list header, MQDH)

The MaxMsgLength attribute of the queue manager holds the size of message that the queue manager can process. This has a default of 4 MB (1 MB=1048576 bytes), or 100 MB for all MQSeries or WebSphere MQ Version 5 products.

To determine the value of this attribute, use the MQINQ call on the queue manager object. For large messages, you can change this value.

The MaxMsgLength attribute of a queue determines the maximum size of message you can put on the queue. If you attempt to put a message with a size larger than the value of this attribute, your MQPUT call fails. If you are putting a message on a remote queue, the maximum size of message that you can successfully put is determined by the MaxMsgLength attribute of the remote queue, of any intermediate transmission queues that the message is put on along the route to its destination, and of the channels used.

For an MQPUT operation, the size of the message must be smaller than or equal to the MaxMsgLength attribute of both the queue and the queue manager. The values of these attributes are independent, but you are recommended to set the MaxMsgLength of the queue to a value less than or equal to that of the queue manager.

WebSphere MQ adds header information to messages in the following circumstances:

- When you put a message on a remote queue, WebSphere MQ adds a transmission header, MQXQH, structure to the message. This structure includes the name of the destination queue and its owning queue manager.
- If WebSphere MQ cannot deliver a message to a remote queue, it attempts to put the message on the dead-letter (undelivered-message) queue. It adds an MQDLH structure to the message. This structure includes the name of the destination queue and the reason the message was put on the dead-letter (undelivered-message) queue.
- If you want to send a message to multiple destination queues, WebSphere MQ adds an MQDH header to the message. This describes the data that is present in a message, belonging to a distribution list, on a transmission queue. This point should be considered when choosing an optimum value for the maximum message length.
- If the message is a segment or a message in a group, then WebSphere MQ may add an MQMDE.

These structures are described in WebSphere MQ Application Programming Reference.
If your messages are of the maximum size allowed for these queues, the addition of these headers means that the put operations fail because the messages are now too big. To reduce the possibility of the put operations failing:

- Make the size of your messages smaller than the `MaxMsgLength` attribute of the transmission and dead-letter (undelivered-message) queues. Allow at least the value of the MQ_MSG_HEADER_LENGTH constant (more for large distribution lists).
- Make sure that the `MaxMsgLength` attribute of the dead-letter (undelivered-message) queue is set to the same as the `MaxMsgLength` of the queue manager that owns the dead-letter queue.

The attributes for the queue manager and the message queuing constants are described in "WebSphere MQ Application Programming Reference".

For information on how undelivered messages are handled in a distributed queuing environment, see "WebSphere MQ Intercommunication".

**Putting messages on a remote queue**

When you want to put a message on a remote queue (that is, a queue owned by a queue manager other than the one to which your application is connected) rather than a local queue, the only extra consideration is how you specify the name of the queue when you open it. This is described in "Opening remote queues" on page 103. There is no change to how you use the MQPUT or MQPUT1 call for a local queue.

For more information on using remote and transmission queues, see "WebSphere MQ Intercommunication".

**Controlling context information**

To control context information, you use the `Options` field in the MQPMO structure.

If you don’t, the queue manager will overwrite context information that may already be in the message descriptor with the identity and context information it has generated for your message. This is the same as specifying the MQPMO_DEFAULT_CONTEXT option. You may want this default context information when you create a new message (for example, when processing user input from an inquiry screen).

If you want no context information associated with your message, use the MQPMO_NO_CONTEXT option.

**Passing identity context**

In general, programs should pass identity context information from message to message around an application until the data reaches its final destination. Programs should change the origin context information each time they change the data. However, applications that want to change or set any context information must have the appropriate level of authority. The queue manager checks this authority when the applications open the queues; they must have authority to use the appropriate context options for the MQOPEN call.

If your application gets a message, processes the data from the message, then puts the changed data into another message (possibly for processing by another
MQPUT context information

application), the application should pass the identity context information from the original message to the new message. You can allow the queue manager to create the origin context information.

To save the context information from the original message, you must use the MQOO_SAVE_ALL_CONTEXT option when you open the queue for getting the message. This is in addition to any other options you use with the MQOPEN call. Note, however, that you cannot save context information if you only browse the message.

When you create the second message, you must:
- Open the queue using the MQOO_PASS_IDENTITY_CONTEXT option (in addition to the MQOO_OUTPUT option).
- In the Context field of the put-message options structure, give the handle of the queue from which you saved the context information.
- In the Options field of the put-message options structure, specify the MQPMO_PASS_IDENTITY_CONTEXT option.

Passing all context

If your application gets a message, and puts the message data (unchanged) into another message, the application should pass both the identity and the origin context information from the original message to the new message. An example of an application that might do this is a message mover, which moves messages from one queue to another.

Follow the same procedure as for passing identity context, except you use the MQOPEN option MQOO_PASS_ALL_CONTEXT and the put-message option MQPMO_PASS_ALL_CONTEXT.

Setting identity context

If you want to set the identity context information for a message, leaving the queue manager to set the origin context information:
- Open the queue using the MQOO_SET_IDENTITY_CONTEXT option.
- Put the message on the queue, specifying the MQPMO_SET_IDENTITY_CONTEXT option. In the message descriptor, specify whatever identity context information you require.

Setting all context

If you want to set both the identity and the origin context information for a message:
- Open the queue using the MQOO_SET_ALL_CONTEXT option.
- Put the message on the queue, specifying the MQPMO_SET_ALL_CONTEXT option. In the message descriptor, specify whatever identity and origin context information you require.

Appropriate authority is needed for each type of context setting.

Putting one message on a queue using the MQPUT1 call

Use the MQPUT1 call when you want to close the queue immediately after you have put a single message on it. For example, a server application is likely to use the MQPUT1 call when it is sending a reply to each of the different queues.
Using MQPUT1

MQPUT1 is functionally equivalent to calling MQOPEN followed by MQPUT, followed by MQCLOSE. The only difference in the syntax for the MQPUT and MQPUT1 calls is that for MQPUT you must specify an object handle, whereas for MQPUT1 you must specify an object descriptor structure (MQOD) as defined in MQOPEN (see “Identifying objects (the MQOD structure)” on page 96). This is because you need to give information to the MQPUT1 call about the queue it has to open, whereas when you call MQPUT, the queue must already be open.

As input to the MQPUT1 call, you must supply:

- A connection handle.
- A description of the object you want to open. This is in the form of an object descriptor structure (MQOD).
- A description of the message you want to put on the queue. This is in the form of a message descriptor structure (MQMD).
- Control information in the form of a put-message options structure (MQPMO).
- The length of the data contained within the message (MQLONG).
- The address of the message data.

The output from MQPUT1 is:

- A completion code
- A reason code

If the call completes successfully, it also returns your options structure and your message descriptor structure. The call modifies your options structure to show the name of the queue and the queue manager to which the message was sent. If you request that the queue manager generate a unique value for the identifier of the message you are putting (by specifying binary zero in the MsgId field of the MQMD structure), the call inserts the value in the MsgId field before returning this structure to you.

Note: You cannot use MQPUT1 with a model queue name; however, once a model queue has been opened, you can issue an MQPUT1 to the dynamic queue.

The six input parameters for MQPUT1 are:

- **Hconn** This is a connection handle. For CICS applications, you can specify the constant MQHC_DEF_HCONN (which has the value zero), or use the connection handle returned by the MQCONN or MQCONNX call. For other programs, always use the connection handle returned by the MQCONN or MQCONNX call.

- **ObjDesc** This is an object descriptor structure (MQOD).

  In the **ObjectName** and **ObjectQMgrName** fields, give the name of the queue on which you want to put a message, and the name of the queue manager that owns this queue.

  The **DynamicQName** field is ignored for the MQPUT1 call because it cannot use model queues.

  Use the **AlternateUserId** field if you want to nominate an alternate user identifier that is to be used to test authority to open the queue.

- **MsgDesc** This is a message descriptor structure (MQMD). As with the MQPUT call, use this structure to define the message you are putting on the queue.
PutMsgOpts

This is a put-message options structure (MQPMO). Use it as you would for the MQPUT call (see “Specifying options using the MQPMO structure” on page 106).

When the Options field is set to zero, the queue manager uses your own user ID when it performs tests for authority to access the queue. Also, the queue manager ignores any alternate user identifier given in the AlternateUserId field of the MQOD structure.

BufferLength

This is the length of your message.

Buffer

This is the buffer area that contains the text of your message.

When you use clusters, MQPUT1 operates as though MQOO_BIND_NOT_FIXED is in effect. Applications must use the resolved fields in the MQPMO structure rather than the MQOD structure to determine where the message was sent. See WebSphere MQ Queue Manager Clusters for more information.

There is a description of the MQPUT1 call in WebSphere MQ Application Programming Reference.

Distribution lists

Not supported in WebSphere MQ for z/OS.

Distribution lists allow you to put a message to multiple destinations in a single MQPUT or MQPUT1 call. Multiple queues can be opened using a single MQOPEN and a message can then be put to each of those queues using a single MQPUT.

Some generic information from the MQI structures used for this process can be superseded by specific information relating to the individual destinations included in the distribution list.

When an MQOPEN call is issued, generic information is taken from the Object Descriptor (MQOD). If you specify MQOD_VERSION_2 in the Version field and a value greater than zero in the RecsPresent field, the Hobj can be defined as a handle of a list (of one or more queues) rather than of a queue. In this case, specific information is given through the object records (MQORs), which give details of destination (that is, ObjectName and ObjectQMgrName).

The object handle (Hobj) is passed to the MQPUT call, allowing you to put to a list rather than to a single queue.

When a message is put on the queues (MQPUT), generic information is taken from the Put Message Option structure (MQPMO) and the Message Descriptor (MQMD). Specific information is given in the form of Put Message Records (MQPMRs).

Response Records (MQRR) can receive a completion code and reason code specific to each destination queue.

Figure 5 on page 114 shows how distribution lists work.
Opening distribution lists

Use the MQOPEN call to open a distribution list, and use the options of the call to specify what you want to do with the list.

As input to MQOPEN, you must supply:

- A connection handle (see Chapter 9, “Putting messages on a queue”, on page 105 for a description)
- Generic information in the Object Descriptor structure (MQOD)
- The name of each queue you want to open, using the Object Record structure (MQOR)

The output from MQOPEN is:

- An object handle that represents your access to the distribution list
- A generic completion code
- A generic reason code
- Response Records (optional), containing a completion code and reason for each destination

Using the MQOD structure

Use the MQOD structure to identify the queues you want to open. To define a distribution list, you must specify MQOD_VERSION_2 in the Version field, a value greater than zero in the RecsPresent field, and MQOT_Q in the ObjectType field. See WebSphere MQ Application Programming Reference for a description of all the fields of the MQOD structure.

Using the MQOR structure

An MQOR structure must be provided for each destination. The structure contains the destination queue and queue manager names. The ObjectName and ObjectQMgrName fields in the MQOD are not used for distribution lists. There must
be one or more object records. If the \texttt{ObjectQMgrName} is left blank, the local queue manager is used. See WebSphere MQ Application Programming Reference for further information about these fields.

You can specify the destination queues in two ways:

- **By using the offset field \texttt{ObjectRecOffset}.**
  In this case, the application should declare its own structure containing an MQOD structure, followed by the array of MQOR records (with as many array elements as are needed), and set \texttt{ObjectRecOffset} to the offset of the first element in the array from the start of the MQOD. Care must be taken to ensure that this offset is correct.

  Use of built-in facilities provided by the programming language is recommended, if these are available in all of the environments in which the application must run. The following illustrates this technique for the COBOL programming language:

  ```cobol
  01 MY-OPEN-DATA.
  02 MY-MQOD.
    COPY CMQODV.
  02 MY-MQOR-TABLE OCCURS 100 TIMES.
    COPY CMQORV.
    MOVE LENGTH OF MY-MQOD TO MQOD-OBJECTRECOFFSET.
  ```

  Alternatively, the constant MQOD_CURRENT_LENGTH can be used if the programming language does not support the necessary built-in facilities in all of the environments concerned. The following illustrates this technique:

  ```cobol
  01 MY-MQ-CONSTANTS.
    COPY CMQV.
  01 MY-OPEN-DATA.
  02 MY-MQOD.
    COPY CMQODV.
  02 MY-MQOR-TABLE OCCURS 100 TIMES.
    COPY CMQORV.
    MOVE MQOD-CURRENT-LENGTH TO MQOD-OBJECTRECOFFSET.
  ```

  However, this will work correctly only if the MQOD structure and the array of MQOR records are contiguous; if the compiler inserts skip bytes between the MQOD and the MQOR array, these must be added to the value stored in \texttt{ObjectRecOffset}.

  Using \texttt{ObjectRecOffset} is recommended for programming languages that do not support the pointer data type, or that implement the pointer data type in a way that is not portable to different environments (for example, the COBOL programming language).

- **By using the pointer field \texttt{ObjectRecPtr}.**
  In this case, the application can declare the array of MQOR structures separately from the MQOD structure, and set \texttt{ObjectRecPtr} to the address of the array. The following illustrates this technique for the C programming language:

  ```c
  MQOD MyMqod;
  MQOR MyMqor[100];
  MyMqod.ObjectRecPtr = MyMqor;
  ```

  Using \texttt{ObjectRecPtr} is recommended for programming languages that support the pointer data type in a way that is portable to different environments (for example, the C programming language).
Distribution lists

Whichever technique is chosen, one of ObjectRecOffset and ObjectRecPtr must be used; the call fails with reason code MQRC_OBJECT_RECORDS_ERROR if both are zero, or both are nonzero.

Using the MQRR structure

These structures are destination specific as each Response Record contains a CompCode and Reason field for each queue of a distribution list. You must use this structure to enable you to distinguish where any problems lie.

For example, if you receive a reason code of MQRC_MULTIPLE_REASONS and your distribution list contains five destination queues, you will not know which queues the problems apply to if you do not use this structure. However, if you have a completion code and reason code for each destination, you can locate the errors more easily.

See WebSphere MQ Application Programming Reference for further information about the MQRR structure.

Figure 6 shows how you can open a distribution list in C.

```
MQOD 2 n  ptr  ptr
MQOR 0 Q  QMgr
     Q  QMgr
     Q  QMgr
MQRR 0 CompCode  Reason
      CompCode  Reason
      CompCode  Reason
```

Figure 6. Opening a distribution list in C. The MQOD uses pointers to the MQOR and MQRR structures.

Figure 7 shows how you can open a distribution list in COBOL.

```
MQOD 2 n  offset x 0 offset y
MQOR Q  QMgr
     Q  QMgr
     Q  QMgr
MQRR CompCode  Reason
      CompCode  Reason
      CompCode  Reason
```

Figure 7. Opening a distribution list in COBOL. The MQOD uses offsets in COBOL.

Using the MQOPEN options

The following options can be specified when opening a distribution list:
- MQOO_OUTPUT
- MQOO_FAIL_IF_QUIESCING (optional)
- MQOO_ALTERNATE_USER_AUTHORITY (optional)
- MQOO_*_CONTEXT (optional)

See Chapter 8, “Opening and closing objects”, on page 95 for a description of these options.

Putting messages to a distribution list

To put messages to a distribution list, you can use MQPUT or MQPUT1. As input, you must supply:
- A connection handle (see Chapter 9, “Putting messages on a queue”, on page 105 for a description).
Putting messages to a distribution list

- An object handle. If a distribution list is opened using MQOPEN, the *Hobj* allows you only to put to the list.
- A message descriptor structure (MQMD). See *WebSphere MQ Application Programming Reference* for a description of this structure.
- Control information in the form of a put-message option structure (MQPMO). See “Specifying options using the MQPMO structure” on page 106 for information about filling in the fields of the MQPMO structure.
- Control information in the form of Put Message Records (MQPMR).
- The length of the data contained within the message (MQLONG).
- The message data itself.

The output is:
- A completion code
- A reason code
- Response Records (optional)

**Using the MQPMR structure**

This structure is optional and gives destination-specific information for some fields that you may want to identify differently from those already identified in the MQMD. For a description of these fields, see *WebSphere MQ Application Programming Reference*.

The content of each record depends on the information given in the PutMsgRecFields field of the MQPMO. For example, in the sample program AMQSPTL0.C (see “The Distribution List sample program” on page 423 for a description) showing the use of distribution lists, the sample chooses to provide values for *MsgId* and *CorrelId* in the MQPMR. This section of the sample program looks like this:

```c
typedef struct {
    MQBYTE24 MsgId;
    MQBYTE24 CorrelId;
} PutMsgRec;

/********************
MQLONG PutMsgRecFields=MQPMRF_MSG_ID | MQPMRF_CORREL_ID;

This implies that *MsgId* and *CorrelId* are provided for each destination of a distribution list. The Put Message Records are provided as an array.

**Figure 8** shows how you can put a message to a distribution list in C.

```

![Diagram](https://example.com/diagram.png)

**Figure 8.** Putting a message to a distribution list in C. The MQPMO uses pointers to the MQPMR and MQRR structures.

**Figure 9 on page 118** shows how you can put a message to a distribution list in COBOL.
Using MQPUT1

If you are using MQPUT1, consider the following:

1. The values of the ResponseRecOffset and ResponseRecPtr fields must be null or zero.
2. The Response Records, if required, must be addressed from the MQOD.

Some cases where the put calls fail

If certain attributes of a queue are changed using the FORCE option on a command during the interval between you issuing an MQOPEN and an MQPUT call, the MQPUT call fails and returns the MQRC_OBJECT_CHANGED reason code. The queue manager marks the object handle as being no longer valid. This also happens if the changes are made while an MQPUT1 call is being processed, or if the changes apply to any queue to which the queue name resolves. The attributes that affect the handle in this way are listed in the description of the MQOPEN call in *WebSphere MQ Application Programming Reference*. If your call returns the MQRC_OBJECT_CHANGED reason code, close the queue, reopen it, then try to put a message again.

If put operations are inhibited for a queue on which you are attempting to put messages (or any queue to which the queue name resolves), the MQPUT or MQPUT1 call fails and returns the MQRC_PUT_INHIBITED reason code. You may be able to put a message successfully if you attempt the call at a later time, if the design of the application is such that other programs change the attributes of queues regularly.

Further, if the queue that you are trying to put your message on is full, the MQPUT or MQPUT1 call fails and returns MQRC_Q_FULL.

If a dynamic queue (either temporary or permanent) has been deleted, MQPUT calls using a previously acquired object handle fail and return the MQRC_Q_DELETED reason code. In this situation, it is good practice to close the object handle as it is no longer of any use to you.

In the case of distribution lists, multiple completion codes and reason codes can occur in a single request. These cannot be handled using only the CompCode and Reason output fields on MQOPEN and MQPUT.

When distribution lists are used to put messages to multiple destinations, the Response Records contain the specific CompCode and Reason for each destination. If you receive a completion code of MQCC_FAILED, no message is put on any destination queue successfully. If the completion code is MQCC_WARNING, the message is successfully put on one or more of the destination queues. If you receive a return code of MQRC_MULTIPLE_REASONS, the reason codes are not all the same for every destination. Therefore, it is recommended to use the MQRR structure so that you can determine which queue or queues caused an error and the reasons for each.
Chapter 10. Getting messages from a queue

You can get messages from a queue in two ways:
1. You can remove a message from the queue so that other programs can no longer see it.
2. You can copy a message, leaving the original message on the queue. This is known as browsing. You can easily remove the message once you have browsed it.

In both cases, you use the MQGET call, but first your application must be connected to the queue manager, and you must use the MQOPEN call to open the queue (for input, browse, or both). These operations are described in Chapter 7, “Connecting to and disconnecting from a queue manager”, on page 87 and Chapter 8, “Opening and closing objects”, on page 95.

When you have opened the queue, you can use the MQGET call repeatedly to browse or remove messages on the same queue. Call MQCLOSE when you have finished getting all the messages you want from the queue.

This chapter introduces getting messages from a queue, under these headings:
- “Getting messages from a queue using the MQGET call” on page 119
- “The order in which messages are retrieved from a queue” on page 124
- “Getting a particular message” on page 131
- “Type of index” on page 132
- “Handling messages greater than 4 MB long” on page 133
- “Waiting for messages” on page 139
- “Signaling” on page 140
- “Skipping backout” on page 142
- “Application data conversion” on page 145
- “Browsing messages on a queue” on page 147
- “Browsing messages in logical order” on page 150
- “Some cases where the MQGET call fails” on page 152

Getting messages from a queue using the MQGET call

The MQGET call gets a message from an open local queue. It cannot get a message from a queue on another system.

As input to the MQGET call, you must supply:
- A connection handle.
- A queue handle.
- A description of the message you want to get from the queue. This is in the form of a message descriptor (MQMD) structure.
- Control information in the form of a Get Message Options (MQGMO) structure.
- The size of the buffer you have assigned to hold the message (MQLONG).
- The address of the storage in which the message must be put.

The output from MQGET is:
- A reason code
- A completion code
Using MQGET

- The message in the buffer area you specified, if the call completes successfully
- Your options structure, modified to show the name of the queue from which the message was retrieved
- Your message descriptor structure, with the contents of the fields modified to describe the message that was retrieved
- The length of the message (MQLONG)

There is a description of the MQGET call in WebSphere MQ Application Programming Reference.

The following sections describe the information you must supply as input to the MQGET call.

Specifying connection handles

For CICS on z/OS and VSE/ESA applications, you can specify the constant MQHC_DEF_HCONN (which has the value zero), or use the connection handle returned by the MQCONN or MQCONNX call. For other applications, always use the connection handle returned by the MQCONN or MQCONNX call.

Use the queue handle (Hobj) that is returned when you call MQOPEN.

Describing messages using the MQMD structure and the MQGET call

To identify the message you want to get from a queue, use the message descriptor structure (MQMD). This is an input/output parameter for the MQGET call. There is an introduction to the message properties that MQMD describes in Chapter 3, “WebSphere MQ messages”, on page 19, and there is a description of the structure itself in WebSphere MQ Application Programming Reference.

If you know which message you want to get from the queue, see “Getting a particular message” on page 131.

If you do not specify a particular message, MQGET retrieves the first message in the queue. “The order in which messages are retrieved from a queue” on page 124 describes how the priority of a message, the MsgDeliverySequence attribute of the queue, and the MQGMO_LOGICAL_ORDER option determine the order of the messages in the queue.

Note: If you want to use MQGET more than once (for example, to step through the messages in the queue), you must set the MsgId and CorrelId fields of this structure to null after each call. This clears these fields of the identifiers of the message that was retrieved.

However, if you want to group your messages, the GroupId should be the same for messages in the same group, so that the call will look for a message having the same identifiers as the previous message in order to make up the whole group.

Specifying MQGET options using the MQGMO structure

The MQGMO structure is an input/output variable for passing options to the MQGET call.
The following sections give you help on filling in some of the fields of this structure. There is a description of the structure in WebSphere MQ Application Programming Reference.

**StrucId**

StrucId is a 4-character field used to identify the structure as a get-message options structure. Always specify MQGMO_STRUC_ID.

**Version**

Version describes the version number of the structure. MQGMO_VERSION_1 is the default. If you wish to use the Version 2 fields or retrieve messages in logical order, specify MQGMO_VERSION_2. If you wish to use the Version 3 fields or retrieve messages in logical order, specify MQGMO_VERSION_3. MQGMO_CURRENT_VERSION sets your application to use the most recent level.

**Options**

Within your code, you can select the options in any order as each option is represented by a bit in the Options field.

The Options field controls:

- Whether the MQGET call waits for a message to arrive on the queue before it completes (see "Waiting for messages" on page 139)
- Whether the get operation is included in a unit of work.
- Whether a nonpersistent message is retrieved outside syncpoint, allowing fast messaging
- In WebSphere MQ for z/OS, whether the message retrieved is marked as skipping backout (see "Skipping backout" on page 142)
- Whether the message is removed from the queue, or merely browsed
- Whether to select a message by using a browse cursor or by other selection criteria
- Whether the call succeeds even if the message is longer than your buffer
- In WebSphere MQ for z/OS, whether to allow the call to complete, and sets a signal to indicate that you want to be notified when a message arrives
- Whether the call fails if the queue manager is in a quiescing state
- In WebSphere MQ for z/OS, whether the call fails if the connection is in a quiescing state
- Whether application message data conversion is required (see “Application data conversion” on page 145)
- The order in which messages and (with the exception of WebSphere MQ for z/OS) segments are retrieved from a queue
- Except on WebSphere MQ for z/OS, whether complete, logical messages only are retrievable
- Whether messages in a group can be retrieved only when all messages in the group are available
- Except on WebSphere MQ for z/OS, whether segments in a logical message can be retrieved only when all segments in the logical message are available

If you leave the Options field set to the default value (MQGMO_NO_WAIT), the MQGET call operates this way:

- If there is no message matching your selection criteria on the queue, the call does not wait for a message to arrive, but completes immediately.
Using MQGET

Also, in WebSphere MQ for z/OS, the call does not set a signal requesting notification when such a message arrives.

- The way that the call operates with syncpoints is determined by the platform:

<table>
<thead>
<tr>
<th>Platform</th>
<th>Under syncpoint control</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS/400</td>
<td>No</td>
</tr>
<tr>
<td>UNIX systems</td>
<td>No</td>
</tr>
<tr>
<td>z/OS</td>
<td>Yes</td>
</tr>
<tr>
<td>OS/2</td>
<td>No</td>
</tr>
<tr>
<td>Compaq NonStop Kernel</td>
<td>Yes</td>
</tr>
<tr>
<td>VSE/ESA</td>
<td>Yes</td>
</tr>
<tr>
<td>Windows systems</td>
<td>No</td>
</tr>
</tbody>
</table>

- In WebSphere MQ for z/OS, the message retrieved is not marked as skipping backout.
- The selected message is removed from the queue (not browsed).
- No application message data conversion is required.
- The call fails if the message is longer than your buffer.

**WaitInterval**

The `WaitInterval` field specifies the maximum time (in milliseconds) that the MQGET call waits for a message to arrive on the queue when you use the MQGMO_WAIT option. If no message arrives within the time specified in `WaitInterval`, the call completes and returns a reason code showing that there was no message that matched your selection criteria on the queue.

In WebSphere MQ for z/OS, if you use the MQGMO_SET_SIGNAL option, the `WaitInterval` field specifies the time for which the signal is set.

For more information on these options, see “Waiting for messages” on page 139 and “Signaling” on page 140.

**Signal1**

Signal1 is supported on WebSphere MQ for z/OS and MQSeries for Compaq NonStop Kernel only.

If you have chosen to use the MQGMO_SET_SIGNAL option to request that your application is notified when a suitable message arrives, you must specify the type of signal in the `Signal1` field. In WebSphere MQ on all other platforms, the `Signal1` field is reserved and its value is not significant.

For more information, see “Signaling” on page 140.

**Signal2**

The `Signal2` field is reserved on all platforms and its value is not significant.

For more information, see “Signaling” on page 140.

**ResolvedQName**

`ResolvedQName` is an output field in which the queue manager returns the name of the queue (after resolution of any alias) from which the message was retrieved.

**MatchOptions**

`MatchOptions` controls the selection criteria for MQGET.
GroupStatus

*GroupStatus* indicates whether the message you have retrieved is in a group.

SegmentStatus

*SegmentStatus* indicates whether the item you have retrieved is a segment of a logical message.

Segmentation

*Segmentation* indicates whether segmentation is allowed for the message retrieved.

MsgToken

*Only supported in WebSphere MQ for z/OS.*

*MsgToken* uniquely identifies a message.

For more information, see “WebSphere MQ Workflow” on page 271.

ReturnedLength

*ReturnedLength* is an output field in which the queue manager returns the length of message data returned (in bytes).

### Specifying the size of the buffer area

In the *BufferLength* parameter of the MQGET call, specify the size of the buffer area you want to use to hold the message data that you retrieve. There are three ways to decide how big this should be:

1. You may already know what length of messages to expect from this program. If so, specify a buffer of this size.
   
   However, you can use the MQGMO_ACCEPT_TRUNCATED_MSG option in the MQGMO structure if you want the MQGET call to complete even if the message is too big for the buffer. In this case:
   
   - The buffer is filled with as much of the message as it can hold
   - The call returns a warning completion code
   - The message is removed from the queue (discarding the remainder of the message), or the browse cursor is advanced (if you are browsing the queue)
   - The real length of the message is returned in *DataLength*

   Without this option, the call still completes with a warning, but it does not remove the message from the queue (or advance the browse cursor).

2. Estimate a size for the buffer (or even specify a size of zero bytes) and do not use the MQGMO_ACCEPT_TRUNCATED_MSG option. If the MQGET call fails (for example, because the buffer is too small), the length of the message is returned in the *DataLength* parameter of the call. (The buffer is still filled with as much of the message as it can hold, but the processing of the call is not completed.) Store the *MsgId* of this message, then repeat the MQGET call, specifying a buffer area of the correct size, and the *MsgId* you noted from the first call.

   If your program is serving a queue that is also being served by other programs, one of those other programs may remove the message you want before your program can issue another MQGET call. Your program could waste time searching for a message that no longer exists. To avoid this, first browse the queue until you find the message you want, specifying a *BufferLength* of zero and using the MQGMO_ACCEPT_TRUNCATED_MSG option. This positions the browse cursor under the message you want. You can then retrieve the message by calling MQGET again, specifying the MQGMO_MSG_UNDER_CURSOR option. If another program removes the...
Using MQGET

message between your browse and removal calls, your second MQGET fails immediately (without searching the whole queue), because there is no message under your browse cursor.

3. The MaxMsgLength queue attribute determines the maximum length of messages accepted for that queue and the MaxMsgLength queue manager attribute determines the maximum length of messages accepted for that queue manager. If you do not know what length of message to expect, you can inquire about the MaxMsgLength attribute (using the MQINQ call), then specify a buffer of this size.

Try to make the buffer size as close as possible to the actual message size to avoid reduced performance.

For further information about the MaxMsgLength attribute, see "Increasing the maximum message length" on page 134.

The order in which messages are retrieved from a queue

You have control over the order in which you retrieve messages from a queue. This section looks at the options.

Priority

A program can assign a priority to a message when it puts the message on a queue (see "Message priorities" on page 28). Messages of equal priority are stored in a queue in order of arrival, not the order in which they are committed.

The queue manager maintains queues either in strict FIFO (first in, first out) sequence, or in FIFO within priority sequence. This depends on the setting of the MsgDeliverySequence attribute of the queue. When a message arrives on a queue, it is inserted immediately following the last message that has the same priority.

Programs can either get the first message from a queue, or they can get a particular message from a queue, ignoring the priority of those messages. For example, a program may want to process the reply to a particular message that it sent earlier. For more information, see "Getting a particular message" on page 131.

If an application puts a sequence of messages on a queue, another application can retrieve those messages in the same order that they were put, provided:

- The messages all have the same priority
- The messages were all put within the same unit of work, or all put outside a unit of work
- The queue is local to the putting application

If these conditions are not met, and the applications depend on the messages being retrieved in a certain order, the applications must either include sequencing information in the message data, or establish a means of acknowledging receipt of a message before the next one is sent.

On WebSphere MQ for z/OS, the queue attribute, IndexType, can be used to increase the speed of MQGET operations on the queue. For more information, see "Type of index" on page 132.

Logical and physical ordering

Messages on queues can occur (within each priority level) in physical or logical order:
Order Meaning

Physical
This is the order in which messages arrive on a queue.

Logical
This is when all of the messages and segments within a group are in their logical sequence, adjacent to each other, in the position determined by the physical position of the first item belonging to the group.

For a description of groups, messages, and segments, see “Message groups” on page 28. These physical and logical orders may differ because:

- Groups can arrive at a destination at similar times from different applications, therefore losing any distinct physical order.
- Even within a single group, messages may get out of order due to rerouting or delay of some of the messages in the group.

For example, the logical order might look like Figure 10. These messages would appear in the following logical order on a queue:

<table>
<thead>
<tr>
<th>Group</th>
<th>Message</th>
<th>Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y3 (last)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y3.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y3.2</td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z2 (last)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10. Logical order on a queue

1. Message A (not in a group)
2. Logical message 1 of group Y
3. Logical message 2 of group Y
4. Segment 1 of (last) logical message 3 of group Y
5. (Last) segment 2 of (last) logical message 3 of group Y
6. Logical message 1 of group Z
7. (Last) logical message 2 of group Z
8. Message B (not in a group)

The physical order, however, might be entirely different. As stated on page 124, the physical position of the first item within each group determines the logical position...
of the whole group. For example, if groups Y and Z arrived at similar times, and message 2 of group Z overtook message 1 of the same group, the physical order would look like Figure 11:

These messages appear in the following physical order on the queue:
1. Message A (not in a group)
2. Logical message 1 of group Y
3. Logical message 2 of group Z
4. Logical message 2 of group Y
5. Segment 1 of (last) logical message 3 of group Y
6. (Last) segment 2 of (last) logical message 3 of group Y
7. Logical message 1 of group Z
8. Message B (not in a group)

Note: On WebSphere MQ for z/OS, the physical order of messages on the queue is not guaranteed if the queue is indexed by GROUPID.

When getting messages, you can specify MQGMO_LOGICAL_ORDER to retrieve messages in logical rather than physical order.

If you issue an MQGET call with MQGMO_BROWSE_FIRST and MQGMO_LOGICAL_ORDER, subsequent MQGET calls with MQGMO_BROWSE_NEXT must also specify this option. Conversely, if the
MQGET with MQGMO_BROWSE_FIRST does not specify MQGMO_LOGICAL_ORDER, neither must the following MQGETs with MQGMO_BROWSE_NEXT.

The group and segment information that the queue manager retains for MQGET calls that browse messages on the queue is separate from the group and segment information that the queue manager retains for MQGET calls that remove messages from the queue. When MQGMO_BROWSE_FIRST is specified, the queue manager ignores the group and segment information for browsing, and scans the queue as though there were no current group and no current logical message.

**Note:** Special care is needed if an MQGET call is used to browse beyond the end of a message group (or logical message not in a group) when MQGMO_LOGICAL_ORDER is not specified. For example, if the last message in the group happens to precede the first message in the group on the queue, using MQGMO_BROWSE_NEXT to browse beyond the end of the group, specifying MQMO_MATCH_MSG_SEQ_NUMBER with MsgSeqNumber set to 1 (to find the first message of the next group) would return again the first message in the group already browsed. This could happen immediately, or a number of MQGET calls later (if there are intervening groups).

The possibility of an infinite loop can be avoided by opening the queue twice for browse:

- Use the first handle to browse only the first message in each group.
- Use the second handle to browse only the messages within a specific group.
- Use the MQMO_* options to move the second browse cursor to the position of the first browse cursor, before browsing the messages in the group.
- Do not use the MQGMO_BROWSE_NEXT browse beyond the end of a group.

For further information about this, see `WebSphere MQ Application Programming Reference`.

For most applications you will probably choose either logical or physical ordering when browsing. However, if you want to switch between these modes, remember that when you first issue a browse with MQGMO_LOGICAL_ORDER, your position within the logical sequence is established.

If the first item within the group is not present at this time, the group you are in is not considered to be part of the logical sequence.

Once the browse cursor is within a group, it can continue within the same group, even if the first message is removed. Initially though, you can never move into a group using MQGMO_LOGICAL_ORDER where the first item is not present.

**Grouping logical messages**

There are two main reasons for using logical messages in a group:

- The messages may need to be processed in the correct order
- Each of the messages in a group may need to be processed in a related way.

In either case, retrieval of the entire group must be carried out by the same getting application instance.

For example, assume that the group consists of four logical messages. The putting application looks like this:
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_LAST_MSG_IN_GROUP
MQCMIT

The getting application chooses not to start processing any group until all of the
messages within it have arrived. MQGMO_ALL_MSGS_AVAILABLE is therefore
specified for the first message in the group; the option is ignored for subsequent
messages within the group.

Once the first logical message of the group is retrieved,
MQGMO_LOGICAL_ORDER is used to ensure that the remaining logical messages
of the group are retrieved in order.

So, the getting application looks like this:
/* Wait for the first message in a group, or a message not in a group */
GMO.Options = MQGMO_SYNCPOINT | MQGMO_WAIT
| MQGMO_ALL_MSGS_AVAILABLE | MQGMO_LOGICAL_ORDER
do while ( GroupStatus == MQGS_MSG_IN_GROUP )
MQGET
/* Process each remaining message in the group */
...

MQCMIT

For further examples of grouping messages, see "Application segmentation of
logical messages" on page 136 and "Putting and getting a group that spans units of
work".

Putting and getting a group that spans units of work
In the previous case, messages or segments cannot start to leave the node (if its
destination is remote) or start to be retrieved until all of the group has been put
and the unit of work is committed. This may not be what you want if it takes a
long time to put the whole group, or if queue space is limited on the node. To
overcome this, the group can be put in several units of work.

If the group is put within multiple units of work, it is possible for some of the
group to commit even when a failure of the putting application occurs. The
application must therefore save status information, committed with each unit of
work, which it can use after a restart to resume an incomplete group. The simplest
place to record this information is in a STATUS queue. If a complete group has
been successfully put, the STATUS queue is empty.

If segmentation is involved, the logic is similar. In this case, the StatusInfo must
include the Offset.

Here is an example of putting the group in several units of work:
/* First UOW */

MQCMIT
MQCMIT

/* Next and subsequent UOWs */
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQGET (from STATUS queue) GMO.Options = MQGMO_SYNCPOINT
StatusInfo = GroupId,MsgSeqNumber from MQMD
MQPUT (StatusInfo to STATUS queue) PMO.Options = MQPMO_SYNCPOINT
MQCMIT

/* Last UOW */
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
MQPUT MD.MsgFlags = MQMF_LAST_MSG_IN_GROUP
MQGET (from STATUS queue) GMO.Options = MQGMO_SYNCPOINT
MQCMIT

If all the units of work have been committed, the entire group has been put successfully, and the STATUS queue is empty. If not, the group must be resumed at the point indicated by the status information. MQPMO_LOGICAL_ORDER cannot be used for the first put, but can thereafter.

Restart processing looks like this:
MQGET (StatusInfo from STATUS queue) GMO.Options = MQGMO_SYNCPOINT
if (Reason == MQRC_NO_MSG_AVAILABLE)
   /* Proceed to normal processing */
   ...  
else  /* Group was terminated prematurely */
   Set GroupId, MsgSeqNumber in MQMD to values from Status message
   PMO.Options = MQPMO_SYNCPOINT
   MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP

   /* Now normal processing is resumed. Assume this is not the last message */
   PMO.Options = MQPMO_LOGICAL_ORDER | MQPMO_SYNCPOINT
   MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
   MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP
   StatusInfo = GroupId,MsgSeqNumber from MQMD
   MQPUT (StatusInfo to STATUS queue) PMO.Options = MQPMO_SYNCPOINT
   MQCMIT

From the getting application, you may want to start processing the messages in a group before the whole group has arrived. This improves response times on the messages within the group, and also means that storage is not required for the entire group.

For recovery reasons, each message must be retrieved within a unit of work. However, in order to realize the above benefits, several units of work must be used for each group of messages.

As with the corresponding putting application, this requires status information to be recorded somewhere automatically as each unit of work is committed. Again, the simplest place to record this information is on a STATUS queue. If a complete group has been successfully processed, the STATUS queue is empty.

**Note:** For intermediate units of work, you can avoid the MQGET calls from the STATUS queue by specifying that each MQPUT to the status queue is a segment of a message (that is, by setting the MQMF_SEGMENT flag), instead of putting a complete new message for each unit of work. In the last
unit of work, a final segment is put to the status queue specifying MQMF_LAST_SEGMENT, and then the status information is cleared with an MQGET specifying MQGMO_COMPLETE_MSG.

During restart processing, instead of using a single MQGET to get a possible status message, browse the status queue with MQGMO_LOGICAL_ORDER until you reach the last segment (that is, until no further segments are returned). In the first unit of work after restart, also specify the offset explicitly when putting the status segment.

In the following example, we consider only messages within a group. It is assumed that the application’s buffer is always large enough to hold the entire message, whether or not the message has been segmented. MQGMO_COMPLETE_MSG is therefore specified on each MQGET. The same principles apply if segmentation is involved (in this case, the StatusInfo must include the Offset).

For simplicity, we assume that a maximum of 4 messages should be retrieved within a single UOW:

```java
msgs = 0 /* Counts messages retrieved within UOW */
/* Should be no status message at this point */
/* Retrieve remaining messages in the group */
do while ( GroupStatus == MQGS_MSG_IN_GROUP )
   /* Process up to 4 messages in the group */
   GMO.Options = MQGMO_SYNCPOINT | MQGMO_WAIT | MQGMO_LOGICAL_ORDER
   do while ( (GroupStatus == MQGS_MSG_IN_GROUP) && (msgs < 4) )
      MQGET
      msg = msg + 1
      /* Process this message */
      ...
   /* Have retrieved last message or 4 messages */
   /* Update status message if not last in group */
   MQGET (from STATUS queue) GMO.Options = MQGMO_SYNCPOINT
   if ( GroupStatus == MQGS_MSG_IN_GROUP )
      StatusInfo = GroupId,MsgSeqNumber from MQMD
      MQPUT (StatusInfo to STATUS queue) PMO.Options = MQPMO_SYNCPOINT
      MQCMIT
   msg = 0
   /* end while */
else
   /* Come here if there was only 1 message in the group */
   MQCMIT
endif
```

If all of the units of work have been committed, then the entire group has been retrieved successfully, and the STATUS queue is empty. If not, then the group must be resumed at the point indicated by the status information. MQGMO_LOGICAL_ORDER cannot be used for the first retrieve, but can thereafter.

Restart processing looks like this:

```java
MQGET (from STATUS queue) GMO.Options = MQGMO_SYNCPOINT
if (Reason == MQRC_NO_MSG_AVAILABLE)
   /* Proceed to normal processing */
   ...
else
```

MQGET retrieval sequence
MQGET retrieval sequence

/* Group was terminated prematurely */
/* The next message on the group must be retrieved by matching
the sequence number and group id with those retrieved from the
status information. */
GMO.Options = MQGMO_COMPLETE_MSG | MQGMO_SYNCPOINT | MQGMO_WAIT
MQGET GMO.MatchOptions = MQMO_MATCH_GROUP_ID | MQMO_MATCH_MSG_SEQ_NUMBER,
MQMD.GroupId = value from Status message,
MQMD.MsgSeqNumber = value from Status message plus 1
msgs = 1
/* Process this message */
...

/* Now normal processing is resumed */
/* Retrieve remaining messages in the group */
do while ( GroupStatus == MQGS_MSG_IN_GROUP )

/* Process up to 4 messages in the group */
GMO.Options = MQGMO_COMPLETE_MSG | MQGMO_SYNCPOINT | MQGMO_WAIT
| MQGMO_LOGICAL_ORDER
do while ( (GroupStatus == MQGS_MSG_IN_GROUP) && (msgs < 4) )
MQGET
msgs = msgs + 1
/* Process this message */
...

/* Have retrieved last message or 4 messages */
/* Update status message if not last in group */
MQGET (from STATUS queue) GMO.Options = MQGMO_SYNCPOINT
if ( (GroupStatus == MQGS_MSG_IN_GROUP) )
StatusInfo = GroupId,MsgSeqNumber from MQMD
MQPUT (StatusInfo to STATUS queue) PMO.Options = MQPMO_SYNCPOINT
MQCMIT
msgs = 0

Getting a particular message

To get a particular message from a queue, use the MsgId and CorrelId fields of the MQMD structure. Note, however, that applications can explicitly set these fields, so the values you specify may not identify a unique message. Table 4 shows which message is retrieved for the possible settings of these fields. These fields are ignored on input if you specify MQGMO_MSG_UNDER_CURSOR in the GetMsgOpts parameter of the MQGET call.

Table 4. Using message and correlation identifiers

<table>
<thead>
<tr>
<th>To retrieve ...</th>
<th>MsgId</th>
<th>CorrelId</th>
</tr>
</thead>
<tbody>
<tr>
<td>First message in the queue</td>
<td>MQMI_NONE</td>
<td>MQCI_NONE</td>
</tr>
<tr>
<td>First message that matches MsgId</td>
<td>Nonzero</td>
<td>MQCI_NONE</td>
</tr>
<tr>
<td>First message that matches CorrelId</td>
<td>MQMI_NONE</td>
<td>Nonzero</td>
</tr>
<tr>
<td>First message that matches both MsgId and CorrelId</td>
<td>Nonzero</td>
<td>Nonzero</td>
</tr>
</tbody>
</table>

In each case, first means the first message that satisfies the selection criteria (unless MQGMO_BROWSE_NEXT is specified, when it means the next message in the sequence satisfying the selection criteria).

On return, the MQGET call sets the MsgId and CorrelId fields to the message and correlation identifiers (respectively) of the message returned (if any).

If you set the Version field of the MQMD structure to 2 or 3, you can use the GroupId, MsgSeqNumber, and Offset fields. Table 5 on page 132 shows which
Getting a specific message

message is retrieved for the possible settings of these fields.

Table 5. Using the group identifier

<table>
<thead>
<tr>
<th>To retrieve ...</th>
<th>Match options</th>
</tr>
</thead>
<tbody>
<tr>
<td>First message in the queue</td>
<td>MQMO_NONE</td>
</tr>
<tr>
<td>First message that matches MsgId</td>
<td>MQMO_MATCH_MSG_ID</td>
</tr>
<tr>
<td>First message that matches CorrelId</td>
<td>MQMO_MATCH_CORREL_ID</td>
</tr>
<tr>
<td>First message that matches GroupId</td>
<td>MQMO_MATCH_GROUP_ID</td>
</tr>
<tr>
<td>First message that matches MsgSeqNumber</td>
<td>MQMO_MATCH_MSG_SEQ_NUMBER</td>
</tr>
<tr>
<td>First message that matches MsgToken</td>
<td>MQMO_MATCH_MSG_TOKEN</td>
</tr>
<tr>
<td>First message that matches Offset</td>
<td>MQMO_MATCH_OFFSET</td>
</tr>
</tbody>
</table>

Notes:
1. MQMO_MATCH_XXX implies that the XXX field in the MQMD structure is set to the value to be matched.
2. The MQMO flags can be used in combination. For example, MQMO_MATCH_GROUP_ID, MQMO_MATCH_MSG_SEQ_NUMBER, and MQMO_MATCH_OFFSET can be used together to give the segment identified by the GroupId, MsgSeqNumber, and Offset fields.
3. If you specify MQGMO_LOGICAL_ORDER, the message you are trying to retrieve is affected because the option depends on state information controlled for the queue handle. For information about this, see “Logical and physical ordering” on page 124 and WebSphere MQ Application Programming Reference.
4. MQMO_MATCH_MSG_TOKEN is used only on queues managed by the z/OS workload manager.

Notes:
1. The MQGET call usually retrieves the first message from a queue. If you specify a particular message when you use the MQGET call, the queue manager has to search the queue until it finds that message. This can affect the performance of your application.
2. If you are using Version 2 or 3 of the MQMD structure, you can use the MQMO_MATCH_MSG_ID and MQMO_MATCH_CORREL_ID flags. This avoids having to reset the MsgId and CorrelId fields between MQGETs.

On WebSphere MQ for z/OS, the queue attribute, IndexType, can be used to increase the speed of MQGET operations on the queue. For more information, see “Type of index”.

Type of index

Only supported in WebSphere MQ for z/OS.

The queue attribute, IndexType, specifies the type of index that the queue manager maintains in order to increase the speed of MQGET operations on the queue.

You have five options:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NONE</td>
<td>No index is maintained. Use this when messages are retrieved sequentially (see “Priority” on page 124).</td>
</tr>
</tbody>
</table>
GROUPID
An index of group identifiers is maintained. This index type must be used if you want logical ordering of message groups (see “Logical and physical ordering” on page 124).

MSGID
An index of message identifiers is maintained. Use this when messages are retrieved using the MsgId field as a selection criterion on the MQGET call (see “Getting a particular message” on page 131).

MSGTOKEN
An index of message tokens is maintained. Use this when messages are retrieved using the MsgToken field as a selection criterion on the MQGET call (see “WebSphere MQ Workflow” on page 271).

CORRELID
An index of correlation identifiers is maintained. Use this when messages are retrieved using the CorrelId field as a selection criterion on the MQGET call (see “Getting a particular message” on page 131).

Notes:
1. If you are indexing using the MSGID option or CORRELID option, set the relative MsgId or CorrelId parameters in the MQMD. It is not beneficial to set both.
2. Browse uses the index mechanism to find a message if a queue matches all of the following conditions:
   • It has index type MSGID, CORRELID, or GROUPID
   • It is browsed with the same type of id
   • It has messages of only one priority
3. Avoid queues (indexed by MsgId or CorrelId) containing thousands of messages because this affects restart time. (This does not apply to nonpersistent messages as they are deleted at restart.)
4. MSGTOKEN is used to define queues managed by the z/OS workload manager.

For a full description of the IndexType attribute, see WebSphere MQ Application Programming Reference. For conditions needed to change the IndexType attribute, see WebSphere MQ Script (MQSC) Command Reference.

Handling messages greater than 4 MB long
Messages can be too large for the application, queue, or queue manager. Depending on the environment, WebSphere MQ provides a number of ways of dealing with messages that are longer than 4 MB.

On WebSphere MQ for z/OS, you can increase the MaxMsgLength attribute, up to 100 MB. This value should be set to reflect the size of the messages using the queue. On other MQSeries or WebSphere MQ Version 5 products you can:
1. Increase the queue and queue manager MaxMsgLength attributes.
2. Use segmented messages. (Messages can be segmented by either the application or the queue manager.)
3. Use reference messages.

Each of these approaches is described in the remainder of this section.
Handling large messages

Increasing the maximum message length

The MaxMsgLength queue manager attribute defines the maximum length of a message that can be handled by a queue manager. Similarly, the MaxMsgLength queue attribute is the maximum length of a message that can be handled by a queue. The default maximum message length supported depends on the environment in which you are working.

If you are handling large messages, you can alter these attributes independently. The attribute value can be set between 32768 bytes and 100 MB, or between 0 bytes and 100 MB on WebSphere MQ for z/OS.

After changing one or both of the MaxMsgLength attributes, restart your applications and channels to ensure that the changes take effect.

Note that on WebSphere MQ for z/OS you are permitted to change the queue MaxMsgLength attribute, but not the queue manager MaxMsgLength attribute (which is fixed at 100 MB).

When these changes are made, the message length must be less than or equal to both the queue and the queue manager MaxMsgLength attributes. However, existing messages may be longer than either attribute.

If the message is too big for the queue, MQRC_MSG_TOO_BIG_FOR_Q is returned. Similarly, if the message is too big for the queue manager, MQRC_MSG_TOO_BIG_FOR_Q_MGR is returned.

This method of handling large messages is easy and convenient. However, consider the following factors before using it:

- Uniformity among queue managers is reduced. The maximum size of message data is determined by the MaxMsgLength for each queue (including transmission queues) on which the message will be put. This value is often defaulted to the queue manager’s MaxMsgLength, especially for transmission queues. This makes it difficult to predict whether a message is too large when it is to travel to a remote queue manager.
- Usage of system resources is increased. For example, applications need larger buffers, and on some platforms, there may be increased usage of shared storage. Note that queue storage should be affected only if actually required for larger messages.
- Channel batching is affected. A large message still counts as just one message towards the batch count but needs longer to transmit, thereby increasing response times for other messages.

Message segmentation

Not supported in WebSphere MQ for z/OS.

Increasing the maximum message length as discussed on page 134 has some negative implications. Also, it could still result in the message being too large for the queue or queue manager. In these cases, a message can be segmented. For information about segments, see “Message groups” on page 28.

The next sections look at common uses for segmenting messages. For putting and destructively getting, it is assumed that the MQPUT or MQGET calls always operate within a unit of work. It is strongly recommended that this technique is always used, to reduce the possibility of incomplete groups being present in the
network. Single-phase commit by the queue manager is assumed, but of course other coordination techniques are equally valid.

Also, in the getting applications, it is assumed that if multiple servers are processing the same queue, each server executes similar code, so that one server never fails to find a message or segment that it expects to be there (because it had specified MQGMO_ALL_MSGS_AVAILABLE or MQGMO_ALL_SEGMENTS_AVAILABLE earlier).

**Segmentation and reassembly by queue manager**
This is the simplest scenario, in which one application puts a message to be retrieved by another. The message may be large: not too large for either the putting or the getting application to handle in a single buffer, but possibly too large for the queue manager or a queue on which the message is to be put.

The only changes necessary for these applications are for the putting application to authorize the queue manager to perform segmentation if necessary,

```plaintext
PMO.Options = (existing options)
MQPUT MD.MsgFlags = MQMF_SEGMENTATION_ALLOWED
```

and for the getting application to ask the queue manager to reassemble the message if it has been segmented:

```plaintext
GMO.Options = MQGMO_COMPLETE_MSG | (existing options)
MQGET
```

The application buffer must be large enough to contain the reassembled message (unless the MQGMO_ACCEPT_TRUNCATED_MSG option is included).

If data conversion is necessary, it may have to be done by the getting application specifying MQGMO_CONVERT. This should be straightforward because the data conversion exit is presented with the complete message. Attempting to do data conversion in a sender channel will not be successful if the message is segmented, and the format of the data is such that the data-conversion exit cannot carry out the conversion on incomplete data.

**Application segmentation**
Application segmentation is used for two main reasons:
1. Queue-manager segmentation alone is not adequate because the message is too large to be handled in a single buffer by the applications.
2. Data conversion must be performed by sender channels, and the format is such that the putting application needs to stipulate where the segment boundaries are to be in order for conversion of an individual segment to be possible.

However, if data conversion is not an issue, or if the getting application always uses MQGMO_COMPLETE_MSG, queue-manager segmentation can also be allowed by specifying MQMF_SEGMENTATION_ALLOWED. In our example, the application segments the message into four segments:

```plaintext
PMO.Options = MQPMO_LOGICAL_ORDER | MQPMO_SYNCPOINT
MQPUT MD.MsgFlags = MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_LAST_SEGMENT
MQCMIT
```
Handling large messages

If you do not use MQPMO_LOGICAL_ORDER, the application must set the Offset and the length of each segment. In this case, logical state is not maintained automatically.

The getting application cannot, or chooses not to, guarantee to have a buffer that will hold any reassembled message. It must therefore be prepared to process segments individually.

For messages that are segmented, this application does not want to start processing one segment until all of the segments that constitute the logical message are present. MQGMO_ALL_SEGMENTS_AVAILABLE is therefore specified for the first segment. If you specify MQGMO_LOGICAL_ORDER and there is a current logical message, MQGMO_ALL_SEGMENTS_AVAILABLE is ignored.

Once the first segment of a logical message has been retrieved, MQGMO_LOGICAL_ORDER is used to ensure that the remaining segments of the logical message are retrieved in order.

No consideration is given to messages within different groups. If such messages do occur, they are processed in the order in which the first segment of each message appears on the queue.

```
GMO.Options = MQGMO_SYNCPOINT | MQGMO_LOGICAL_ORDER | MQGMO_ALL_SEGMENTS_AVAILABLE | MQGMO_WAIT
```

```
do while ( SegmentStatus == MQSS_SEGMENT )
    MQGET
    /* Process each remaining segment of the logical message */
    ...

MQCMIT
```

Application segmentation of logical messages

The messages must be maintained in logical order in a group, and some or all of them may be so large that they require application segmentation.

In our example, a group of four logical messages is to be put. All but the third message are large, and require segmentation which is performed by the putting application:

```
PMO.Options = MQPMO_LOGICAL_ORDER | MQPMO_SYNCPOINT
```

```
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP | MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP | MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP | MQMF_LAST_SEGMENT
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP | MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP | MQMF_LAST_SEGMENT
MQPUT MD.MsgFlags = MQMF_MSG_IN_GROUP | MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_LAST_MSG_IN_GROUP | MQMF_SEGMENT
MQPUT MD.MsgFlags = MQMF_LAST_MSG_IN_GROUP | MQMF_LAST_SEGMENT
MQPUT MD.MsgFlags = MQMF_LAST_MSG_IN_GROUP | MQMF_LAST_SEGMENT
```

```
MQCMIT
```

In the getting application, MQGMO_ALL_MSGS_AVAILABLE is specified on the first MQGET. This means that no messages or segments of a group are retrieved until the entire group is available. When the first physical message of a group has been retrieved, MQGMO_LOGICAL_ORDER is used to ensure that the segments and messages of the group are retrieved in order:
Handling large messages

```c
GMO.Options = MQGMO_SYNCPOINT | MQGMO_LOGICAL_ORDER
| MQGMO_ALL_MESSAGES_AVAILABLE | MQGMO_WAIT

do while ( (GroupStatus != MQGS_LAST_MSG_IN_GROUP) ||
(SegmentStatus != MQGS_LAST_SEGMENT) )
MQGET
/* Process a segment or complete logical message. Use the GroupStatus
and SegmentStatus information to see what has been returned */
...
MQCMIT
```

Note: If you specify MQGMO_LOGICAL_ORDER and there is a current group,
MQGMO_ALL_MSGS_AVAILABLE is ignored.

Putting and getting a segmented message that spans units of work

You can put and get a segmented message that spans a unit of work in a similar
way to “Putting and getting a group that spans units of work” on page 128.

You cannot, however, put or get segmented messages in a global unit of work.

Reference messages

Not supported in WebSphere MQ for z/OS.

This method allows a large object to be transferred from one node to another
without the need for the object to be stored on WebSphere MQ queues at either the
source or the destination nodes. This is of particular benefit where the data already
exists in another form, for example, for mail applications.

To do this, you need to specify a message exit at both ends of a channel. For
information on how to do this, see WebSphere MQ Intercommunication.

WebSphere MQ defines the format of a reference message header (MQRMH). See
WebSphere MQ Application Programming Reference for a description of this. This is
recognized by means of a defined format name and may or may not be followed
by actual data.

To initiate transfer of a large object, an application can put a message consisting of
a reference message header with no data following it. As this message leaves the
node, the message exit retrieves the object in an appropriate way and appends it to
the reference message. It then returns the message (now larger than before) to the
sending Message Channel Agent for transmission to the receiving MCA.

Another message exit is configured at the receiving MCA. When this message exit
sees one of these messages, it creates the object using the object data that was
appended and passes on the reference message without it. The reference message
can now be received by an application and this application knows that the object
(or at least the portion of it represented by this reference message) has been
created at this node.

The maximum amount of object data that a sending message exit can append to
the reference message is limited by the negotiated maximum message length for
the channel. The exit can only return a single message to the MCA for each
message that it is passed, so the putting application can put several messages to
cause one object to be transferred. Each message must identify the logical length
and offset of the object that is to be appended to it. However, in cases where it is
Handing large messages

not possible to know the total size of the object or the maximum size allowed by
the channel, the sending message exit can be designed so that the putting
application just puts a single message, and the exit itself puts the next message on
the transmission queue when it has appended as much data as it can to the
message it has been passed.

Before using this method of dealing with large messages, consider the following:

• The MCA and the message exit run under a WebSphere MQ user ID. The
  message exit (and therefore, the user ID) needs to access the object to either
  retrieve it at the sending end or create it at the receiving end; this may only be
  feasible in cases where the object is universally accessible. This raises a security
  issue.

• If the reference message with bulk data appended to it must travel through
  several queue managers before reaching its destination, the bulk data is present
  on WebSphere MQ queues at the intervening nodes. However, no special
  support or exits need to be provided in these cases.

• Designing your message exit is made difficult if rerouting or dead-letter queuing
  is allowed. In these cases, the portions of the object may arrive out of order.

• When a reference message arrives at its destination, the receiving message exit
  creates the object. However, this is not synchronized with the MCA’s unit of
  work, so if the batch is backed out, another reference message containing this
  same portion of the object will arrive in a later batch, and the message exit may
  attempt to recreate the same portion of the object. If the object is, for example, a
  series of database updates, this might be unacceptable. If so, the message exit
  must keep a log of which updates have been applied; this may require the use
  of a WebSphere MQ queue.

• Depending on the characteristics of the object type, the message exits and
  applications may need to cooperate in maintaining use counts, so that the object
  can be deleted when it is no longer needed. An instance identifier may also be
  required; a field is provided for this in the reference message header (see
  WebSphere MQ Application Programming Reference).

• If a reference message is put as a distribution list, the object must be retrievable
  for each resulting distribution list or individual destination at that node. You
  may need to maintain use counts. Also consider the possibility that a given node
  may be the final node for some of the destinations in the list, but an
  intermediate node for others.

• Bulk data is not normally converted. This is because conversion takes place
  before the message exit is invoked. For this reason, conversion should not be
  requested on the originating sender channel. If the reference message passes
  through an intermediate node, the bulk data is converted when sent from the
  intermediate node, if requested.

• Reference messages cannot be segmented.

Using the MQRMH and MQMD structures

See WebSphere MQ Application Programming Reference for a description of the fields
in the reference message header and the message descriptor.

In the MQMD structure, the Format field must be set to
MQFMT_REF_MSG_HEADER. The MQHREF format, when requested on MQGET,
is converted automatically by WebSphere MQ along with any bulk data that
follows.

Here is an example of the use of the DataLogicalOffset and DataLogicalLength
fields of the MQRMH:
A putting application might put a reference message with:

- No physical data
- DataLogicalLength = 0 (this message represents the entire object)
- DataLogicalOffset = 0.

Assuming that the object is 70,000 bytes long, the sending message exit sends the first 40,000 bytes along the channel in a reference message containing:

- 40,000 bytes of physical data following the MQRMH
- DataLogicalLength = 40,000
- DataLogicalOffset = 0 (from the start of the object).

It then places another message on the transmission queue containing:

- No physical data
- DataLogicalLength = 0 (to the end of the object). You could specify a value of 30,000 here.
- DataLogicalOffset = 40,000 (starting from this point).

When this message exit is seen by the sending message exit, the remaining 30,000 bytes of data is appended, and the fields are set to:

- 30,000 bytes of physical data following the MQRMH
- DataLogicalLength = 30,000
- DataLogicalOffset = 40,000 (starting from this point).

The MQRMHF_LAST flag is also set.

For a description of the sample programs provided for the use of reference messages, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

Waiting for messages

If you want a program to wait until a message arrives on a queue, specify the MQGMO_WAIT option in the Options field of the MQGMO structure. Use the WaitInterval field of the MQGMO structure to specify the maximum time (in milliseconds) that you want an MQGET call to wait for a message to arrive on a queue.

If the message does not arrive within this time, the MQGET call completes with the MQRC_NO_MSG_AVAILABLE reason code.

You can specify an unlimited wait interval using the constant MQWI_UNLIMITED in the WaitInterval field. However, events outside your control could cause your program to wait for a long time, so use this constant with caution. IMS applications should not specify an unlimited wait interval because this would prevent the IMS system terminating. (When IMS terminates, it requires all dependent regions to end.) Instead, IMS applications should specify a finite wait interval; then, if the call completes without retrieving a message after that interval, issue another MQGET call with the wait option.

Note: If more than one program is waiting on the same shared queue to remove a message, only one program is activated by a message arriving. However, if more than one program is waiting to browse a message, all the programs can be activated. For more information, see the description of the Options field of the MQGMO structure in WebSphere MQ Application Programming Reference.
Waiting for messages

If the state of the queue or the queue manager changes before the wait interval expires, the following actions occur:

- If the queue manager enters the quiescing state, and you used the MQGMO_FAIL_IF_QUIESCING option, the wait is canceled and the MQGET call completes with the MQRC_Q_MGR_QUIESCING reason code. Without this option, the call remains waiting.
- On z/OS, if the connection (for a CICS or IMS application) enters the quiescing state, and you used the MQGMO_FAIL_IF_QUIESCING option, the wait is canceled and the MQGET call completes with the MQRC_CONN_QUIESCING reason code. Without this option, the call remains waiting.
- If the queue manager is forced to stop, or is canceled, the MQGET call completes with either the MQRC_Q_MGR_STOPPING or the MQRC_CONNECTION_BROKEN reason code.
- If the attributes of the queue (or a queue to which the queue name resolves) are changed so that get requests are now inhibited, the wait is canceled and the MQGET call completes with the MQRC_GET_INHIBITED reason code.
- If the attributes of the queue (or a queue to which the queue name resolves) are changed in such a way that the FORCE option is required, the wait is canceled and the MQGET call completes with the MQRC_OBJECT_CHANGED reason code.

If you want your application to wait on more than one queue, use the signal facility of WebSphere MQ for z/OS (see “Signaling”). For more information about the circumstances in which these actions occur, see WebSphere MQ Application Programming Reference.

Signaling

Signaling is supported only on WebSphere MQ for z/OS and MQSeries for Compaq NonStop Kernel.

Signaling is an option on the MQGET call to allow the operating system to notify (or signal) a program when an expected message arrives on a queue. This is similar to the “get with wait” function described on page 139 because it allows your program to continue with other work while waiting for the signal. However, if you use signaling, you can free the application thread and rely on the operating system to notify the program when a message arrives.

To set a signal

To set a signal, do the following in the MQGMO structure that you use on your MQGET call:

1. Set the MQGMO_SET_SIGNAL option in the Options field.
2. Set the maximum life of the signal in the WaitInterval field. This sets the length of time (in milliseconds) for which you want WebSphere MQ to monitor the queue. Use the MQWL_UNLIMITED value to specify an unlimited life.

Note: IMS applications should not specify an unlimited wait interval because this would prevent the IMS system from terminating. (When IMS terminates, it requires all dependent regions to end.) Instead, IMS applications should examine the state of the ECB at regular intervals (see step 3). A program can have signals set on several queue handles at the same time:
3. On MQSeries for Compaq NonStop Kernel, specify an application tag in the Signal1 field. This can be used by an application to associate the IPC notification message with a particular MQGET call (see “When the message arrives”). On WebSphere MQ for z/OS, specify the address of the Event Control Block (ECB) in the Signal1 field. This notifies you of the result of your signal. The ECB storage must remain available until the queue is closed.

**Note:** You cannot use the MQGMO_SET_SIGNAL option in conjunction with the MQGMO_WAIT option.

### When the message arrives

When a suitable message arrives, the following occurs:

- On MQSeries for Compaq NonStop Kernel An Inter-Process Communication (IPC) message is sent to the $RECEIVE queue of the process that made the MQGET call.
- On WebSphere MQ for z/OS, a completion code is returned to the ECB.

The completion code describes one of the following:

- The message you set the signal for has arrived on the queue. The message is not reserved for the program that requested a signal, so the program must issue an MQGET call again to get the message.
  
  **Note:** Another application could get the message in the time between you receiving the signal and you issuing another MQGET call.

- The wait interval you set has expired and the message you set the signal for did not arrive on the queue. WebSphere MQ has canceled the signal.

- The signal has been canceled. This happens, for example, if the queue manager stops or the attribute of the queue is changed so that MQGET calls are no longer allowed.

When a suitable message is already on the queue, the MQGET call completes in the same way as an MQGET call without signaling. Also, if an error is detected immediately, the call completes and the return codes are set.

When the call is accepted and no message is immediately available, control is returned to the program so that it can continue with other work. None of the output fields in the message descriptor are set, but the CompCode and Reason parameters are set to MQCC_WARNING and MQRC_SIGNAL_REQUEST_ACCEPTED, respectively.

For information on what WebSphere MQ can return to your application when it makes an MQGET call using signaling, see WebSphere MQ Application Programming Reference.

On WebSphere MQ for z/OS, if the program has no other work to do while it is waiting for the ECB to be posted, it can wait for the ECB using:

- For a CICS Transaction Server for z/OS program, the EXEC CICS WAIT EXTERNAL command
- For batch and IMS programs, the z/OS WAIT macro

If the state of the queue or the queue manager changes while the signal is set (that is, the ECB has not yet been posted), the following actions occur:
Signaling

- If the queue manager enters the quiescing state, and you used the MQGMO_FAIL_IF_QUIESCING option, the signal is canceled. The ECB is posted with the MQEC_Q_MGR_QUIESCING completion code. Without this option, the signal remains set.
- If the queue manager is forced to stop, or is canceled, the signal is canceled. The signal is delivered with the MQEC_WAIT_CANCELED completion code.
- If the attributes of the queue (or a queue to which the queue name resolves) are changed so that get requests are now inhibited, the signal is canceled. The signal is delivered with the MQEC_WAIT_CANCELED completion code.

Notes:

1. If more than one program has set a signal on the same shared queue to remove a message, only one program is activated by a message arriving. However, if more than one program is waiting to browse a message, all the programs can be activated. The rules that the queue manager follows when deciding which applications to activate are the same as those for waiting applications: for more information, see the description of the Options field of the MQGMO structure in WebSphere MQ Application Programming Reference.
2. If there is more than one MQGET call waiting for the same message, with a mixture of wait and signal options, each waiting call is considered equally. For more information, see the description of the Options field of the MQGMO structure in WebSphere MQ Application Programming Reference.
3. Under some conditions, it is possible both for an MQGET call to retrieve a message and for a signal (resulting from the arrival of the same message) to be delivered. This means that when your program issues another MQGET call (because the signal was delivered), there could be no message available. You should design your program to test for this situation.

For information about how to set a signal, see the description of the MQGMO_SET_SIGNAL option and the Signal1 field in WebSphere MQ Application Programming Reference.

Skipping backout

Only supported in WebSphere MQ for z/OS.

As part of a unit of work, an application program can issue one or more MQGET calls to get messages from a queue. If the application program detects an error, it can back out the unit of work. This restores all the resources updated during that unit of work to the state they were in before the unit of work started, and reinstates the messages retrieved by the MQGET calls.

Once reinstated, these messages are available to subsequent MQGET calls issued by the application program. In many cases, this does not cause a problem for the application program. However, in cases where the error leading to the backout cannot be circumvented, having the message reinstated on the queue can cause the application program to enter an ‘MQGET–error–backout’ loop.

To avoid this problem, specify the MQGMO_MARK_SKIP_BACKOUT option on the MQGET call. This marks the MQGET request as not being involved in application-initiated backout; that is, it should not be backed out. Use of this option means that when a backout occurs, updates to other resources are backed out as required, but the marked message is treated as if it had been retrieved under a new unit of work. The application program can then perform exception handling, such as informing the originator that the message has been discarded,
and then commit the new unit of work, causing the message to be removed from
the queue. If the new unit of work is backed out (for any reason) the message is
reinstated on the queue.

Within a unit of work, there can be only one MQGET request marked as skipping
backout; however, there can be several other messages that are not marked as
skipping backout. Once a message has been marked as skipping backout, any
further MQGET calls within the unit of work that specify
MQGMO_MARK_SKIP_BACKOUT will fail with reason code
MQRC_SECOND_MARK_NOT_ALLOWED.

Notes:
1. The marked message only skips backout if the unit of work containing it is
terminated by an application request to back it out. If the unit of work is
backed out for any other reason, the message is backed out on to the queue in
the same way that it would be if it was not marked to skip backout.
2. Skip backout is not supported within DB2 stored procedures participating in
units of work controlled by RRS. For example, an MQGET call with the
MQGMO_MARK_SKIP_BACKOUT option will fail with the reason code
MQRC_OPTION_ENVIRONMENT_ERROR.
Figure 12 illustrates a typical sequence of steps that an application program might contain when an MQGET request is required to skip backout:

**Step 1** Initial processing occurs within the transaction, including an MQOPEN call to open the queue (specifying one of the MQOO_INPUT_* options in order to get messages from the queue in Step 2).

**Step 2** MQGET is called, with MQGMO_SYNCPOINT and MQGMO_MARK_SKIP_BACKOUT. MQGMO_SYNCPOINT is required.
because MQGET must be within a unit of work for MQGMO_MARK_SKIP_BACKOUT to be effective. In this unit of work is referred to as UOW1.

Step 3 Other resource updates are made as part of UOW1. These may include further MQGET calls (issued without MQGMO_MARK_SKIP_BACKOUT).

Step 4 All updates from Steps 2 and 3 complete as required. The application program commits the updates and UOW1 ends. The message retrieved in Step 2 is removed from the queue.

Step 5 Some of the updates from Steps 2 and 3 do not complete as required. The application program requests that the updates made during these steps are backed out.

Step 6 The updates made in Step 3 are backed out.

Step 7 The MQGET request made in Step 2 skips backout and becomes part of a new unit of work, UOW2.

Step 8 UOW2 performs exception handling in response to UOW1 being backed out. (For example, an MQPUT call to another queue, indicating that a problem occurred that caused UOW1 to be backed out.)

Step 9 Step 8 completes as required, the application program commits the activity, and UOW2 ends. As the MQGET request is part of UOW2 (see Step 7), this commit causes the message to be removed from the queue.

Step 10 Step 8 does not complete as required and the application program backs out UOW2. Because the get message request is part of UOW2 (see Step 7), it too is backed out and reinstated on the queue. It is now available to further MQGET calls issued by this or another application program (in the same way as any other message on the queue).

---

Application data conversion

When necessary, MCAs convert the message descriptor and header data into the required character set and encoding. Either end of the link (that is, the local MCA or the remote MCA) may do the conversion.

When an application puts messages on a queue, the local queue manager adds control information to the message descriptors to facilitate the control of the messages when they are processed by queue managers and MCAs. Depending on the environment, the message header data fields will be created in the character set and encoding of the local system.

When you move messages between systems, it is necessary, on some occasions, to convert the application data into the character set and encoding required by the receiving system. This can be done either from within application programs on the receiving system or by the MCAs on the sending system. If data conversion is supported on the receiving system, it is recommended to use application programs to convert the application data, rather than depending on the conversion having already occurred at the sending system.
MQGET data conversion

Application data is converted within an application program when the MQGMO_CONVERT option is specified in the Options field of the MQGMO structure passed to an MQGET call, and all of the following are true:

- The CodedCharSetId or Encoding fields set in the MQMD structure associated with the message on the queue differ from the CodedCharSetId or Encoding fields set in the MQMD structure specified on the MQGET call.
- The Format field in the MQMD structure associated with the message is not MQFMT_NONE.
- The BufferLength specified on the MQGET call is not zero.
- The message data length is not zero.
- The queue manager supports conversion between the CodedCharSetId and Encoding fields specified in the MQMD structures associated with the message on the queue and the MQGET call. See WebSphere MQ Application Programming Reference for details of the coded character set identifiers and machine encodings supported.
- The queue manager supports conversion of the message format. If the Format field in the MQMD structure associated with the message is one of the built-in formats, the queue manager is able to convert the message. If the Format is not one of the built-in formats, you need to write a data-conversion exit to convert the message.

If the sending MCA is to convert the data, the CONVERT(YES) keyword must be specified on the definition of each sender or server channel for which conversion is required. If the data conversion fails, the message is sent to the DLQ at the sending queue manager and the Feedback field of the MQDLH structure indicates the reason. If the message cannot be put on the DLQ, the channel will close and the unconverted message will remain on the transmission queue. Data conversion within applications rather than at sending MCAs avoids this situation.

As a general rule, data in the message that is described as “character” data by the built-in format or data-conversion exit is converted from the coded character set used by the message to that requested, and “numeric” fields are converted to the encoding requested.

For further details of the conversion processing conventions used when converting the built-in formats, and for information about writing your own data-conversion exits, see Chapter 11, “Writing data-conversion exits”, on page 153. See also WebSphere MQ Application Programming Reference for information about the language support tables and about the supported machine encodings.

Conversion of EBCDIC newline characters

If you need to ensure that the data you send from an EBCDIC platform to an ASCII one is identical to the data you receive back again, you must control the conversion of EBCDIC newline characters. This can be done using a platform-dependent switch that forces WebSphere MQ to use the unmodified conversion tables but you must be aware of the inconsistent behavior that may result.

The problem arises because the EBCDIC newline character is not converted consistently across platforms or conversion tables. As a result, if the data is displayed on an ASCII platform, the formatting may be incorrect. This would make it difficult, for example, to administer an iSeries system remotely from an ASCII platform using RUNMQSC.
Browsing messages on a queue

To use the MQGET call to browse the messages on a queue:

1. Call MQOPEN to open the queue for browsing, specifying the MQOO_BROWSE option.
2. To browse the first message on the queue, call MQGET with the MQGMO_BROWSE_FIRST option. To find the message you want, you can call MQGET repeatedly with the MQGMO_BROWSE_NEXT option to step through many messages.
   You must set the MsgId and CorrelId fields of the MQMD structure to null after each MQGET call in order to see all messages.
3. Call MQCLOSE to close the queue.

The browse cursor

When you open (MQOPEN) a queue for browsing, the call establishes a browse cursor for use with MQGET calls that use one of the browse options. You can think of the browse cursor as a logical pointer that is positioned before the first message on the queue.

You can have more than one browse cursor active (from a single program) by issuing several MQOPEN requests for the same queue.

When you call MQGET for browsing, use one of the following options in your MQGMO structure:

MQGMO_BROWSE_FIRST
   Gets a copy of the first message that satisfies the conditions specified in your MQMD structure.

MQGMO_BROWSE_NEXT
   Gets a copy of the next message that satisfies the conditions specified in your MQMD structure.

In both cases, the message remains on the queue.

When you open a queue, the browse cursor is positioned logically just before the first message on the queue. This means that if you make your MQGET call immediately after your MQOPEN call, you can use the MQGMO_BROWSE_NEXT option to browse the first message; you do not have to use the MQGMO_BROWSE_FIRST option.

The order in which messages are copied from the queue is determined by the MsgDeliverySequence attribute of the queue. (For more information, see “The order in which messages are retrieved from a queue” on page 124.)

Queues in FIFO (first in, first out) sequence

The first message in a queue in this sequence is the message that has been on the queue the longest.

Use MQGMO_BROWSE_NEXT to read the messages sequentially in the queue. You will see any messages put to the queue while you are browsing, as a queue in this sequence will have messages placed at the end. When the cursor has recognized that it has reached the end of the queue, the browse cursor will stay
Browsing messages

where it is and return with MQRC_NO_MSG_AVAILABLE. You may then either leave it there waiting for further messages or reset it to the beginning of the queue with a MQGMO_BROWSE_FIRST call.

Queues in priority sequence

The first message in a queue in this sequence is the message that has been on the queue the longest and has the highest priority at the time the MQOPEN call is issued.

Use MQGMO_BROWSE_NEXT to read the messages in the queue.

The browse cursor will point to the next message, working from the priority of the first message to finish with the message at the lowest priority. It will browse any messages put to the queue during this time as long as they are of equal or lower priority to the message identified by the current browse cursor.

Any messages put to the queue of higher priority can only be browsed by:

- Opening the queue for browse again, at which point a new browse cursor is established
- Using the MQGMO_BROWSE_FIRST option

Uncommitted messages

An uncommitted message is never visible to a browse; the browse cursor skips past it. Messages within a unit-of-work cannot be browsed until the unit-of-work is committed. Messages do not change their position on the queue when committed, so skipped uncommitted messages will not be seen, even when they are committed, unless you use the MQGMO_BROWSE_FIRST option and work through the queue again.

Change to queue sequence

If the message delivery sequence is changed from priority to FIFO while there are messages on the queue, the order of the messages that are already queued is not changed. Messages added to the queue subsequently take the default priority of the queue.

Use of the queue’s index

Only supported in WebSphere MQ for z/OS.

When you browse an indexed queue that only contains messages of a single priority (either persistent or non-persistent or both), the queue manager performs the browse by making use of the index, when any of the following forms of browse are used:

1. If the queue is indexed by MSGID, and the above condition is true, then browse requests that pass a MSGID in the MQMD structure will be processed using the index to find the target message.
2. If the queue is indexed by CORRELID, and the above condition is true, then browse requests that pass a CORRELID in the MQMD structure will be processed using the index to find the target message.
3. If the queue is indexed by GROUPID, and the above condition is true, then browse requests that pass a GROUPID in the MQMD structure will be processed using the index to find the target message.

If the browse request does not pass a MSGID, CORRELID, or GROUPID in the MQMD structure, and the queue is indexed, and a message is returned, then the index entry for the message must be found, and information within it is used to
update the browse cursor. If you use a very wide selection of index values, then this extra processing will add very little overhead to the browse request.

**Browsing messages when message length unknown**

To browse a message when you do not know the size of the message, and you do not wish to use the `MsgId`, `CorrelId`, or `GroupId` fields to locate the message, you can use the MQGMO_BROWSE_MSG_UNDER_CURSOR option:

1. Issue an MQGET with:
   - Either the MQGMO_BROWSE_FIRST or MQGMO_BROWSE_NEXT option
   - The MQGMO_ACCEPT_TRUNCATED_MSG option
   - Buffer length zero

   **Note:** If another program is likely to get the same message, consider using the MQGMO_LOCK option as well. MQRC_TRUNCATED_MSG_ACCEPTED should be returned.

2. Use the returned `DataLength` to allocate the storage needed.
3. Issue an MQGET with the MQGMO_BROWSE_MSG_UNDER_CURSOR.

The message pointed to is the last one that was retrieved; the browse cursor will not have moved. You can choose either to lock the message using the MQGMO_LOCK option, or to unlock a locked message using MQGMO_UNLOCK option.

The call fails if no MQGET with either the MQGMO_BROWSE_FIRST or MQGMO_BROWSE_NEXT options has been issued successfully since the queue was opened.

**Restriction**

MQGMO_LOCK and MQGMO_UNLOCK are not available on MQSeries for Compaq NonStop Kernel.

**Removing a message you have browsed**

You can remove from the queue a message you have already browsed provided you have opened the queue for removing messages as well as for browsing. (You must specify one of the MQOO_INPUT_* options, as well as the MQOO_BROWSE option, on your MQOPEN call.)

To remove the message, call MQGET again, but in the `Options` field of the MQGMO structure, specify MQGMO_MSG_UNDER_CURSOR. In this case, the MQGET call ignores the `MsgId`, `CorrelId`, and `GroupId` fields of the MQMD structure.

In the time between your browsing and removal steps, another program may have removed messages from the queue, including the message under your browse cursor. In this case, your MQGET call returns a reason code to say that the message is not available.
Browsing messages in logical order

"Logical and physical ordering" on page 124 discusses the difference between the logical and physical order of messages on a queue. This distinction is particularly important when browsing a queue, because, in general, messages are not being deleted and browse operations do not necessarily start at the beginning of the queue. If an application browses through the various messages of one group (using logical order), it is important that logical order should be followed to reach the start of the next group, since the last message of one group may occur physically after the first message of the next group. The MQGMO_LOGICAL_ORDER option ensures that logical order is followed when scanning a queue.

MQGMO_ALL_MSGS_AVAILABLE (or MQGMO_ALL_SEGMENTS_AVAILABLE) needs to be used with care for browse operations. Consider the case of logical messages with MQGMO_ALL_MSGS_AVAILABLE. The effect of this is that a logical message is available only if all of the remaining messages in the group are also present. If they are not, the message is passed over. This can mean that when the missing messages arrive subsequently, they will not be noticed by a browse-next operation.

For example, if the following logical messages are present,

- Logical message 1 (not last) of group 123
- Logical message 1 (not last) of group 456
- Logical message 2 (last) of group 456

and a browse function is issued with MQGMO_ALL_MSGS_AVAILABLE, the first logical message of group 456 is returned, leaving the browse cursor on this logical message. If the second (last) message of group 123 now arrives,

- Logical message 1 (not last) of group 123
- Logical message 2 (last) of group 123
- Logical message 1 (not last) of group 456 <=== browse cursor
- Logical message 2 (last) of group 456

and the same browse-next function is issued, it will not be noticed that group 123 is now complete, because the first message of this group is before the browse cursor.

In some cases (for example, if messages are retrieved destructively when the group is present in its entirety), it may be acceptable to use MQGMO_ALL_MSGS_AVAILABLE together with MQGMO_BROWSE_FIRST. Otherwise, thebrowse scan must be repeated in order to take note of newly arrived messages that have been missed; just issuing MQGMO_WAIT together with MQGMO_BROWSE_NEXT and MQGMO_ALL_MSGS_AVAILABLE does not take account of them. (This also happens to higher-priority messages that might arrive after scanning the messages is complete.)

The next sections look at browsing examples that deal with unsegmented messages; segmented messages follow similar principles.

Browsing messages in groups

In this example, the application browses through each message on the queue, in logical order.

Messages on the queue may either be grouped or not. For grouped messages, the application does not want to start processing any group until all of the messages
within it have arrived. MQGMO_ALL_MSGS_AVAILABLE is therefore specified for the first message in the group; for subsequent messages in the group, this option is unnecessary.

MQGMO_WAIT is used in this example. However, although the wait can be satisfied if a new group arrives, for the reasons in “Browsing messages in logical order” on page 150, it will not be satisfied if the browse cursor has already passed the first logical message in a group, and the remaining messages now arrive. Nevertheless, waiting for a suitable interval ensures that the application does not constantly loop while waiting for new messages or segments.

MQGMO_LOGICAL_ORDER is used throughout, to ensure that the scan is in logical order. This contrasts with the destructive MQGET example, where because each group is being removed, MQGMO_LOGICAL_ORDER is not used when looking for the first (or only) message in a group.

It is assumed that the application’s buffer is always large enough to hold the entire message, whether or not the message has been segmented. MQGMO_COMPLETE_MSG is therefore specified on each MQGET.

The following gives an example of browsing logical messages in a group:

```c
/* Browse the first message in a group, or a message not in a group */
GMO.Options = MQGMO_BROWSE_NEXT | MQGMO_COMPLETE_MSG | MQGMO_LOGICAL_ORDER
| MQGMO_ALL_MSGS_AVAILABLE | MQGMO_WAIT
MQGET GMO.MatchOptions = MQMO_MATCH_MSG_SEQ_NUMBER, MD.MsgSeqNumber = 1
/* Examine first or only message */
...
GMO.Options = MQGMO_BROWSE_NEXT | MQGMO_COMPLETE_MSG | MQGMO_LOGICAL_ORDER
do while ( GroupStatus == MQGS_MSG_IN_GROUP )
  MQGET
  /* Examine each remaining message in the group */
  ...
```

The above group is repeated until MQRC_NO_MSG_AVAILABLE is returned.

Note that the Application Messaging Interface (AMI) supports simulated message grouping on WebSphere MQ for z/OS. Refer to WebSphere MQ Application Messaging Interface for further details.

**Browsing and retrieving destructively**

In this example, the application browses each of the logical messages within a group, before deciding whether to retrieve that group destructively.

The first part of this example is similar to the previous one. However in this case, having browsed an entire group, we may decide to go back and retrieve it destructively.

As each group is removed in this example, MQGMO_LOGICAL_ORDER is not used when looking for the first or only message in a group.

The following gives an example of browsing and then retrieving destructively:

```c
GMO.Options = MQGMO_BROWSE_NEXT | MQGMO_COMPLETE_MSG | MQGMO_LOGICAL_ORDER
| MQGMO_ALL_MESSAGES_AVAILABLE | MQGMO_WAIT
do while ( GroupStatus == MQGS_MSG_IN_GROUP )
  MQGET
  /* Examine each remaining message in the group (or as many as necessary to decide whether or not to get it destructively) */
  ...
```
Browsing messages in logical order

if ( we want to retrieve the group destructively )

if ( GroupStatus == "")
    /* We retrieved an ungrouped message */
    GMO.Options = MQGMO_MSG_UNDER_CURSOR | MQGMO_SYNCPOINT
    MQGET GMO.MatchOptions = 0
    /* Process the message */
    ...

else
    /* We retrieved one or more messages in a group. The browse cursor */
    /* will not normally be still on the first in the group, so we have */
    /* to match on the GroupId and MsgSeqNumber = 1. */
    /* Another way, which works for both grouped and ungrouped messages, */
    /* would be to remember the MsgId of the first message when it was */
    /* browsed, and match on that. */
    GMO.Options = MQGMO_COMPLETE_MSG | MQGMO_SYNCPOINT
    MQGET GMO.MatchOptions = MQMO_MATCH_GROUP_ID
    MQMD.GroupId = value already in the MD)
    MQMD.MsgSeqNumber = 1
    /* Process first or only message */
    ...

    GMO.Options = MQGMO_COMPLETE_MSG | MQGMO_SYNCPOINT | MQGMO_LOGICAL_ORDER
    do while ( GroupStatus == MQGS_MSG_IN_GROUP )
        MQGET
        /* Process each remaining message in the group */
        ...

Some cases where the MQGET call fails

If certain attributes of a queue are changed using the FORCE option on a
command between issuing an MQOPEN and an MQGET call, the MQGET call fails
and returns the MQRC_OBJECT_CHANGED reason code. The queue manager
marks the object handle as being no longer valid. This also happens if the changes
apply to any queue to which the queue name resolves. The attributes that affect
the handle in this way are listed in the description of the MQOPEN call in
WebSphere MQ Application Programming Reference. If your call returns the
MQRC_OBJECT_CHANGED reason code, close the queue, reopen it, then try to
get a message again.

If get operations are inhibited for a queue from which you are attempting to get
messages (or any queue to which the queue name resolves), the MQGET call fails
and returns the MQRC_GET_INHIBITED reason code. This happens even if you
are using the MQGET call for browsing. You may be able to get a message
successfully if you attempt the MQGET call at a later time, if the design of the
application is such that other programs change the attributes of queues regularly.

If a dynamic queue (either temporary or permanent) has been deleted, MQGET
calls using a previously acquired object handle fail and return the
MQRC_Q_DELETED reason code.
Chapter 11. Writing data-conversion exits

Not supported in MQSeries for VSE/ESA.

The Message Descriptor of a message is created by your application when you do an MQPUT. Because WebSphere MQ needs to be able to understand the contents of the MQMD regardless of the platform it is created on, it is converted automatically by the system.

Application data, however, is not converted automatically. If character data is being exchanged between platforms where the CodedCharSetId and Encoding fields differ, for example, between ASCII and EBCDIC, it is the responsibility of the application to arrange for conversion of the message. Application data conversion may be performed by the queue manager itself or by a user exit program, referred to as a data-conversion exit. The queue manager can perform data conversion itself, using one of its built-in conversion routines, if the application data is in one of the built-in formats (such as MQFMT_STRING). This chapter discusses the data-conversion exit facility that WebSphere MQ provides for when the application data is not in a built-in format.

Control may be passed to the data-conversion exit during an MQGET call. This avoids converting across different platforms before reaching the final destination. However, if the final destination is a platform that does not support data conversion on the MQGET, you must specify CONVERT(YES) on the sender channel that sends the data to its final destination. This ensures that WebSphere MQ converts the data during transmission. In this case, your data-conversion exit must reside on the system where the sender channel is defined.

The MQGET call is issued directly by the application. Set the CodedCharSetId and Encoding fields in the MQMD to the character set and encoding required. If your application is using the same character set and encoding as the queue manager, you can set CodedCharSetId to MQCCSI_Q_MGR, and Encoding to MQENC_NATIVE. After the MQGET call completes, these fields have the values appropriate to the message data returned. These may differ from the values required if the conversion was not successful. Your application should reset these fields to the values required prior to each MQGET call.

The conditions required for the data-conversion exit to be called are defined for the MQGET call in the WebSphere MQ Application Programming Reference.

For a description of the parameters that are passed to the data-conversion exit, and detailed usage notes, see the WebSphere MQ Application Programming Reference for the MQ_DATA_CONV_EXIT call and the MQDXP structure.

Programs that convert application data between different machine encodings and CCSIDs must conform to the WebSphere MQ data conversion interface (DCI).

This chapter introduces data-conversion exits, under these headings:
- “Invoking the data-conversion exit” on page 154
- “Writing a data-conversion exit program” on page 155
- “Writing a data-conversion exit program for WebSphere MQ for iSeries” on page 159
Data-conversion exits

- “Writing a data-conversion exit program for WebSphere MQ for z/OS” on page 162
- “Writing a data-conversion exit for MQSeries for Compaq NonStop Kernel” on page 163
- “Writing a data-conversion exit for WebSphere MQ on UNIX systems and Compaq OpenVMS Alpha” on page 164
- “Writing a data-conversion exit for WebSphere MQ for Windows” on page 169

Invoking the data-conversion exit

A data-conversion exit is a user-written exit that receives control during the processing of an MQGET call. The exit is invoked if the following are true:

- The MQGMO_CONVERT option is specified on the MQGET call.
- Some or all of the message data is not in the requested character set or encoding.
- The Format field in the MQMD structure associated with the message is not MQFMT_NONE.
- The BufferLength specified on the MQGET call is not zero.
- The message data length is not zero.

The message contains data that has a user-defined format. The user-defined format can occupy the entire message, or be preceded by one or more built-in formats. For example, the user-defined format might be preceded by an MQFMT_DEAD LETTER HEADER format. The exit is invoked to convert only the user-defined format; the queue manager converts any built-in formats that precede the user-defined format.

A user-written exit can also be invoked to convert a built-in format, but this happens only if the built-in conversion routines cannot convert the built-in format successfully.

There are some other conditions, described fully in the usage notes of the MQDATA_CONV_EXIT call in the WebSphere MQ Application Programming Reference.

See the WebSphere MQ Application Programming Reference for details of the MQGET call. Data-conversion exits cannot use MQI calls, other than MQXCNVC.

A new copy of the exit is loaded when an application attempts to retrieve the first message that uses that Format since the application connected to the queue manager. A new copy may also be loaded at other times if the queue manager has discarded a previously-loaded copy.

The data-conversion exit runs in an environment similar to that of the program which issued the MQGET call. As well as user applications, the program can be an MCA (message channel agent) sending messages to a destination queue manager that does not support message conversion. The environment includes address space and user profile, where applicable. The exit cannot compromise the queue manager’s integrity, since it does not run in the queue manager’s environment.

In a client-server environment, the exit is loaded at the server, and conversion takes place there.
Data conversion on z/OS

On z/OS, you must also be aware of the following:

- Exit programs can be written in assembler language only.
- Exit programs must be reentrant, and capable of running anywhere in storage.
- Exit programs must restore the environment on exit to that at entry, and must free any storage obtained.
- Exit programs must not WAIT, or issue ESTAEs or SPIEs.
- Exit programs are normally invoked as if by z/OS LINK in:
  - Non-authorized problem program state
  - Primary address space control mode
  - Non cross-memory mode
  - Non access-register mode
  - 31 bit addressing mode
  - TCB-PRB mode

- When used by a CICS application, the exit is invoked by EXEC CICS LINK, and should conform to the CICS programming conventions. The parameters are passed by pointers (addresses) in the CICS communication area (COMMAREA). Although not recommended, user exit programs can also make use of CICS API calls, with the following caution:
  - Do not issue syncpoints, as the results could influence units of work declared by the MCA.
  - Do not update any resources controlled by a resource manager other than WebSphere MQ for z/OS, including those controlled by CICS Transaction Server for z/OS.
- For distributed queuing without CICS, the exit is loaded from the data set referenced by the CSQXLIB DD statement.
- For distributed queuing using CICS, data-conversion exits are not supported.

Writing a data-conversion exit program

For z/OS, you must write data-conversion exits in assembler language. For other platforms, it is recommended that you use the C programming language.

To help you create a data-conversion exit program, the following are supplied:

- A skeleton source file
- A convert characters call
- A utility that creates a fragment of code that performs data conversion on data type structures. This utility takes C input only. On z/OS, it produces assembler code.

These are described in subsequent sections.

For the procedure for writing the programs see:

- “Writing a data-conversion exit program for WebSphere MQ for iSeries” on page 159
- “Writing a data-conversion exit program for WebSphere MQ for z/OS” on page 162
- “Writing a data-conversion exit for MQSeries for Compaq NonStop Kernel” on page 163
- “Writing a data-conversion exit for WebSphere MQ on UNIX systems and Compaq OpenVMS Alpha” on page 164
- “Writing a data-conversion exit for WebSphere MQ for Windows” on page 169
Writing a data-conversion exit

Skeleton source file

These can be used as your starting point when writing a data-conversion exit program. The files supplied are listed in Table 6.

Table 6. Skeleton source files

<table>
<thead>
<tr>
<th>Platform</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIX</td>
<td>amqsvf0.c</td>
</tr>
<tr>
<td>OS/400</td>
<td>QMQMSAMP/QCSRC(AMQSVFC4)</td>
</tr>
<tr>
<td>AT&amp;T GIS UNIX</td>
<td>amqsvfxc.c</td>
</tr>
<tr>
<td>Compaq Tru64 UNIX</td>
<td>amqsvfxc.c</td>
</tr>
<tr>
<td>Compaq OpenVMS Alpha</td>
<td>AMQSVFCX.C</td>
</tr>
<tr>
<td>HP-UX</td>
<td>amqsvf0.c</td>
</tr>
<tr>
<td>Linux</td>
<td>amqsvf0.c</td>
</tr>
<tr>
<td>OS/2</td>
<td>AMQSVFC0.C</td>
</tr>
<tr>
<td>SINIX and DC/OSx</td>
<td>amqsvfxc.c</td>
</tr>
<tr>
<td>Solaris</td>
<td>amqsvf0.c</td>
</tr>
<tr>
<td>Compaq NonStop Kernel</td>
<td>amqsvfcn</td>
</tr>
<tr>
<td>Windows systems</td>
<td>amqsvf0.c</td>
</tr>
</tbody>
</table>

Notes:
1. Illustrates the MQXCVNC call.
2. A wrapper for the code fragments generated by the utility for use in all environments except CICS.
3. A wrapper for the code fragments generated by the utility for use in the CICS environment.

Convert characters call

The MQXCNVC (Convert characters) call can be used from within a data-conversion exit program to convert character message data from one character set to another. For certain multibyte character sets (for example, UCS2 character sets), the appropriate options must be used.

No other MQI calls can be made from within the exit; an attempt to make such a call fails with reason code MQRC_CALL_IN_PROGRESS.

See WebSphere MQ Application Programming Reference for further information on the MQXCNVC call and appropriate options.

Utility for creating conversion-exit code

The commands for creating conversion-exit code are:

iSeries
CVTMQMDTA (Convert WebSphere MQ Data Type)

OS/2, Compaq OpenVMS Alpha, Compaq NonStop Kernel, Windows systems, and UNIX systems
crtmqcvx (Create WebSphere MQ conversion-exit)

z/OS CSQUCVX
The command for your platform produces a fragment of code that performs data conversion on data type structures, for use in your data-conversion exit program. The command takes a file containing one or more C language structure definitions. On z/OS, it then generates a data set containing assembler code fragments and conversion functions. On other platforms, it generates a file with a C function to convert each structure definition. On z/OS, the utility requires access to the LE/370 run-time library SCEERUN.

**Invoking the CSQUCVX utility on z/OS**

Figure 13 shows an example of the JCL used to invoke the CSQUCVX utility.

```plaintext
//CVX       EXEC PGM=CSQUCVX
//STEPLIB   DD DISP=SHR,DSN=thlqual.SCSQANLE
//          DD DISP=SHR,DSN=thlqual.SCSQLOAD
//          DD DISP=SHR,DSN=le370qual.SCEERUN
//SYSPRINT  DD SYSOUT=*                     
//CSQUINP   DD DISP=SHR,DSN=MY.MQSERIES.FORMATS(MSG1)
//CSQUOUT   DD DISP=OLD,DSN=MY.MQSERIES.EXITS(MSG1)
```

**z/OS data definition statements**

The CSQUCVX utility requires DD statements with the following DDnames:

**SYSPRINT**

This specifies a data set or print spool class for reports and error messages.

**CSQUINP**

This specifies the sequential data set containing the definitions of the data structures to be converted.

**CSQUOUT**

This specifies the sequential data set where the conversion code fragments are to be written. The logical record length (LRECL) must be 80 and the record format (RECFM) must be FB.

**Error messages in OS/2, Windows systems, and UNIX systems**

The `crtmqcvx` command returns messages in the range AMQ7953 through AMQ7970. For other platforms, see the appropriate System Management Guide for your platform.

There are two main types of error:

- Major errors, such as syntax errors, when processing cannot continue. A message is displayed on the screen giving the line number of the error in the input file. The output file may have been partially created.
- Other errors when a message is displayed stating that a problem has been found but parsing of the structure can continue.

The output file has been created and contains error information on the problems that have occurred. This error information is prefixed by `#error` so that the code produced will not be accepted by any compiler without intervention to rectify the problems.

**Valid syntax**

Your input file for the utility must conform to the C language syntax. If you are unfamiliar with C, refer to "Example of valid syntax for the input data set" on page 158.
Writing a data-conversion exit

In addition, you must be aware of the following rules:

- typedef is recognized only before the struct keyword.
- A structure tag is required on your structure declarations.
- Empty square brackets [ ] may be used to denote a variable length array or string at the end of a message.
- Multidimensional arrays and arrays of strings are not supported.
- The following additional data types are recognized:
  
  MQBYTE
  MQCHAR
  MQSHORT
  MQLONG

MQCHAR fields are code page converted, but MQBYTE is left untouched. If the encoding is different, MQSHORT and MQLONG are converted accordingly.

- The following should not be used:
  
  float
  double
  pointers
  bit-fields

  This is because the utility for creating conversion-exit code does not provide the facility to convert these data types. To overcome this, you can write your own routines and call them from the exit.

Other points to note:

- Do not use sequence numbers in the input data set.
- If there are fields for which you want to provide your own conversion routines, declare them as MQBYTE, and then replace the generated CMQXCFBA macros with your own conversion code.

Example of valid syntax for the input data set

```
struct TEST {
  MQLONG SERIAL_NUMBER;
  MQCHAR ID[5];
  MQSHORT VERSION;
  MQBYTE CODE[4];
  MQLONG DIMENSIONS[3];
  MQCHAR NAME[24];
};
```

This corresponds to the following declarations in other programming languages:

**COBOL:**

```
10 TEST.
15 SERIAL-NUMBER PIC S9(9) BINARY.
15 ID PIC X(5).
15 VERSION PIC S9(4) BINARY.
* CODE IS NOT TO BE CONVERTED
15 CODE PIC X(4).
15 DIMENSIONS PIC S9(9) BINARY OCCURS 3 TIMES.
15 NAME PIC X(24).
```

**System/390 assembler:** Only supported in WebSphere MQ for z/OS.

```
TEST EQU *
SERIAL_NUMBER DS F
ID DS CL5
```
PL/I: Supported on AIX, z/OS, OS/2 and Windows systems only

DCL 1 TEST,
  2 SERIAL_NUMBER  FIXED BIN(31),
  2 ID             CHAR(5),
  2 VERSION        FIXED BIN(15),
  2 CODE           CHAR(4), /* not to be converted */
  2 DIMENSIONS(3)  FIXED BIN(31),
  2 NAME           CHAR(24);  

Writing a data-conversion exit program for WebSphere MQ for iSeries

Follow these steps:

1. Name your message format. The name must fit in the Format field of the MQMD. The Format name should not have leading embedded blanks, and trailing blanks are ignored. The object's name must have no more than eight non-blank characters, because the Format is only eight characters long. Remember to use this name each time you send a message (our example uses the name Format).

2. Create a structure to represent your message. See “Valid syntax” on page 157 for an example.

3. Run this structure through the CVTMQMDTA command to create a code fragment for your data-conversion exit.

   The functions generated by the CVTMQMDTA command use macros that are shipped in the file QMQM/H(AMQSVMHA). These macros are written assuming that all structures are packed; they should be amended if this is not the case.

4. Take a copy of the supplied skeleton source file, QMQMSAMP/QCSRC(AMQSVFC4) and rename it. (Our example uses the name EXIT_MOD.)

5. Find the following comment boxes in the source file and insert code as described:
   a. Towards the bottom of the source file, a comment box starts with:
      /* Insert the functions produced by the data-conversion exit */
      Here, insert the code fragment generated in step 3.
   b. Near the middle of the source file, a comment box starts with:
      /* Insert calls to the code fragments to convert the format's */
      This is followed by a commented-out call to the function ConverttagSTRUCT.
      Change the name of the function to the name of the function you added in step 5a above. Remove the comment characters to activate the function. If there are several functions, create calls for each of them.
   c. Near the top of the source file, a comment box starts with:
      /* Insert the function prototypes for the functions produced by */
      Here, insert the function prototype statements for the functions added in step 5a above.
WebSphere MQ for iSeries data-conversion exit

If the message contains character data, the generated code calls MQXCNVC; this can be resolved by binding the service program QMQM/LIBMQM.

6. Compile the source module, EXIT_MOD, as follows:
   CRTCMOD MODULE(library/EXIT_MOD) +
   SRCFILE(QCSRC) +
   TERASPACE(*YES *TSIFC)

7. Create/link the program.
   For nonthreaded applications, use the following:
   CRTPGM PGM(library/Format) +
   MODULE(library/EXIT_MOD) +
   BNDSRVPGM(QMQM/LIBMQM) +
   ACTGRP(QMQM) +
   USRPRF(*USER)
   In addition to creating the data-conversion exit for the basic environment, another is required in the threaded environment. This loadable object must be followed by _R. The LIBMQM_R library should be used to resolve calls to the MQXCNVC. Both loadable objects are required for a threaded environment.
   CRTPGM PGM(library/Format_R) +
   MODULE(library/EXIT_MOD) +
   BNDSRVPGM(QMQM/LIBMQM_R) +
   ACTGRP(QMQM) +
   USRPRF(*USER)

8. Place the output in the library list for the WebSphere MQ job. It is recommended that, for production, data-conversion exit programs be stored in QSYS.

Notes:
1. If CVTMQMDTA uses packed structures, all WebSphere MQ applications must use the _Packed qualifier.
2. Data-conversion exit programs must be reentrant.
3. MQXCNVC is the only MQI call that may be issued from a data-conversion exit.
4. The exit program should be compiled with the user profile compiler option set to *USER, so that the exit runs with the authority of the user.
5. Teraspace memory enablement is required for all user exits with WebSphere MQ for iSeries and TERASPACE(*YES *TSIFC) must be specified in the CRTCMOD and CRTBNDC commands.

Writing a data-conversion exit for MQSeries for OS/2 Warp

Follow these steps:
1. Name your message format. The name must fit in the Format field of the MQMD. The Format name should not have leading blanks. Trailing blanks are ignored. The object’s name must have no more than eight non-blank characters, because the Format is only eight characters long.
   A .DEF file called AMQSVFC2.DEF is also supplied in the samples directory, <drive:\directory\MQM\TOOLS\C\SAMPLES. Take a copy of this file and rename it, for example, to MYFORMAT.DEF. Make sure that the name of the DLL being created and the name specified in MYFORMAT.DEF are the same. Overwrite the name FORMAT1 in MYFORMAT.DEF with the new format name.
   Remember to use this name each time you send a message.
2. Create a structure to represent your message. See “Valid syntax” on page 157 for an example.
3. Run this structure through the `crtmqcvx` command to create a code fragment for your data-conversion exit.

The functions generated by the `crtmqcvx` command use macros which are written assuming that all structures are packed; they should be amended if this is not the case.

4. Take a copy of the supplied skeleton source file, AMQSVFC0.C, renaming it to the name of your message format that you decided on in step 1 (that is, MYFORMAT.C in this example). AMQSVFC0.C is in `<drive:\directory>\MQM\TOOLS\C\SAMPLES` (where `<drive:\directory>` was specified at installation).

The skeleton includes a sample header file AMQSVMHA.H in the same directory. Make sure that your include path points to this directory to pick up this file.

The AMQSVMHA.H file contains macros that are used by the code generated by the `crtmqcvx` command. If the structure to be converted contains character data, then these macros call MQXCNVC.

5. Find the following comment boxes in the source file and insert code as described:
   a. Towards the bottom of the source file, a comment box starts with:
      ```
      /* Insert the functions produced by the data-conversion exit */
      ```
      Here, insert the code fragment generated in step 3.
   b. Near the middle of the source file, a comment box starts with:
      ```
      /* Insert calls to the code fragments to convert the format's */
      ```
      This is followed by a commented-out call to the function `ConverttagSTRUCT`. Change the name of the function to the name of the function you added in step 5a above. Remove the comment characters to activate the function. If there are several functions, create calls for each of them.
   c. Near the top of the source file, a comment box starts with:
      ```
      /* Insert the function prototypes for the functions produced by */
      ```
      Here, insert the function prototype statements for the functions added in step 5a above.

6. Resolve this call by linking the routine with the library MQMVX.LIB, in the directory `<drive:\directory>\MQM\TOOLS\LIB`.

7. Create the following command file:

   ```
   icc /Ge- /I<drive:\directory>\mqm\tools\c\samples \ 
   /I<drive:\directory>\mqm\tools\c\include MYFORMAT.C \ 
   /I<drive:\directory>\mqm\tools\lib\mqm.lib MYFORMAT.DEF \ 
   /I<drive:\directory>\mqm\tools\lib\mqmvx.lib
   ```

   where `<drive:\directory>` is specified at installation.

   Issue the command file to compile your exit as a DLL file.

8. Place the output in the `\mqm\exits` subdirectory. The path used to look for the data-conversion exits is given in the qm.ini file as DefaultExitPath. This path is set for each queue manager and the exit will only be looked for in that path or paths.
MQSeries for OS/2 Warp data-conversion exit

Notes:
1. If CVTMQCVX uses packed structures, all WebSphere MQ applications must be compiled in this way.
2. Data-conversion exit programs must be reentrant.
3. MQXCNVC is the only MQI call that may be issued from a data-conversion exit.

Writing a data-conversion exit program for WebSphere MQ for z/OS

Follow these steps:
1. Take the supplied source skeleton CSQ4BAX9 (for non-CICS environments) or CSQ4CAX9 (for CICS) as your starting point.
2. Run the CSQUCVX utility.
3. Follow the instructions in the prolog of CSQ4BAX9 or CSQ4CAX9 to incorporate the routines generated by the CSQUCVX utility, in the order that the structures occur in the message you want to convert.
4. The utility assumes that the data structures are not packed, that the implied alignment of the data is honored, and that the structures start on a fullword boundary, with bytes being skipped as required (as between ID and VERSION in the “Example of valid syntax for the input data set” on page 158). If the structures are packed, you will need to omit the CMQXCALA macros that are generated. You are therefore strongly recommended to declare your structures in such a way that all fields are named and no bytes are skipped; in the “Example of valid syntax for the input data set” on page 158 you would add a field “MQBYTE DUMMY;” between ID and VERSION.
5. The supplied exit returns an error if the input buffer is shorter than the message format to be converted. Although the exit converts as many complete fields as possible, the error causes an unconverted message to be returned to the application. If you want to allow short input buffers to be converted as far as possible, including partial fields, change the TRUNC= value on the CSQXCDFA macro to YES; no error is returned, so the application receives a converted message. The application is responsible for handling the truncation.
6. Add any other special processing code that you need.
7. Rename the program to your data format name.
8. Compile and link-edit your program like a batch application program (unless it is for use with CICS applications). The macros in the code generated by the utility are in the library, thlqual.SCSQMACS.
   If the message contains character data, the generated code will call MQXCNVC. If your exit uses this call, link-edit it with the exit stub program CSQASTUB. The stub is language-independent and environment-independent. Alternatively, you can load the stub dynamically using the dynamic call name CSQXCNVC. See “Dynamically calling the WebSphere MQ stub” on page 387 for more information.
   Place the link-edited module in your application load library, and in a data set that is referenced by the CSQXLIB DD statement of your task procedure started by your channel initiator.
9. If the exit is for use by CICS applications, compile and link-edit it like a CICS application program, including CSQASTUB if required. Place it in your CICS application program library. Define the program to CICS in the usual way, specifying EXECKEY(CICS) in the definition.
WebSphere MQ for z/OS data-conversion exit

Note: Although the LE/370 run-time libraries are needed for running the
CSQUCVX utility (see step 2 on page 162), they are not needed for
link-editing or running the data-conversion exit itself (see steps 8 on
page 162 and 9 on page 162).

See “Writing WebSphere MQ-IMS bridge applications” on page 315 for information
about data conversion within the WebSphere MQ-IMS bridge.

Writing a data-conversion exit for MQSeries for Compaq NonStop
Kernel

Dynamically bound libraries are not supported by MQSeries for Compaq NonStop
Kernel. Data conversion exits (and channel exits) are implemented by including
statically bound stub functions in the WebSphere MQ libraries and executables that
can be replaced using the REPLACE bind option.

A data conversion exit must be called DATACONVEXIT (see sample AMQSVFCN),
and can be bound into the chosen executable (or library) using the TACL macro
BEXITE.

Note: This procedure modifies the target executable; you are recommended to
make a backup copy of the target executable or library before using the
macro.

Exit functions, once compiled, must be bound directly into the target executable or
library to be accessible by WebSphere MQ. The following TACL macro is used for
this purpose:

BEXITE

Usage: BEXITE target-executable-or-library source-exit-file-or-
library

For example, to bind the sample data conversion exit into the sample MQSGETA,
follow these steps:
1. Compile the exit function DATACONVEXIT (CSAMP AMQSVFCN).
2. Compile the get application (CSAMP AMQSGET0).
3. Bind the get application (BSAMP AMQSGET).
4. Bind the exit function into the get application (BEXITE AMQSGET
AMQSVFCO).

Alternatively, if all applications are to have this data conversion exit, the following
steps would create both a user library and an application with the exit bound in:
1. Compile the exit function DATACONVEXIT (CSAMP AMQSVFCN).
2. Compile the get application (CSAMP AMQSGET0).
3. Bind the exit function into the user library (BEXITE ZMQSLIB.MQMLIBC
AMQSVFCO).
4. Bind the get application with the modified library (BSAMP AMQSGET).

If the data conversion exit is to be used by channels processing within WebSphere
MQ, it must also be bound into the caller executable by the system administrator.
For example:
BEXITE ZMQSEXE.MQMCACAL AMQSVFCO
MQSeries for Compaq NonStop Kernel data-conversion exit

Use the TACL macro BDCXALL to bind the data conversion exit into all required WebSphere MQ processes. For example:

```
BDCXALL source-exit-file-or-library
```

Reusing data-conversion exit programs

In other MQSeries Version 2 products, a data-conversion exit is required for each application-defined format to be supported. The data-conversion exit programs are named according to the `Format` value (from MQMD) of the message to be converted. The format for which conversion is being requested can be determined from the `Format` field of the `MsgDesc` parameter. The appropriate data-conversion exit program can therefore be invoked from MQDATACONVEXIT(). The parameters supplied to MQDATACONVEXIT() can be supplied to the invoked data-conversion function.

Writing a data-conversion exit for WebSphere MQ on UNIX systems and Compaq OpenVMS Alpha

For SINIX and DC/OSx, data-conversion exits must not use DCE.

Follow these steps:

1. Name your message format. The name must fit in the `Format` field of the MQMD, and be in uppercase, for example, MYFORMAT. The `Format` name should not have leading blanks. Trailing blanks are ignored. The object’s name must have no more than eight non-blank characters because the `Format` is only eight characters long. Remember to use this name each time you send a message.

2. Create a structure to represent your message. See “Valid syntax” on page 157 for an example.

3. Run this structure through the `crtmqcvx` command to create a code fragment for your data-conversion exit.
   The functions generated by the `crtmqcvx` command use macros which are written assuming that all structures are packed; they should be amended if this is not the case.

4. Take a copy of the supplied skeleton source file renaming it to the name of your message format that you decided on in step 1 (that is, MYFORMAT.C). The skeleton source file, and the copy, are read-only.
   On WebSphere MQ for AIX, Compaq Tru64 UNIX, HP-UX, Linux, and Solaris the skeleton source file is called amqsvfc0.c. On MQSeries for AT&T GIS UNIX, Compaq OpenVMS Alpha, and SINIX and DC/OSx the skeleton source file is called amqsvfcx.c.

5. With WebSphere MQ for AIX, a skeleton export file called amqsvfexp is also supplied. Copy this file, renaming it to MYFORMAT.EXP.

6. The skeleton includes a sample header file amqsvmha.h in the directory `/usr/mqm/inc` (on AIX) or `/opt/mqm/inc` (on other UNIX systems). Make sure that your include path points to this directory to pick up this file.
   The amqsvmha.h file contains macros that are used by the code generated by the `crtmqcvx` command. If the structure to be converted contains character data, then these macros call MQXCNVC.

7. Find the following comment boxes in the source file and insert code as described:
   a. Towards the bottom of the source file, a comment box starts with:
      `/* Insert the functions produced by the data-conversion exit */`
UNIX or Compaq OpenVMS Alpha data-conversion exit

Here, insert the code fragment generated in step 3.

b. Near the middle of the source file, a comment box starts with:

/* Insert calls to the code fragments to convert the format's */

This is followed by a commented-out call to the function ConverttagSTRUCT.

Change the name of the function to the name of the function you added in step 7a above. Remove the comment characters to activate the function. If there are several functions, create calls for each of them.

c. Near the top of the source file, a comment box starts with:

/* Insert the function prototypes for the functions produced by */

Here, insert the function prototype statements for the functions added in step 5a above.

8. Resolve this call by linking the routine with the library libmqm. For threaded programs, the routine must be linked with the library libmqm_r (AIX and HP-UX only).

9. Compile your exit as a shared library, using MQStart as the entry point. To do this, see “Compiling data-conversion exits on UNIX” on page 166 or “Compiling data-conversion exits on Compaq OpenVMS Alpha” on page 166.

10. Place the output in the default system directory, /var/mqm/exits, to ensure that it can be loaded when required. The path used to look for the data-conversion exits is given in the qm.ini file. This path can be set for each queue manager and the exit is only looked for in that path or paths.

Notes:

1. If crtmqcvx uses packed structures, all WebSphere MQ applications must be compiled in this way.

2. Data-conversion exit programs must be reentrant.

3. MQXCNVC is the only MQI call that may be issued from a data-conversion exit.

UNIX environment

There are two environments to consider: non threaded and threaded.

Non-threaded environment

The loadable object must have its name in upper case, for example MYFORMAT. The libmqm library should be used to resolve the calls to MQXCNVC.

Threaded environment

In addition to creating the data-conversion exit for the basic environment, another is required in the threaded environment. This loadable object must be followed by _r (on AIX, HP-UX, Linux, and Tru64 V4.0) and _d (on Solaris) to indicate that it is a DCE-threaded version. The libmqm_r and lmqmcs_d libraries should be used to resolve the calls to MQXCNVC. Note that both loadable objects (non-threaded and threaded) are required for a threading environment.

If you are running MQI clients, all data conversion is performed by the proxy running on the machine to which the client is attached. This means that any data conversion exits are run on the server, in the environment of the proxy, and not as part of the client application.
UNIX or Compaq OpenVMS Alpha data-conversion exit

For most platforms, the proxy/responder program is a threaded program. Consequently, the data conversion exit must be compiled with appropriate options to run in this threaded environment. Whether or not the client application is threaded is irrelevant.

On the WebSphere MQ V5 for UNIX systems, the proxy is threaded. The model of threads used depends on whether the DCE option has been installed.

**Note:** If the data-conversion exits are in a mixed non-threaded and threaded environment, the calling environment is detected and the appropriate object loaded. The shared object should be placed in /var/mqm/exits to ensure it can be loaded when required.

Compiling data-conversion exits on Compaq OpenVMS Alpha

The names of the routines which are called by the data-conversion exit must be made universal.

```bash
$ CC /INCLUDE_DIRECTORY=MQS_INCLUDE AMQSVFCX.C
$ LINK /SYS$SHARE:SYSLIB MYFORMAT AMQSVFCX.OBJ,MYFORMAT/OPTIONS
```

The contents of MYFORMAT.OPT vary depending on which platform you are working on:

On Alpha:

- SYSSSHARE:MQM/SHAREABLE
- SYSSSHARE:MQMCS/SHAREABLE
- SYMBOL_VECTOR=(MQSTART=PROCEDURE)

On VAX:

- SYSSSHARE:MQM/SHAREABLE
- SYSSSHARE:MQMCS/SHAREABLE
- UNIVERSAL=MQSTART

If you are using threaded applications linked with the pthread library, you must also build a second copy of the data-conversion exit with the thread options and libraries:

```bash
$ CC /INCLUDE_DIRECTORY=MQS_INCLUDE AMQSVFCX.C
$ LINK /SYS$SHARE:SYSLIB MYFORMAT AMQSVFCX.OBJ,MYFORMAT/OPTIONS
```

Again, the contents of MYFORMAT.OPT vary depending on which platform you are working on:

On Alpha:

- SYSSSHARE:MQM_R/SHAREABLE
- SYSSSHARE:MQMCS_R/SHAREABLE
- SYSSSHARE:CMA$OPEN_RTL.EXE/SHAREABLE
- SYMBOL_VECTOR=(MQSTART=PROCEDURE)

On VAX:

- SYSSSHARE:MQM_R/SHAREABLE
- SYSSSHARE:MQMCS_R/SHAREABLE
- SYSSSHARE:CMA$OPEN_RTL.EXE/SHAREABLE
- UNIVERSAL=MQSTART

Compiling data-conversion exits on UNIX

The following sections give examples of how to compile a data conversion exit on the UNIX platforms.
UNIX or Compaq OpenVMS Alpha data-conversion exit

On all platforms, the entry point to the module is MQStart.

**On AIX 4.3**

```
$ cc -c -I/usr/mqm/inc MYFORMAT.C
$ ld MYFORMAT.o -e MQStart -o MYFORMAT -bM:SRE -HS12 -T512 -bE:MYFORMAT.EXP -lmqm -lc
$ cp MYFORMAT /var/mqm/exits
```

You must build conversion exits for the threaded environment using the draft 10 POSIX threads interface, which is the AIX 4.3 default.

```
$ xlc_r -c -I/usr/mqm/inc MYFORMAT.C
$ ld MYFORMAT.o -e MQStart -o MYFORMAT_r -bM:SRE -HS12 -T512 -bE:MYFORMAT.EXP -lmqm_r -lpthreads_compat -lpthreads -lc_r
$ cp MYFORMAT_r /var/mqm/exits
```

**On AT&T GIS UNIX**

```
$ cc -c -K PIC -I/opt/mqm/inc MYFORMAT.C
$ ld -G MYFORMAT.O -o MYFORMAT
$ cp MYFORMAT /opt/mqm/lib
```

**On Compaq Tru64 UNIX Version 4.0**

This example shows how to compile a data-conversion exit program in a nonthreaded environment:

```
$ cc -std1 -c -I /opt/mqm/inc myformat.c
$ cc -std1 -shared -o myformat myformat.o -L /opt/mqm/lib -lmqm -e MQStart -lc
$ cp myformat /var/mqm/exits
```

This example shows how to compile a data-conversion exit program in a threaded environment:

```
$ cc -std1 -c -I /opt/mqm/inc myformat.c
$ cc -std1 -shared -pthread -o myformat myformat.o -L /opt/mqm/lib -lmqm_r -e MQStart -lc
$ cp myformat /var/mqm/exits
```

**On Compaq Tru64 UNIX Version 5.0**

This example shows how to compile a data-conversion exit program:

```
$ cc -std1 -c -I /opt/mqm/inc myformat.c
$ cc -std1 -shared -pthread -o myformat myformat.o -L /opt/mqm/lib -lmqm -e MQStart -lc
$ cp myformat /var/mqm/exits
```

**On HP-UX Version 11.00**

```
$ c89 -c +e +z -I/opt/mqm/inc MYFORMAT.C
$ ld -b MYFORMAT.o -o MYFORMAT -L /opt/mqm/lib -lmqm +IMQStart +eMQStart
$ cp MYFORMAT /var/mqm/exits
```

If you are using threaded applications linked with the POSIX Draft 10 pthreads library, or you are running client applications, you must build the conversion exit for Draft 10 threads.

```
$ c89 -c +e +z -I/opt/mqm/inc MYFORMAT.C
$ ld -b MYFORMAT.o -o MYFORMAT_r -L /opt/mqm/lib -lmqm_r -lpthread -lc
       +IMQStart +eMQStart_r
$ cp MYFORMAT_r /var/mqm/exits
```

If you are using threaded applications linked with the POSIX Draft 4 (DCE) pthreads library, or you are running client applications, you must build the conversion exit for Draft 4 threads.

Chapter 11. Writing data-conversion exits  167
UNIX or Compaq OpenVMS Alpha data-conversion exit

$ c89 -c +e +z -I/opt/mqm/inc -D_PTHREADS_DRAFT4 MYFORMAT.C
$ ld -b MYFORMAT.o -o MYFORMAT_d -L/opt/mqm/lib -lmqm_d -1dr -lcma -lc
+IMQStart +eMQStart
$ cp MYFORMAT_d /var/mqm/exits

On Linux
To compile a user exit program for a nonthreaded environment use:

$ gcc -c -I/opt/mqm/inc MYFORMAT.C
$ gcc -o MYFORMAT -L/opt/mqm/lib \
   -lmqm -shared MYFORMAT.o

For a multithreaded environment, you must build a second copy of the conversion exit. Use:

$ gcc -c -I/opt/mqm/inc MYFORMAT.C
$ gcc -o MYFORMAT -L/opt/mqm/lib \
   -lpthread -lmqm_r -shared MYFORMAT.o

On SINIX
$ cc -c -K PIC -I/opt/mqm/inc -lmproc -lext MYFORMAT.C
$ ld -G MYFORMAT.O -o MYFORMAT
$ cp MYFORMAT /opt/mqm/lib

On DC/OSx
$ cc -c -K PIC -I/opt/mqm/inc -liconv -lmproc -lext MYFORMAT.C
$ ld -G MYFORMAT.O -o MYFORMAT
$ cp MYFORMAT /opt/mqm/lib

On Solaris
If your application uses no threading calls or POSIX V10 threading calls:
    cc -c -KPIC -I/opt/mqm/inc MYFORMAT.C

    ld -G /opt/SUNWspro/SC4.0/lib/crt1.o
    /opt/SUNWspro/SC4.0/lib/crti.o
    /opt/SUNWspro/SC4.0/lib/crtn.o
    /opt/SUNWspro/SC4.0/lib/values-xt.o
    MYFORMAT.o -o MYFORMAT -lmqm -lthread -lsocket -lc -lnsl -ldl

    cp MYFORMAT /var/mqm/exits

If your application requires DCE threading (for example, if it is a CICS application):
    cc -c -KPIC -I/opt/mqm/inc MYFORMAT.C

    ld -G /opt/SUNWspro/SC4.0/lib/crt1.o
    /opt/SUNWspro/SC4.0/lib/crti.o
    /opt/SUNWspro/SC4.0/lib/crtn.o
    /opt/SUNWspro/SC4.0/lib/values-xt.o
    MYFORMAT.o -o MYFORMAT_d -ldce -lnsl -lthread -lm -lsocket \
    -lmqmcs_d -lmqm -lc -ldl

    cp MYFORMAT_d /var/mqm/exits

Note: The SC4.0 directory name varies depending on the release of compiler.
UNIX or Compaq OpenVMS Alpha data-conversion exit

If you want to run applications using both the POSIX V10-threaded and the DCE-threaded variants on a single queue manager:

1. Build a POSIX V10 type of data-conversion exit. Name it MYFORMAT and place it in the appropriate exit directory.
2. Build a DCE-threaded type of data-conversion exit. Name it MYFORMAT_d and place it in the appropriate exit directory.

Two object files are generated; one of which loads the MYFORMAT data-conversion exit, and the other of which loads the MYFORMAT_d data-conversion exit.

Writing a data-conversion exit for WebSphere MQ for Windows

Follow these steps:

1. Name your message format. The name must fit in the Format field of the MQMD. The Format name should not have leading blanks. Trailing blanks are ignored. The object’s name must have no more than eight non-blank characters, because the Format is only eight characters long.

A .DEF file called amqsvfcn.def is also supplied in the samples directory, <drive:\directory>\Program Files\IBM\WebSphere MQ\Tools\C\Samples. Take a copy of this file and rename it, for example, to MYFORMAT.DEF. Make sure that the name of the DLL being created and the name specified in MYFORMAT.DEF are the same. Overwrite the name FORMAT1 in MYFORMAT.DEF with the new format name.

Remember to use this name each time you send a message.

2. Create a structure to represent your message. See "Valid syntax" on page 157 for an example.

3. Run this structure through the crtmqcvx command to create a code fragment for your data-conversion exit.

The functions generated by the CVTMQCVX command use macros which are written assuming that all structures are packed; they should be amended if this is not the case.

4. Take a copy of the supplied skeleton source file, amqsvfc0.c, renaming it to the name of your message format that you decided on in step 1 (that is, MYFORMAT).

    amqsvfc0.c is in <drive:\directory>\Tools\C\Samples where <drive:\directory> is the directory specified on installation. (The default installation directory is C:\Program Files\IBM\WebSphere MQ.)

    The skeleton includes a sample header file amqsvmha.h in the same directory. Make sure that your include path points to this directory to pick up this file.

    The amqsvmha.h file contains macros that are used by the code generated by the CRTMQCVX command. If the structure to be converted contains character data, then these macros call MQXCNVC.

5. Find the following comment boxes in the source file and insert code as described:

a. Towards the bottom of the source file, a comment box starts with:

   /* Insert the functions produced by the data-conversion exit */

   Here, insert the code fragment generated in step 3

b. Near the middle of the source file, a comment box starts with:

   /* Insert calls to the code fragments to convert the format's */

Chapter 11. Writing data-conversion exits 169
**WebSphere MQ for Windows data-conversion exit**

This is followed by a commented-out call to the function `ConverttagSTRUCT`.

Change the name of the function to the name of the function you added in step 5a above. Remove the comment characters to activate the function. If there are several functions, create calls for each of them.

c. Near the top of the source file, a comment box starts with:
   /* Insert the function prototypes for the functions produced by */

Here, insert the function prototype statements for the functions added in step 5a above.

6. Resolve this call by linking the routine with the library `MQMVX.LIB`, in the directory `<drive:\directory>\Program Files\IBM\WebSphere MQ\Tools\Lib`.

7. Create the following command file:

   ```
   cl -I <drive:\directory>\Program Files\IBM\WebSphere MQ\Tools\C\Include -TpMYFORMAT.C -LD -DEFAULTLIB \\
   <drive:\directory>\Program Files\IBM\WebSphere MQ\Tools\Lib\mqm.lib \\
   <drive:\directory>\Program Files\IBM\WebSphere MQ\Tools\Lib\mqmvx.lib \\
   MYFORMAT.DEF
   ```

   where `<drive:\directory>` is specified at installation.

   Issue the command file to compile your exit as a DLL file.

8. Place the output in the Exits subdirectory below the WebSphere MQ data directory. Unless you have modified the `ExitsDefaultPath`, the default directory for installing your exits is:

   ```
   C:\Program Files\IBM\WebSphere MQ\Exits
   ```

   The path used to look for the data-conversion exits is given in the registry. The registry folder is:

   ```
   HKEY_LOCAL_MACHINE\SOFTWARE\IBM\MQSeries\CurrentVersion\Configuration\ClientExitPath\ExitsDefaultPath
   ```

   and the registry key is: `ExitsDefaultPath`. This path can be set for each queue manager and the exit is only looked for in that path or paths.

**Notes:**

1. If `CVTMQCVX` uses packed structures, all WebSphere MQ applications must be compiled in this way.

2. Data-conversion exit programs must be reentrant.

3. `MQXCNVC` is the only MQI call that may be issued from a data-conversion exit.
Chapter 12. Inquiring about and setting object attributes

Attributes are the properties that define the characteristics of a WebSphere MQ object. They affect the way that an object is processed by a queue manager. The attributes of each type of WebSphere MQ object are described in detail in WebSphere MQ Application Programming Reference.

Some attributes are set when the object is defined, and can be changed only by using the WebSphere MQ commands; an example of such an attribute is the default priority for messages put on a queue. Other attributes are affected by the operation of the queue manager and may change over time; an example is the current depth of a queue.

You can inquire about the current values of most attributes using the MQINQ call. The MQI also provides an MQSET call with which you can change some queue attributes. You cannot use the MQI calls to change the attributes of any other type of object; instead you must use:

For WebSphere MQ for z/OS
The ALTER operator commands (or the DEFINE commands with the REPLACE option), which are described in WebSphere MQ for z/OS Command Reference.

For WebSphere MQ for iSeries
The CHGMQMx CL commands, which are described in WebSphere MQ for iSeries V5.3 System Administration Guide or you can use the MQSC facility.

For MQSeries for Compaq NonStop Kernel
The MQM screen-based interface, which is described in MQSeries for Compaq NonStop Kernel System Administration, or you can use the MQSC facility.

For MQSeries for VSE/ESA
The panel interface, which is described in MQSeries for VSE/ESA System Management Guide.

For WebSphere MQ for all other platforms
The MQSC facility, described in WebSphere MQ Script (MQSC) Command Reference.

Note: The names of the attributes of objects are shown in this book in the form that you use them with the MQINQ and MQSET calls. When you use WebSphere MQ commands to define, alter, or display the attributes, you must identify the attributes using the keywords shown in the descriptions of the commands in the above books.

Both the MQINQ and the MQSET calls use arrays of selectors to identify those attributes you want to inquire about or set. There is a selector for each attribute you can work with. The selector name has a prefix, determined by the nature of the attribute:

MQCA_ These selectors refer to attributes that contain character data (for example, the name of a queue).
Object attributes

These selectors refer to attributes that contain either numeric values (such as CurrentQueueDepth, the number of messages on a queue) or a constant value (such as SyncPoint, whether or not the queue manager supports syncpoints).

Before you use the MQINQ or MQSET calls your application must be connected to the queue manager, and you must use the MQOPEN call to open the object for setting or inquiring about attributes. These operations are described in Chapter 7, "Connecting to and disconnecting from a queue manager", on page 87 and Chapter 8, "Opening and closing objects", on page 95.

Inquiring about the attributes of an object

Use the MQINQ call to inquire about the attributes of any type of WebSphere MQ object.

As input to this call, you must supply:

- A connection handle.
- An object handle.
- The number of selectors.
- An array of attribute selectors, each selector having the form MQCA_* or MQIA_. Each selector represents an attribute whose value you want to inquire about, and each selector must be valid for the type of object that the object handle represents. You can specify selectors in any order.
- The number of integer attributes that you are inquiring about. Specify zero if you are not inquiring about integer attributes.
- The length of the character attributes buffer in CharAttrLength. This must be at least the sum of the lengths required to hold each character attribute string. Specify zero if you are not inquiring about character attributes.

The output from MQINQ is:

- A set of integer attribute values copied into the array. The number of values is determined by IntAttrCount. If either IntAttrCount or SelectorCount is zero, this parameter is not used.
- The buffer in which character attributes are returned. The length of the buffer is given by the CharAttrLength parameter. If either CharAttrLength or SelectorCount is zero, this parameter is not used.
- A completion code. If the completion code gives a warning, this means that the call completed only partially. In this case, you should examine the reason code.
- A reason code. There are three partial-completion situations:
  - The selector does not apply to the queue type
  - There is not enough space allowed for integer attributes
  - There is not enough space allowed for character attributes
    
    If more than one of these situations arise, the first one that applies is returned.

If you open a queue for output or inquire and it resolves to a non-local cluster queue you can only inquire the queue name, queue type, and common attributes. The values of the common attributes are those of the chosen queue if MQOO_BIND_ON_OPEN was used. The values are those of an arbitrary one of the possible cluster queues if either MQOO_BIND_NOT_FIXED was used or...
MQOO_BIND_AS_Q_DEF was used and the *DefBind* queue attribute was MQBND_BIND_NOT_FIXED. See [WebSphere MQ Queue Manager Clusters](#) for more information.

**Note:** The values returned by the call are a snapshot of the selected attributes. The attributes can change before your program acts on the returned values.

There is a description of the MQINQ call in [WebSphere MQ Application Programming Reference](#).

### Some cases where the MQINQ call fails

If you open an alias to inquire about its attributes, you are returned the attributes of the alias queue (the WebSphere MQ object used to access another queue), not those of the base queue. However, the definition of the base queue to which the alias resolves is also opened by the queue manager, and if another program changes the usage of the base queue in the interval between your MQOPEN and MQINQ calls, your MQINQ call fails and returns the MQRC_OBJECT_CHANGED reason code. The call also fails if the attributes of the alias queue object are changed.

Similarly, when you open a remote queue to inquire about its attributes, you are returned the attributes of the local definition of the remote queue only.

If you specify one or more selectors that are not valid for the type of queue about whose attributes you are inquiring, the MQINQ call completes with a warning and sets the output as follows:

- For integer attributes, the corresponding elements of *IntAttrs* are set to MQIAV_NOT_APPLICABLE.
- For character attributes, the corresponding portions of the *CharAttrs* string are set to asterisks.

If you specify one or more selectors that are not valid for the type of object about whose attributes you are inquiring, the MQINQ call fails and returns the MQRC_SELECTOR_ERROR reason code.

It is not possible to call MQINQ to look at a model queue. You will have to use either the MQSC facility or use the commands available on your platform.

### Setting queue attributes

You can set only the following queue attributes using the MQSET call:

- *InhibitGet* (but not for remote queues)
- *DistList* (only for those platforms supporting distribution lists; see “Distribution lists” on page 113)
- *InhibitPut*
- *TriggerControl*
- *TriggerType*
- *TriggerDepth*
- *TriggerMsgPriority*
- *TriggerData*

The MQSET call has the same parameters as the MQINQ call. However for MQSET, all parameters except the completion code and reason code are input parameters. There are no partial-completion situations.
Using MQSET

Note: You cannot use the MQI to set the attributes of WebSphere MQ objects other than locally-defined queues.

There is a description of the MQSET call in [WebSphere MQ Application Programming Reference](#).
Chapter 13. Committing and backing out units of work

This chapter describes how to commit and back out any recoverable get and put operations that have occurred in a unit of work. The following terms, described below, are used in this topic:

- Commit
- Back out
- Syncpoint coordination
- Syncpoint
- Unit of work
- Single-phase commit
- Two-phase commit

If you are familiar with these transaction processing terms, you can skip to “Syncpoint considerations in WebSphere MQ applications” on page 176.

Commit and back out

When a program puts a message on a queue within a unit of work, that message is made visible to other programs only when the program commits the unit of work. To commit a unit of work, all updates must be successful to preserve data integrity. If the program detects an error and decides that the put operation should not be made permanent, it can back out the unit of work. When a program performs a back out, WebSphere MQ restores the queue by removing the messages that were put on the queue by that unit of work. The way in which the program performs the commit and back out operations depends on the environment in which the program is running.

Similarly, when a program gets a message from a queue within a unit of work, that message remains on the queue until the program commits the unit of work, but the message is not available to be retrieved by other programs. The message is permanently deleted from the queue when the program commits the unit of work. If the program backs out the unit of work, WebSphere MQ restores the queue by making the messages available to be retrieved by other programs.

Changes to queue attributes (either by the MQSET call or by commands) are not affected by the committing or backing out of units of work.

Syncpoint coordination, syncpoint, unit of work

Syncpoint coordination is the process by which units of work are either committed or backed out with data integrity.

The decision to commit or back out the changes is taken, in the simplest case, at the end of a transaction. However, it can be more useful for an application to synchronize data changes at other logical points within a transaction. These logical points are called syncpoints (or synchronization points) and the period of processing a set of updates between two syncpoints is called a unit of work. Several MQGET calls and MQPUT calls can be part of a single unit of work. The maximum number of messages within a unit of work can be controlled by the DEFINE MAXMSGS command on z/OS, or by the MAXUMSGS attribute of the ALTER QMGR command on other platforms. See WebSphere MQ Script (MQSC) Command Reference for details of these commands.
Commit and back out

**Single-phase commit**

A *single-phase commit* process is one in which a program can commit updates to a queue without coordinating its changes with other resource managers.

**Two-phase commit**

A *two-phase commit* process is one in which updates that a program has made to WebSphere MQ queues can be coordinated with updates to other resources (for example, databases under the control of DB2®). Under such a process, updates to *all* resources are committed or backed out together.

To help handle units of work, WebSphere MQ provides the *BackoutCount* attribute. This is incremented each time a message, within a unit of work, is backed out. If the message repeatedly causes the unit of work to abend, the value of the *BackoutCount* finally exceeds that of the *BackoutThreshold*. This value is set when the queue is defined. In this situation, the application can choose to remove the message from the unit of work and put it onto another queue, as defined in *BackoutRequeueQName*. When the message is moved, the unit of work can commit.

This chapter introduces committing and backing out units of work, under these headings:

- “Syncpoint considerations in WebSphere MQ applications”
- “Syncpoints in WebSphere MQ for z/OS applications” on page 177
- “Syncpoints in WebSphere MQ on UNIX systems” on page 180
- “Syncpoints in MQSeries for Compaq OpenVMS Alpha” on page 180
- “Syncpoints in MQSeries for Compaq NonStop Kernel applications” on page 187
- “Syncpoints in MQSeries for Compaq Tru64 UNIX” on page 187
- “Syncpoints in MQSeries for HP-UX” on page 187
- “Syncpoints in MQSeries for OS/2 Warp” on page 187
- “Syncpoints in MQSeries for Solaris” on page 187
- “Syncpoints in MQSeries for Windows” on page 187
- “Syncpoints in MQSeries for Windows NT” on page 187
- “Syncpoints in MQSeries for MVS/ESA” on page 187
- “Syncpoints in MQSeries for CICS” on page 187
- “Syncpoints in MQSeries for IMS” on page 187
- “Syncpoints in MQSeries for TXSeries” on page 187
- “Syncpoints in MQSeries for TXSeries for z/OS” on page 187
- “Syncpoints in MQSeries for TXSeries for z/OS” on page 187
- “Syncpoints in MQSeries for z/OS batch with RRS” on page 187
- “Syncpoints in MQSeries for Other external coordinators using the X/Open XA interface” on page 187

**Syncpoint considerations in WebSphere MQ applications**

Two-phase commit is supported under:

- WebSphere MQ for AIX
- MQSeries for Compaq NonStop Kernel
- MQSeries for Compaq OpenVMS Alpha
- MQSeries for Compaq Tru64 UNIX
- WebSphere MQ for iSeries
- WebSphere MQ for HP-UX
- WebSphere MQ for Linux
- MQSeries for OS/2 Warp
- WebSphere MQ for Solaris
- WebSphere MQ for Windows
- CICS for MVS/ESA 4.1
- CICS Transaction Server for z/OS
- CICS on Open Systems
- TXSeries for Windows NT
- IMS/ESA
- z/OS batch with RRS
- Other external coordinators using the X/Open XA interface

Single-phase commit is supported under:

- WebSphere MQ for iSeries
- MQSeries for OS/2 Warp
- MQSeries for Compaq NonStop Kernel
- WebSphere MQ on UNIX systems
Syncpoints in WebSphere MQ for z/OS applications

This section explains how to use syncpoints in transaction manager (CICS and IMS) and batch applications.

Syncpoints in CICS Transaction Server for z/OS and CICS for MVS/ESA applications

In a CICS application you establish a syncpoint by using the EXEC CICS SYNCPOINT command. To back out all changes to the previous syncpoint, you can use the EXEC CICS SYNCPOINT ROLLBACK command. For more information, see the CICS Application Programming Reference.
Syncpointing and CICS

If other recoverable resources are also involved in the unit of work, the queue manager (in conjunction with the CICS syncpoint manager) participates in a two-phase commit protocol; otherwise, the queue manager performs a single-phase commit process.

If a CICS application issues the MQDISC call, no implicit syncpoint is taken. If the application closes down normally, any open queues are closed and an implicit commit occurs. If the application closes down abnormally, any open queues are closed and an implicit backout occurs.

Syncpoints in IMS applications

In an IMS application, you establish a syncpoint by using IMS calls such as GU (get unique) to the IOPCB and CHKP (checkpoint). To back out all changes since the previous checkpoint, you can use the IMS ROLB (rollback) call. For more information, see the following books:

- IMS/ESA® Version 4 Application Programming: DL/I Calls
- IMS/ESA Version 4 Application Programming: Design Guide
- IMS/ESA Version 5 Application Programming: Database Manager
- IMS/ESA Version 5 Application Programming: Design Guide

The queue manager (in conjunction with the IMS syncpoint manager) participates in a two-phase commit protocol if other recoverable resources are also involved in the unit of work.

All open handles are closed by the IMS adapter at a syncpoint (except in a nonmessage batch-oriented BMP). This is because a different user could initiate the next unit of work and WebSphere MQ security checking is performed when the MQCONN, MQCONNX, and MQOPEN calls are made, not when the MQPUT or MQGET calls are made. The handles are closed at the beginning of the MQI call following the IMS call which initiated the syncpoint.

If you have not installed IMS APAR PN83757, handles are also closed after a ROLB call unless you are running IMS Version 3 or are running a nonmessage BMP.

If an IMS application (either a BMP or an MPP) issues the MQDISC call, open queues are closed but no implicit syncpoint is taken. If the application closes down normally, any open queues are closed and an implicit commit occurs. If the application closes down abnormally, any open queues are closed and an implicit backout occurs.

Syncpoints in z/OS batch applications

For batch applications, you can use the WebSphere MQ syncpoint management calls: MQCMIT and MQBACK. For backward compatibility, CSQBCMT and CSQBBAK are available as synonyms.

Note: If you need to commit or back out updates to resources managed by different resource managers, such as WebSphere MQ and DB2, within a single unit of work you could use RRS. For further information see “Transaction management and recoverable resource manager services” on page 179.

Committing changes using the MQCMIT call

As input, you must supply the connection handle (hconn), which is returned by the MQCONN or MQCONNX call.
Syncpointing and batch

The output from MQCMIT is a completion code and a reason code. The call completes with a warning if the syncpoint was completed but the queue manager backed out the put and get operations since the previous syncpoint.

Successful completion of the MQCMIT call indicates to the queue manager that the application has reached a syncpoint and that all put and get operations made since the previous syncpoint have been made permanent.

Not all failure responses mean that the MQCMIT did not complete. For example, the application can receive MQRC_CONNECTION_BROKEN.

There is a description of the MQCMIT call in WebSphere MQ Application Programming Reference.

Backing out changes using the MQBACK call

As input, you must supply a connection handle (hconn). Use the handle that is returned by the MQCONN or MQCONNX call.

The output from MQBACK is a completion code and a reason code.

The output indicates to the queue manager that the application has reached a syncpoint and that all gets and puts that have been made since the last syncpoint have been backed out.

There is a description of the MQBACK call in WebSphere MQ Application Programming Reference.

Transaction management and recoverable resource manager services

Transaction management and recoverable resource manager services (RRS) is an z/OS facility to provide two-phase syncpoint support across participating resource managers. An application can update recoverable resources managed by various z/OS resource managers such as WebSphere MQ and DB2, and then commit or back out these updates as a single unit of work. RRS provides the necessary unit-of-work status logging during normal execution, coordinates the syncpoint processing, and provides appropriate unit-of-work status information during subsystem restart.

WebSphere MQ for z/OS RRS participant support enables WebSphere MQ applications in the batch, TSO, and DB2 stored procedure environments to update both WebSphere MQ and non-WebSphere MQ resources (for example, DB2) within a single logical unit of work. For information about RRS participant support, see the MVS Programming: Resource Recovery book.

Your WebSphere MQ application can use either MQCMIT and MQBACK or the equivalent RRS calls, SRRCMIT and SRRBACK. See “RRS batch adapter” on page 261 for more information.

RRS availability: If RRS is not active on your z/OS system, any WebSphere MQ call issued from a program linked with either RRS stub (CSQBRSTB or CSQBRRSI) returns MQRC_ENVIRONMENT_ERROR.

DB2 stored procedures: If you use DB2 stored procedures with RRS you must be aware of the following guidelines:

- DB2 stored procedures that use RRS must be WLM-managed.
DB2 stored procedures

- If a DB2-managed stored procedure contains WebSphere MQ calls, and it is linked with either RRS stub (CSQBRSTB or CSQBRRSI), the MQCONN or MQCONNX call returns MQRC_ENVIRONMENT_ERROR.
- If a WLM-managed stored procedure contains WebSphere MQ calls, and it is linked with a non-RRS stub, the MQCONN or MQCONNX call returns MQRC_ENVIRONMENT_ERROR, unless it is the first WebSphere MQ call executed since the stored procedure address space started.
- If your DB2 stored procedure contains WebSphere MQ calls and is linked with a non-RRS stub, WebSphere MQ resources updated in that stored procedure are not committed until the stored procedure address space ends, or until a subsequent stored procedure does an MQCMIT (using a WebSphere MQ Batch/TSO stub).
- Multiple copies of the same stored procedure can execute concurrently in the same address space. You should ensure that your program is coded in a reentrant manner if you want DB2 to use a single copy of your stored procedure. Otherwise, you may receive MQRC_HCONN_ERROR on any WebSphere MQ call in your program.
- You must not code MQCMIT or MQBACK in a WLM-managed DB2 stored procedure.
- All programs must be designed to run in Language Environment® (LE).

Syncpoints in CICS for iSeries applications

WebSphere MQ for iSeries participates in CICS for iSeries units of work. You can use the MQI within a CICS for iSeries application to put and get messages inside the current unit of work.

You can use the EXEC CICS SYNCPPOINT command to establish a syncpoint that includes the WebSphere MQ for iSeries operations. To back out all changes up to the previous syncpoint, you can use the EXEC CICS SYNCPPOINT ROLLBACK command.

If you use MQPUT, MQPUT1, or MQGET with the MQPMO_SYNCPPOINT, or MQGMO_SYNCPPOINT option set in a CICS for iSeries application, you cannot log off CICS for iSeries until WebSphere MQ for iSeries has removed its registration as an API commitment resource. Therefore, you should commit or back out any pending put or get operations before you disconnect from the queue manager. This will allow you to log off CICS for iSeries.

Syncpoints in MQSeries for OS/2 Warp, WebSphere MQ for Windows, WebSphere MQ for iSeries, and WebSphere MQ on UNIX systems

Syncpoint support operates on two types of units of work: local and global.

A local unit of work is one in which the only resources updated are those of the WebSphere MQ queue manager. Here syncpoint coordination is provided by the queue manager itself using a single-phase commit procedure.

A global unit of work is one in which resources belonging to other resource managers, such as databases, are also updated. WebSphere MQ can coordinate such units of work itself. They can also be coordinated by an external commitment controller such as another transaction manager or the OS/400 commitment controller.
Syncpointing, other platforms

For full integrity, a two-phase commit procedure must be used. Two-phase commit can be provided by XA-compliant transaction managers and databases such as IBM’s TXSeries and UDB and also by the OS/400 commitment controller. MQSeries or WebSphere MQ Version 5 products (except WebSphere MQ for iSeries and WebSphere MQ for z/OS) can coordinate global units of work using a two-phase commit process. WebSphere MQ for iSeries can act as a resource manager for global units of work within a WebSphere Application Server environment, but cannot act as a transaction manager.

Local units of work

Units of work that involve only the queue manager are called local units of work. Syncpoint coordination is provided by the queue manager itself (internal coordination) using a single-phase commit process.

To start a local unit of work, the application issues MQGET, MQPUT, or MQPUT1 requests specifying the appropriate syncpoint option. The unit of work is committed using MQCMIT or rolled back using MQBACK. However, the unit of work also ends when the connection between the application and the queue manager is broken, whether intentionally or unintentionally.

If an application disconnects (MQDISC) from a queue manager while a global unit of work coordinated by WebSphere MQ is still active, an attempt is made to commit the unit of work. If, however, the application terminates without disconnecting, the unit of work is rolled back as the application is deemed to have terminated abnormally.

Global units of work

Use global units of work when you also need to include updates to resources belonging to other resource managers. Here the coordination may be internal or external to the queue manager:

Internal syncpoint coordination

Queue manager coordination of global units of work is not supported by WebSphere MQ for iSeries or WebSphere MQ for z/OS. It is not supported in a WebSphere MQ client environment.

Here, the coordination is performed by WebSphere MQ. To start a global unit of work, the application issues the MQBEGIN call.

As input to the MQBEGIN call, you must supply the connection handle (Hconn), which is returned by the MQCONN or MQCONNX call. This handle represents the connection to the WebSphere MQ queue manager.

Again, the application issues MQGET, MQPUT, or MQPUT1 requests specifying the appropriate syncpoint option. This means that MQBEGIN can be used to initiate a global unit of work that updates local resources, resources belonging to other resource managers, or both. Updates made to resources belonging to other resource managers are made using the API of that resource manager. However, it is not possible to use the MQI to update queues that belong to other queue managers. MQCMIT or MQBACK must be issued before starting further units of work (local or global).

The global unit of work is committed using MQCMIT; this initiates a two-phase commit of all the resource managers involved in the unit of work. A two-phase commit process is used whereby resource managers (for example, XA-compliant
Syncpointing, other platforms

database managers such as DB2, Oracle, and Sybase) are firstly all asked to prepare
to commit. Only if all are prepared are they asked to commit. If any resource
manager signals that it cannot commit, each is asked to back out instead.
Alternatively, MQBACK can be used to roll back the updates of all the resource
managers.

If an application disconnects (MQDISC) while a global unit of work is still active,
the unit of work is committed. If, however, the application terminates without
disconnecting, the unit of work is rolled back as the application is deemed to have
terminated abnormally.

The output from MQBEGIN is a completion code and a reason code.

When MQBEGIN is used to start a global unit of work, all the external resource
managers that have been configured with the queue manager are included.
However, the call starts a unit of work but completes with a warning if:
• There are no participating resource managers (that is, no resource managers
  have been configured with the queue manager)

or
• One or more resource managers are not available.

In these cases, the unit of work should include updates to only those resource
managers that were available when the unit of work was started.

If one of the resource managers is unable to commit its updates, all of the resource
managers are instructed to roll back their updates, and MQCMIT completes with a
warning. In unusual circumstances (typically, operator intervention), an MQCMIT
call may fail if some resource managers commit their updates but others roll them
back; the work is deemed to have completed with a ‘mixed’ outcome. Such
occurrences are diagnosed in the error log of the queue manager so remedial action
may be taken.

An MQCMIT of a global unit of work succeeds if all of the resource managers
involved commit their updates.

For a description of the MQBEGIN call, see [WebSphere MQ Application Programming
Reference].

External syncpoint coordination

This occurs when a syncpoint coordinator other than WebSphere MQ has been
selected; for example, CICS, Encina, or Tuxedo. In this situation, MQSeries for
OS/2 Warp, WebSphere MQ on UNIX systems, and WebSphere MQ for Windows
register their interest in the outcome of the unit of work with the syncpoint
coordinator so that they can commit or roll back any uncommitted get or put
operations as required. The external syncpoint coordinator determines whether
one- or two-phase commitment protocols are provided.

When an external coordinator is used MQCMIT, MQBACK, and MQBEGIN may
not be issued. Calls to these functions fail with the reason code
MQRC_ENVIRONMENT_ERROR.

The way in which an externally coordinated unit of work is started is dependent
on the programming interface provided by the syncpoint coordinator. An explicit
call may, or may not, be required. If an explicit call is required, and you issue an
MQPUT call specifying the MQPMO_SYNCPOINT option when a unit of work is not started, the completion code MQRC_SYNCPOINT_NOT_AVAILABLE is returned.

The scope of the unit of work is determined by the syncpoint coordinator. The state of the connection between the application and the queue manager affects the success or failure of MQI calls that an application issues, not the state of the unit of work. It is, for example, possible for an application to disconnect and reconnect to a queue manager during an active unit of work and perform further MQGET and MQPUT operations inside the same unit of work. This is known as a pending disconnect.

**Interfaces to external syncpoint managers**

MQSeries for OS/2 Warp, WebSphere MQ on UNIX systems, WebSphere MQ for iSeries, MQSeries for Compaq OpenVMS Alpha, and WebSphere MQ for Windows support coordination of transactions by external syncpoint managers which use the X/Open XA interface. This support is available only on server configurations. The interface is not available to client applications.

Some XA transaction managers (not CICS on Open Systems or Encina) require that each XA resource manager supplies its name. This is the string called name in the XA switch structure. The resource manager for WebSphere MQ on UNIX systems is named “MQSeries_XA_RMI”. The name on OS/400 is “MQSeries XA RMI” For further details on XA interfaces refer to XA documentation CAE Specification Distributed Transaction Processing: The XA Specification, published by The Open Group.

In an XA configuration, WebSphere MQ on UNIX systems, MQSeries for Compaq OpenVMS Alpha, MQSeries for OS/2 Warp and WebSphere MQ for Windows fulfil the role of an XA Resource Manager. An XA syncpoint coordinator can manage a set of XA Resource Managers, and synchronize the commit or backout of transactions in both Resource Managers. This is how it works for a statically-registered resource manager:

1. An application notifies the syncpoint coordinator that it wishes to start a transaction.
2. The syncpoint coordinator issues a call to any resource managers that it knows of, to notify them of the current transaction.
3. The application issues calls to update the resources managed by the resource managers associated with the current transaction.
4. The application requests that the syncpoint coordinator either commit or roll back the transaction.
5. The syncpoint coordinator issues calls to each resource manager using two-phase commit protocols to complete the transaction as requested.

The XA specification requires each Resource Manager to provide a structure called an XA Switch. This structure declares the capabilities of the Resource Manager, and the functions that are to be called by the syncpoint coordinator.

There are two versions of this structure:

**MQRMIXASwitch**
Static XA resource management

**MQRMIXASwitchDynamic**
Dynamic XA resource management
Syncpointing, other platforms

The structure is found in the following libraries:

<table>
<thead>
<tr>
<th>Library</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mqmxa.lib</td>
<td>UNIX, OS/2, and Windows XA library for Static resource management</td>
</tr>
<tr>
<td>mqmenc.lib</td>
<td>AIX, HP-UX, Solaris, and Windows Encina XA library for Dynamic resource management</td>
</tr>
<tr>
<td>libmqmxa.a</td>
<td>UNIX systems XA library (non-threaded)</td>
</tr>
<tr>
<td>libmqmxa_ra.a</td>
<td>UNIX systems XA library (threaded)</td>
</tr>
<tr>
<td>LBMQMXA service program</td>
<td>OS/400 systems XA library (non-threaded)</td>
</tr>
<tr>
<td>LBMQMXA_R service program</td>
<td>OS/400 systems XA library (threaded)</td>
</tr>
</tbody>
</table>

The method that must be used to link them to an XA syncpoint coordinator is defined by the coordinator, and you will need to consult the documentation provided by that coordinator to determine how to enable WebSphere MQ to cooperate with your XA syncpoint coordinator.

The _xa_info_ structure that is passed on any _xa_open_ call by the syncpoint coordinator should be the name of the queue manager that is to be administered. This takes the same form as the queue manager name passed to MQCONN or MQCONNX, and may be blank if the default queue manager is to be used.

### Restrictions

1. Global units of work are not allowed with a shared Hconn (as described in [“Shared (thread independent) connections with MQCONNX” on page 92](#)).
2. WebSphere MQ for iSeries does not support dynamic registration of XA resource managers.
   The only transaction manager supported is WebSphere Application Server.
3. On OS/2, all functions declared in the XA switch are declared as _System functions.
4. On Windows systems, all functions declared in the XA switch are declared as _cdecl functions.
5. Only one queue manager may be administered by an external syncpoint coordinator at a time. This is due to the fact that the coordinator has an effective connection to each queue manager, and is therefore subject to the rule that only one connection is allowed at a time.
6. All applications that are run using the syncpoint coordinator can connect only to the queue manager that is administered by the coordinator because they are already effectively connected to that queue manager. They must issue MQCONN or MQCONNX to obtain a connection handle and must issue MQDISC before they exit. Alternatively, they can use the CICS user exit 15 for CICS for OS/2 V2 and V3, and CICS for Windows NT V2, or the exit UE014015 for TXSeries for Windows NT V4 and CICS on Open Systems.

The features not implemented are:
- Association migration
- Asynchronous calls
Because CICS Transaction Server V4 is 32-bit, changes are required to the source of CICS user exits. The supplied samples have been updated to work with CICS Transaction Server V4 as shown in Table 7.

Table 7. Linking MQSeries for OS/2 Warp with CICS Version 3 applications

<table>
<thead>
<tr>
<th>User exit</th>
<th>CICS V2 source</th>
<th>CICS V2 dll</th>
<th>TS V4 source</th>
<th>TS V4 dll</th>
</tr>
</thead>
<tbody>
<tr>
<td>exit 15</td>
<td>amqzse52.c</td>
<td>faaexp15.dll</td>
<td>amqzse53.c</td>
<td>faaex315.dll</td>
</tr>
<tr>
<td>exit 17</td>
<td>amqzse72.c</td>
<td>faaexp17.dll</td>
<td>amqzse73.c</td>
<td>faaex317.dll</td>
</tr>
</tbody>
</table>

For CICS Transaction Server V4, the supplied user exits faaex315.dll and faaex317.dll should be renamed to the standard names faaexp15.dll and faaexp17.dll.

Interfaces to the OS/400 external syncpoint manager

WebSphere MQ for iSeries can use native OS/400 commitment control as an external syncpoint coordinator. Thread-independent (shared) connections are not allowed with commitment control. See the *iSeries: Backup and Recovery Guide, SC41-5304 for more information about the commitment control capabilities of OS/400.

To start the OS/400 commitment control facilities, use the STRCMCTCTL system command. To end commitment control, use the ENDCMTCTL system command.

Note: The default value of *Commitment definition scope is *ACTGRP. This must be defined as *JOB for WebSphere MQ for iSeries. For example:

```
STRCMCTCTL LCKLVL(*ALL) CMTSCOPE(*JOB)
```

WebSphere MQ for iSeries is also able to perform local units of work containing only updates to WebSphere MQ resources. The choice between local units of work and participation in global units of work coordinated by OS/400 is made in each application when the application calls MQPUT, MQPUT1, or MQGET, specifying MQPMO_SYNCPOINT or MQGMO_SYNCPOINT, or MQBEGIN. If commitment control is not active when the first such call is issued, WebSphere MQ starts a local unit of work and all further units of work for this connection to WebSphere MQ will also use local units of work, regardless of whether commitment control is subsequently started. To commit or back out a local unit of work, you use MQCMIT or MQBACK respectively in the same way as other WebSphere MQ products. The OS/400 commit and rollback calls such as the CL command COMMIT have no effect on WebSphere MQ local units of work.

If you wish to use WebSphere MQ for iSeries with native OS/400 commitment control as an external syncpoint coordinator, you must ensure that any job with commitment control is active and that you are using WebSphere MQ in a single-threaded job. If you call MQPUT, MQPUT1 or MQGET, specifying MQPMO_SYNCPOINT or MQGMO_SYNCPOINT, in a multithreaded job in which commitment control has been started, the call will fail with a reason code of MQRC_SYNCPOINT_NOT_AVAILABLE.

It is possible to use local units of work and the MQCMIT and MQBACK calls in a multithreaded job.

If you call MQPUT, MQPUT1, or MQGET, specifying MQPMO_SYNCPOINT or MQGMO_SYNCPOINT, after starting commitment control, WebSphere MQ for
Syncpoints with WebSphere MQ for iSeries

iSeries adds itself as an API commitment resource to the commitment definition. This is typically the first such call in a job. While there are any API commitment resources registered under a particular commitment definition, you cannot end commitment control for that definition.

WebSphere MQ for iSeries removes its registration as an API commitment resource when you disconnect from the queue manager, provided there are no pending MQI operations in the current unit of work.

If you disconnect from the queue manager while there are pending MQPUT, MQPUT1, or MQGET operations in the current unit of work, WebSphere MQ for iSeries remains registered as an API commitment resource so that it is notified of the next commit or rollback. When the next syncpoint is reached, WebSphere MQ for iSeries commits or rolls back the changes as required. It is possible for an application to disconnect and reconnect to a queue manager during an active unit of work and perform further MQGET and MQPUT operations inside the same unit of work (this is a pending disconnect).

If you attempt to issue an ENDCMTCTL system command for that commitment definition, message CPF8355 is issued, indicating that pending changes were active. This message also appears in the job log when the job ends. To avoid this, ensure that you commit or roll back all pending WebSphere MQ for iSeries operations, and that you disconnect from the queue manager. Thus, using COMMIT or ROLLBACK commands before ENDCMTCTL should enable end-commitment control to complete successfully.

When OS/400 commitment control is used as an external syncpoint coordinator, MQCMT, MQBACK, and MQBEGIN calls may not be issued. Calls to these functions fail with the reason code MQRC_ENVIRONMENT_ERROR.

To commit or roll back (that is, to back out) your unit of work, use one of the programming languages that supports the commitment control. For example:

- CL commands: COMMIT and ROLLBACK
- ILE C Programming Functions: _Rcommit and _Rrollback
- ILE RPG: COMMIT and ROLBK
- COBOL/400®: COMMIT and ROLLBACK

When you are using OS/400 commitment control as an external syncpoint coordinator with WebSphere MQ for iSeries, OS/400 performs a two-phase commit protocol in which WebSphere MQ participates. Because each unit of work is committed in two phases, there is the possibility that the queue manager becomes unavailable for the second phase after having voted to commit in the first phase. This can happen, for example, if the queue manager’s internal jobs are ended. In this situation, the job log performing the commit will contain message CPF835F indicating that a commit or rollback operation failed. The messages preceding this will indicate the cause of the problem, whether it occurred during a commit or rollback operation, and also the Logical Unit of Work ID (LUWID) for the failed unit of work.

If the problem was caused by the failure of the WebSphere MQ API commitment resource during the commit or rollback of a prepared unit of work, you can use the WRKMQMTRN command to complete the operation and restore the integrity of the transaction. The command requires that you know the LUWID of the unit of work to commit and back out.
Syncpoints in MQSeries for Compaq NonStop Kernel applications

When using MQSeries for Compaq NonStop Kernel, transaction management is performed under the control of the Compaq NonStop Kernel TM/MP product, rather than by MQSeries for Compaq NonStop Kernel itself.

The effects of this difference are:

- The default Syncpoint option for the MQPUT and MQGET calls is SYNCPOINT, rather than NO_SYNCPOINT.
- To use the default (SYNCPOINT) option for MQPUT, MQGET, and MQPUT1 operations, the application must have an active TM/MP Transaction that defines the unit of work to be committed. An application initiates a TM/MP transaction by calling the BEGINTRANSACTION() function. All MQPUT, MQPUT1, and MQGET operations performed by the application while this transaction is active are within the same unit of work (transaction). Any other database operations performed by the application are also within this unit of work (UOW). Note that there are system-imposed limits on the number and size of messages that can be written and deleted within a single TM/MP transaction. When the application has completed the UOW, the TM/MP transaction is ended (the UOW is committed) using the ENDTRANSACTION() function. If any error is encountered, the application can cancel the TM/MP transaction (backout the UOW) using the ABORTTRANSACTION() function. Consequently, the standard Version 2 functions MQCMIT() and MQBACK() are not supported on this product. If they are called, an error is returned.
- If an application uses the NO_SYNCPOINT option for MQPUT, MQGET, and MQPUT1 operations, WebSphere MQ starts a TM/MP transaction itself, performs the queuing operation, and commits the transaction before returning to the application. Each operation is therefore performed in its own UOW and, once complete, cannot be backout by the application using TM/MP.
- A TM/MP transaction does not need to be active for MQI calls other than MQGET, MQPUT, and MQPUT1.
- Because TM/MP can cause previously performed MQGET, MQPUT, and MQPUT1 operations to be backout without notification, the current queue-depth and input-and-output-open counts of queues can become inaccurate. The WebSphere MQ Status Server (MQSS) corrects these periodically. You can configure the time interval used. However, you should code applications to allow for errors in these quantities, especially where there could be backout transactions.
- The backout count attribute cannot be maintained in the same way as on standard Version 2 implementations. Also, the harden backout count attribute is not used.
- The MQRC_SYNCPOINT_LIMIT_REACHED reason code is used by MQSeries for Tandem NonStop Kernel V2.2.0.1 to inform an application that the system-imposed limit on the number of I/O operations within a single TM/MP transaction has been reached. If the application specified the SYNCPOINT option, it should cancel the transaction (backout the UOW) and retry with a smaller number of operations in that UOW.
- The MQRC_UOW_CANCELED reason code informs the application that the UOW (TM/MP transaction) has been canceled, either by the system itself (TM/MP imposes some system-wide resource-usage thresholds that will cause this), by user action, or by the initiator of the transaction itself.
Using MQGET wait interval and channel DISCINT and HBINT

When performing MQGET using MQGMO_NO_SYNCPOINT, a TM/MP transaction is started and ended by MQSeries only when a persistent message is available that satisfies the retrieval criteria. No consideration needs to be given by applications to the value of WaitInterval for no syncpoint operation.

For an MQGET issued with the MQGMO_SYNCPOINT or MQGMO_SYNCPOINT_IF_PERSISTENT option, the TM/MP transaction is under the control of the user application which issues the BEGINTRANSACTION. The wait interval should not exceed the TMF Autoabort timeout value and ideally should be small to avoid pinning a significant amount of the TM/MP audit trail (values under a minute should normally be used). Specifying wait unlimited on a lightly used queue or a queue that is idle overnight may cause the autoabort timeout to be exceeded and a MQRC_UOW_CANCELED (2297) to be returned to the MQGET when a message becomes available on the queue. Having a high wait interval or using unlimited can cause TMF audit trails to be pinned, eventually leading (if uncorrected) to the TM/MP subsystem disabling transactions on a system-wide basis.

Similarly the DISCINT value and HBINT value for sending channels controls the length of a TM/MP transaction. Channels are capable of cycling transactions when idle to allow long disconnect intervals, without having a detrimental affect on TM/MP audit trails.

A parameter, MQTRANSACTIONLIFE, can be used to control the refreshing of the TM/MP transaction for channel disconnect intervals and heartbeats that are zero. This is useful if a longer or shorter TM/MP transaction life is desired or to change the amount TM/MP activity the idle channel produces. A higher value will produce less, a lower setting more.

Add to each MQSeries MQS-ECxx PATHWAY server class:

```
PARAM MQTRANSACTIONLIFE <number>
```

where `<number>` is a number such as 100.

This parameter overrides the use of the 10 second default TM/MP transaction refresh interval. For example, a channel with a disconnect interval unlimited without the parameter would cause a refresh approximately every 10 seconds while it waits for a message to arrive.

General XA support

General XA is not supported on OS/400 or Compaq NonStop Kernel.

An XA switch load module is provided to enable you to link CICS with WebSphere MQ on UNIX systems. Additionally, sample source code files are provided to enable you to develop the XA switches for other transaction messages. The names of the switch load modules provided are:
### Table 8. Essential code for CICS applications — XA initialization routine

<table>
<thead>
<tr>
<th>C (source)</th>
<th>C (exec) - add one of the following to your XAD.Stanza</th>
</tr>
</thead>
<tbody>
<tr>
<td>amqzscix.c</td>
<td>amqzsc - CICS for AIX Version 2.1,</td>
</tr>
<tr>
<td></td>
<td>amqzsc - TXSeries for AIX, Version 4.2,</td>
</tr>
<tr>
<td></td>
<td>amqzsc - TXSeries for HP-UX, Version 4.2,</td>
</tr>
<tr>
<td>amqzscin.c</td>
<td>amqzsc - CICS for Siemens Nixdorf SINIX Version 2.2,</td>
</tr>
<tr>
<td></td>
<td>amqzsc - TXSeries for Sun Solaris, Version 4.2</td>
</tr>
<tr>
<td></td>
<td>mqmc4swi - TXSeries for Windows NT, Version 4.2</td>
</tr>
</tbody>
</table>

### WebSphere MQ XA support and Tuxedo

It is possible for WebSphere MQ on Windows and UNIX systems to block Tuxedo-coordinated XA applications indefinitely in xa_start. This can occur only when two or more processes coordinated by Tuxedo in a single global transaction attempt to access WebSphere MQ using the same transaction branch ID, or XID. If Tuxedo gives each process in the global transaction a different XID to use with WebSphere MQ, this cannot occur.

To avoid the problem, configure each application in Tuxedo that will access WebSphere MQ under a single global transaction ID (gtrid), within its own Tuxedo server group. Processes in the same server group use the same XID when accessing resource managers on behalf of a single gtrid, and are therefore vulnerable to blocking in xa_start in WebSphere MQ. Processes in different server groups use separate XIDs when accessing resource managers and so will not have to worry about serializing their transaction work in WebSphere MQ.
Chapter 14. Starting WebSphere MQ applications using triggers

Some WebSphere MQ applications that serve queues run continuously, so they are always available to retrieve messages that arrive on the queues. However, this may not be desirable when the number of messages arriving on the queues is unpredictable. In this case, applications could be consuming system resources even when there are no messages to retrieve.

WebSphere MQ provides a facility that enables an application to be started automatically when there are messages available to retrieve. This facility is known as triggering.

For information about triggering channels see WebSphere MQ Intercommunication.

This chapter introduces triggering, under these headings:
- “What is triggering?”
- “Prerequisites for triggering” on page 196
- “Conditions for a trigger event” on page 198
- “Controlling trigger events” on page 202
- “Designing an application that uses triggered queues” on page 204
- “Trigger monitors” on page 206
- “Properties of trigger messages” on page 209
- “When triggering does not work” on page 213

What is triggering?

The queue manager defines certain conditions as constituting trigger events. If triggering is enabled for a queue and a trigger event occurs, the queue manager sends a trigger message to a queue called an initiation queue. The presence of the trigger message on the initiation queue indicates that a trigger event has occurred.

Trigger messages generated by the queue manager are not persistent. This has the effect of reducing logging (thereby improving performance), and minimizing duplicates during restart, so improving restart time.

The program which processes the initiation queue is called a trigger-monitor application, and its function is to read the trigger message and take appropriate action, based on the information contained in the trigger message. Normally this action would be to start some other application to process the queue which caused the trigger message to be generated. From the point of view of the queue manager, there is nothing special about the trigger-monitor application—it is simply another application that reads messages from a queue (the initiation queue).

If triggering is enabled for a queue, you have the option to create a process-definition object associated with it. This object contains information about the application that processes the message which caused the trigger event. If the process definition object is created, the queue manager extracts this information and places it in the trigger message, for use by the trigger-monitor application. The name of the process definition associated with a queue is given by the ProcessName local-queue attribute. Each queue can specify a different process definition, or several queues can share the same process definition.
Triggering

For all MQSeries or WebSphere MQ Version 5 products, if you want to trigger the start of a channel, you do not need to define a process definition object. The transmission queue definition is used instead.

On MQSeries for VSE/ESA, a trigger event is defined to activate the WebSphere MQ trigger API Handler, that is, the MQ02 CICS Transaction. The trigger API handler executes a CICS LINK to the application program or a CICS START to the application transaction depending on whether you defined a program name or a transaction name in the queue definition. For more information, see MQSeries for VSE/ESA System Management Guide.

Triggering is supported by WebSphere MQ Clients running in the following environments:
- Compaq OpenVMS Alpha
- OS/2
- UNIX systems
- Windows systems

An application running in a client environment is the same as one running in a full WebSphere MQ environment, except that you link it with the client libraries. However the trigger monitor and the application to be started must both be in the same environment.

Triggering involves:

Application queue
An application queue is a local queue, which, when it has triggering set on and when the conditions are met, requires that trigger messages are written.

Process Definition
An application queue can have a process definition object associated with it that holds details of the application that will get messages from the application queue. (See WebSphere MQ Application Programming Reference for a list of attributes.)

Remember that if you want a trigger to start a channel, you do not need to define a process definition object.

Transmission queue
You need a transmission queue if you want a trigger to start a channel.

For a transmission queue on AIX, HP-UX, OS/2 Warp, OS/400, Solaris, Compaq Tru64 UNIX, z/OS, or Windows systems, the TriggerData attribute of the transmission queue can specify the name of the channel to be started. This can replace the process definition for triggering channels, but is used only when a process definition is not created.

Trigger event
A trigger event is an event that causes a trigger message to be generated by the queue manager. This is usually a message arriving on an application queue, but it can also occur at other times (see “Conditions for a trigger event” on page 198). WebSphere MQ has a range of options to allow you to control the conditions that cause a trigger event (see “Controlling trigger events” on page 202).

Trigger message
The queue manager creates a trigger message when it recognizes a trigger event (see “Conditions for a trigger event” on page 198). It copies into the
trigger message information about the application to be started. This information comes from the application queue and the process definition object associated with the application queue. Trigger messages have a fixed format (see “Format of trigger messages” on page 210).

Initiation queue
An initiation queue is a local queue on which the queue manager puts trigger messages. A queue manager can own more than one initiation queue, and each one is associated with one or more application queues. A shared queue, a local queue accessible by queue managers in a queue-sharing group, can be an initiation queue on WebSphere MQ for z/OS.

Trigger monitor
A trigger monitor is a continuously-running program that serves one or more initiation queues. When a trigger message arrives on an initiation queue, the trigger monitor retrieves the message. The trigger monitor uses the information in the trigger message. It issues a command to start the application that is to retrieve the messages arriving on the application queue, passing it information contained in the trigger message header, which includes the name of the application queue.

On all platforms, a special trigger monitor known as the channel initiator is responsible for starting channels. On z/OS, the channel initiator is usually started manually, or it can be done automatically when a queue manager starts by changing CSQINP2 in the queue manager startup JCL. On other Version 5 platforms, it is automatically started when the queue manager starts or it can be started manually with the runmqchi command.

Note: You must issue the runmqchi command to start the trigger monitor on MQSeries Version 2 products.

(For more information, see “Trigger monitors” on page 206)

To understand how triggering works, consider Figure 14 which is an example of trigger type FIRST (MQTT_FIRST).
In Figure 14, the sequence of events is:

1. Application A, which can be either local or remote to the queue manager, puts a message on the application queue. Note that no application has this queue open for input. However, this fact is relevant only to trigger type FIRST and DEPTH.

2. The queue manager checks to see if the conditions are met under which it has to generate a trigger event. They are, and a trigger event is generated. Information held within the associated process definition object is used when creating the trigger message.

3. The queue manager creates a trigger message and puts it on the initiation queue associated with this application queue, but only if an application (trigger monitor) has the initiation queue open for input.

4. The trigger monitor retrieves the trigger message from the initiation queue.

5. The trigger monitor issues a command to start application B (the server application).

6. Application B opens the application queue and retrieves the message.

Notes:

1. If the application queue is open for input, by any program, and has triggering set for FIRST or DEPTH, no trigger event will occur since the queue is already being served.
2. If the initiation queue is not open for input, the queue manager will not generate any trigger messages, it will wait until an application opens the initiation queue for input.

3. When using triggering for channels, you are recommended to use trigger type FIRST or DEPTH.

So far, the relationship between the queues within triggering has been only on a one to one basis. Consider Figure 15.

An application queue has a process definition object associated with it that holds details of the application that will process the message. The queue manager places the information in the trigger message, so only one initiation queue is necessary. The trigger monitor extracts this information from the trigger message and starts the relevant application to deal with the message on each application queue.
Remember that for all MQSeries or WebSphere MQ Version 5 products, if you want to trigger the start of a channel, you do not need to define a process definition object. The transmission queue definition can determine the channel to be triggered.

### Prerequisites for triggering

Before your application can take advantage of triggering, follow the steps below:

1. Either:
   
   a. Create an initiation queue for your application queue. For example:

   ```
   DEFINE QLOCAL (initiation.queue) REPLACE +
   LIKE (SYSTEM.DEFAULT.LOCAL.QUEUE) +
   DESCR ('initiation queue description')
   ```

   or

   b. Determine the name of a local queue that already exists and can be used by your application (usually this is SYSTEM.DEFAULT.INITIATION.QUEUE or, if you are starting channels with triggers, SYSTEM.CHANNEL.INITQ), and specify its name in the `InitiationQName` field of the application queue.

2. Associate the initiation queue with the application queue. A queue manager can own more than one initiation queue. You may want some of your application queues to be served by different programs, in which case you could use one initiation queue for each serving program, although you do not have to. Here is an example of how to create an application queue:

   ```
   DEFINE QLOCAL (application.queue) REPLACE +
   LIKE (SYSTEM.DEFAULT.LOCAL.QUEUE) +
   DESCR ('appl queue description') +
   INITQ ('initiation.queue') +
   PROCESS ('process.name') +
   TRIGGER +
   TRIGTYPE (FIRST)
   ```

   Here is an extract from a CL program for WebSphere MQ for iSeries that creates an initiation queue:

   ```
   /* Queue used by AMQSINQA */
   CRTMQMQ QNAME('SYSTEM.SAMPLE.INQ') +
   QTYPE(*LCL) REPLACE(*YES) +
   MQMNAME +
   TEXT('queue for AMQSINQA') +
   SHARE(*YES) /* Shareable */ +
   DFTMSGPST(*YES)/* Persistent messages OK */ +
   TRGENBL(*YES) /* Trigger control on */ +
   TRGTYPE(*FIRST)/* Trigger on first message*/ +
   PROCMNAME('SYSTEM.SAMPLE.INQPROCESS') +
   INITQNAME('SYSTEM.SAMPLE.TRIGGER') +
   ```

3. If you are triggering an application, create a process definition object to contain information relating to the application that is to serve your application queue. For example, to trigger-start a CICS payroll transaction called PAYR:

   ```
   DEFINE PROCESS (process.name) +
   REPLACE +
   DESCR ('process description') +
   APPLTYPE ('CICS') +
   APPLICID ('PAYR') +
   USERDATA ('Payroll data')
   ```

   Here is an extract from a CL program for WebSphere MQ for iSeries that creates a process definition object:
When the queue manager creates a trigger message, it copies information from the attributes of the process definition object into the trigger message.

### Platform To create a process definition object

<table>
<thead>
<tr>
<th>Platform</th>
<th>Use commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIX systems, Compaq OpenVMS Alpha, Windows systems</td>
<td>Use DEFINE PROCESS or use SYSTEM.DEFAULT.PROCESS and modify using ALTER PROCESS</td>
</tr>
<tr>
<td>z/OS</td>
<td>Use DEFINE PROCESS (see sample code in step 3), or use the operations and control panels.</td>
</tr>
<tr>
<td>OS/400</td>
<td>Use a CL program containing code as in step 3.</td>
</tr>
</tbody>
</table>

4. You need to create a process definition if you want to trigger a channel and you are using a Version 2 MQSeries product. Otherwise, you can create a transmission queue definition and use blanks for the *ProcessName* attribute.

The *TrigData* attribute can contain the name of the channel to be triggered or it can be left blank. Except on WebSphere MQ for z/OS, if it is left blank, the channel initiator searches the channel definition files until it finds a channel that is associated with the named transmission queue. When the queue manager creates a trigger message, it copies information from the *TrigData* attribute of the transmission queue definition into the trigger message.

5. If you have created a process definition object to specify properties of the application that is to serve your application queue, associate the process object with your application queue by naming it in the *ProcessName* attribute of the queue.

### Platform Use commands

<table>
<thead>
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<tr>
<td>UNIX systems, Compaq OpenVMS Alpha, OS/2 Windows systems</td>
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</tr>
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<td>ALTER QLOCAL</td>
</tr>
<tr>
<td>OS/400</td>
<td>CHGMQMQ</td>
</tr>
</tbody>
</table>

6. Start instances of the trigger monitors (or trigger servers in WebSphere MQ for iSeries) that are to serve the initiation queues you have defined. See “Trigger monitors” on page 206 for more information.

If you wish to be aware of any undelivered trigger messages, make sure your queue manager has a dead-letter (undelivered-message) queue defined. Specify the name of the queue in the *DeadLetterQName* queue manager field.

You can then set the trigger conditions you require, using the attributes of the queue object that defines your application queue. For more information on this, see “Controlling trigger events” on page 202.
Trigger event conditions

Conditions for a trigger event

References to shared queues in this section mean shared queues in a queue-sharing group, only available on WebSphere MQ for z/OS.

The queue manager creates a trigger message when the following conditions are satisfied:

1. A message is put on a queue.
2. The message has a priority greater than or equal to the threshold trigger priority of the queue. This priority is set in the TriggerMsgPriority local queue attribute—if it is set to zero, any message qualifies.
3. The number of messages on the queue with priority greater than or equal to TriggerMsgPriority was previously, depending on TriggerType:
   - Zero (for trigger type MQTT_FIRST)
   - Any number (for trigger type MQTT_EVERY)
   - TriggerDepth minus 1 (for trigger type MQTT_DEPTH)

Notes:

a. For non-shared local queues, the queue manager counts both committed and uncommitted messages when it assesses whether the conditions for a trigger event exist. Consequently an application may be started when there are no messages for it to retrieve because the messages on the queue have not been committed. In this situation, you are strongly recommended to consider using the wait option with a suitable WaitInterval, so that the application waits for its messages to arrive.

b. For local shared queues the queue manager counts committed messages only.

4. For triggering of type FIRST or DEPTH, no program has the application queue open for removing messages (that is, the OpenInputCount local queue attribute is zero).

Notes:

a. For shared queues, special conditions apply when multiple queue managers have trigger monitors running against a queue. In this situation, if one or more queue managers have the queue open for input shared, then the trigger criteria on the other queue managers will be treated as TriggerType MQTT_FIRST and TriggerMsgPriority zero. When all the queue managers close the queue for input, the trigger conditions revert to those specified in the queue definition.

b. For shared queues, this condition is applied on a per queue manager basis. That is, a queue manager’s OpenInputCount for a queue must be zero for a trigger message to be generated for the queue by that queue manager. However, if any queue manager in the queue-sharing group has the queue open using the MQOO_INPUT_EXCLUSIVE option, no trigger message will be generated for that queue by any of the queue managers in the queue-sharing group.

5. On WebSphere MQ for z/OS, if the application queue is one with a Usage attribute of MQUS_NORMAL, get requests for it are not inhibited (that is, the InhibitGet queue attribute is MQQA_GET_ALLOWED). Also, if the triggered application queue is one with a usage attribute of MQUS_XMITQ, get requests for it are not inhibited.

6. Either:
   - The ProcessName local queue attribute for the queue is not blank, and the process definition object identified by that attribute has been created.
or

- The ProcessName local queue attribute for the queue is all blank, but the queue is a transmission queue. As the process definition is optional, the TriggerData attribute may also contain the name of the channel to be started. In this case, the trigger message contains attributes with the following values:
  
  - QName: queue name
  - ProcessName: blanks
  - TriggerData: trigger data
  - ApplType: MQAT_UNKNOWN
  - ApplId: blanks
  - EnvData: blanks
  - UserData: blanks

  This option is not available with MQSeries Version 2 products.

7. An initiation queue has been created, and has been specified in the InitiationQName local queue attribute. Also:
   - Get requests are not inhibited for the initiation queue (that is, the InhibitGet queue attribute is MQQA_GET_ALLOWED).
   - Put requests must not be inhibited for the initiation queue (that is, the InhibitPut queue attribute must be MQQA_PUT_ALLOWED).
   - The Usage attribute of the initiation queue must be MQUS_NORMAL.
   - In environments where dynamic queues are supported, the initiation queue must not be a dynamic queue that has been marked as logically deleted.

8. A trigger monitor currently has the initiation queue open for removing messages (that is, the OpenInputCount local queue attribute is greater than zero).

9. The trigger control (TriggerControl local queue attribute) for the application queue is set to MQTC_ON. To do this, set the trigger attribute when you define your queue, or use the ALTER QLOCAL command.

10. The trigger type (TriggerType local queue attribute) is not MQTT_NONE.

If all of the above required conditions are met, and the message that caused the trigger condition is put as part of a unit of work, the trigger message does not become available for retrieval by the trigger monitor application until the unit of work completes, whether the unit of work is committed or, for trigger type MQTT_FIRST or MQTTDEPTH, backed out.

11. A suitable message is placed on the queue, for a TriggerType of MQTT_FIRST or MQTTDEPTH, and the queue:
   - Was not previously empty (MQTT_FIRST)
   - Had TriggerDepth or more messages (MQTT_DEPTH)

and conditions 7 through 10 (excluding 3) are satisfied, if in the case of MQTT_FIRST a sufficient interval (TriggerInterval queue-manager attribute) has elapsed since the last trigger message was written for this queue.

This is to allow for a queue server that ends before processing all of the messages on the queue. The purpose of the trigger interval is to reduce the number of duplicate trigger messages that are generated.
**Trigger event conditions**

**Note:** If you stop and restart the queue manager, the TriggerInterval “timer” is reset. There is a small window during which it is possible to produce two trigger messages. The window exists when the queue’s trigger attribute is set to enabled at the same time as a message arrives and the queue was not previously empty (MQTT_FIRST) or had TriggerDepth or more messages (MQTT_DEPTH).

12. The only application serving a queue issues an MQCLOSE call, for a TriggerType of MQTT_FIRST or MQTT_DEPTH, and there is at least:
   - One (MQTT_FIRST)

or
   - TriggerDepth (MQTT_DEPTH)

messages on the queue of sufficient priority (condition 2 on page 198), and conditions 4 through 10 are also satisfied.

This is to allow for a queue server that issues an MQGET call, finds the queue empty, and so ends; however, in the interval between the MQGET and the MQCLOSE calls, one or more messages arrive.

**Notes:**

a. If the program serving the application queue does not want to retrieve all the messages, this can cause a closed loop. Each time the program closes the queue, the queue manager creates another trigger message which causes the trigger monitor to start the server program again.

b. If the program serving the application queue backs out its get request (or if the program abends) before it closes the queue, the same happens.

c. To prevent such a loop occurring, you could use the BackoutCount field of MQMD to detect messages that are repeatedly backed out. For more information, see “Messages that are backed out” on page 31.

13. The following conditions are satisfied using MQSET or a command:

a. 
   - TriggerControl is changed to MQTC_ON

or
   - TriggerControl is already MQTC_ON and the value of either TriggerType, TriggerMsgPriority, or TriggerDepth (if relevant) is changed,

and there is at least:
   - One (MQTT_FIRST or MQTT_EVERY)

or

   - TriggerDepth (MQTT_DEPTH)

messages on the queue of sufficient priority (condition 2 on page 198), and conditions 4 through 10 (excluding 8) are also satisfied.

This is to allow for an application or operator changing the triggering criteria, when the conditions for a trigger to occur are already satisfied.

b. The InhibitPut queue attribute of an initiation queue changes from MQQA_PUT_INHIBITED to MQQA_PUT_ALLOWED, and there is at least:
   - One (MQTT_FIRST or MQTT_EVERY)
or
• TriggerDepth (MQTT_DEPTH)
messages of sufficient priority (condition \textsuperscript{2} on page 198) on any of the queues for which this is the initiation queue, and conditions \textsuperscript{4} through \textsuperscript{10} are also satisfied. (One trigger message is generated for each such queue satisfying the conditions.)

This is to allow for trigger messages not being generated because of the MQQA_PUT_INHIBITED condition on the initiation queue, but this condition now having been changed.

c. The InhibitGet queue attribute of an application queue changes from MQQA_GET_INHIBITED to MQQA_GET_ALLOWED, and there is at least:
• One (MQTT_FIRST or MQTT_EVERY)

or
• TriggerDepth (MQTT_DEPTH)
messages of sufficient priority (condition \textsuperscript{2} on page 198) on the queue, and conditions \textsuperscript{4} through \textsuperscript{10} excluding \textsuperscript{5} are also satisfied.

This allows applications to be triggered only when they are able to retrieve messages from the application queue.

d. A trigger-monitor application issues an MQOPEN call for input from an initiation queue, and there is at least:
• One (MQTT_FIRST or MQTT_EVERY)

or
• TriggerDepth (MQTT_DEPTH)
messages of sufficient priority (condition \textsuperscript{2} on page 198) on any of the application queues for which this is the initiation queue, and conditions \textsuperscript{4} through \textsuperscript{10} (excluding \textsuperscript{8}) are also satisfied, and no other application has the initiation queue open for input (one trigger message is generated for each such queue satisfying the conditions).

This is to allow for messages arriving on queues while the trigger monitor is not running, and for the queue manager restarting and trigger messages (which are nonpersistent) being lost.

14. MSGDLVSQ is set correctly. If you set MSGDLVSQ=FIFO, messages are delivered to the queue in a First In First Out basis. The priority of the message is ignored and the default priority of the queue is assigned to the message. If TriggerMsgPriority is set to a higher value than the default priority of the queue, no messages are triggered. If TriggerMsgPriority is set equal to or lower than the default priority of the queue, triggering occurs for type FIRST, EVERY, and DEPTH. For information about these types, see the description of the TriggerType field under \textit{“Controlling trigger events”} on page 202. If you set MSGDLVSQ=PRIORITY and the message priority is equal to or greater than the TriggerMsgPriority field, messages only count towards a trigger event. In this case, again triggering occurs for type FIRST, EVERY, and DEPTH. As an example, if you put 100 messages of lower priority than the TriggerMsgPriority, the effective queue depth for triggering purposes is still zero. If you then put another message on the queue, but this time the
Trigger event conditions

Priority is greater than or equal to the `TriggerMsgPriority`, the effective queue depth increases from zero to one and the condition for `TriggerType` FIRST is satisfied.

Notes:

1. From step 12 (where trigger messages are generated as a result of some event other than a message arriving on the application queue), the trigger message is not put as part of a unit of work. Also, if the `TriggerType` is MQTT_EVERY, and if there are one or more messages on the application queue, only one trigger message is generated.

2. If WebSphere MQ segments a message during MQPUT, a trigger event will not be processed until all of the segments have been successfully placed on the queue. However, once message segments are on the queue, WebSphere MQ treats them as individual messages for triggering purposes. For example, a single logical message split into three pieces will cause only one trigger event to be processed when it is first MQPUT and segmented. However, each of the three segments will cause their own trigger events to be processed as they are moved through the WebSphere MQ network.

Controlling trigger events

You control trigger events using some of the attributes that define your application queue. You can enable and disable triggering, and you can select the number or priority of the messages that count toward a trigger event. There is a full description of these attributes in the WebSphere MQ Application Programming Reference.

The relevant attributes are:

`TriggerControl`

Use this attribute to enable and disable triggering for an application queue.

`TriggerMsgPriority`

The minimum priority that a message must have for it to count toward a trigger event. If a message of priority less than `TriggerMsgPriority` arrives on the application queue, the queue manager ignores the message when it determines whether to create a trigger message. If `TriggerMsgPriority` is set to zero, all messages count toward a trigger event.

`TriggerType`

In addition to the trigger type NONE (which disables triggering just like setting the `TriggerControl` to OFF), you can use the following trigger types to set the sensitivity of a queue to trigger events:

**EVERY**

A trigger event occurs every time a message arrives on the application queue. Use this type of trigger if you want a serving program to process only one message, then end.

**FIRST**

A trigger event occurs only when the number of messages on the application queue changes from zero to one. Use this type of trigger if you want a serving program to start when the first message arrives on a queue, continue until there are no more messages to process, then end. Also see “Special case of trigger type FIRST” on page 204.

**DEPTH**

A trigger event occurs only when the number of messages on the application queue reaches the value of the `TriggerDepth` attribute.
A typical use of this type of triggering is for starting a program when all the replies to a set of requests are received.

**Triggering by depth**

With triggering by depth, the queue manager disables triggering (using the TriggerControl attribute) after it creates a trigger message. Your application must re-enable triggering itself (by using the MQSET call) after this has happened.

The action of disabling triggering is not under syncpoint control, so triggering cannot be re-enabled simply by backing out a unit of work. If a program backs out a put request that caused a trigger event, or if the program abends, you must re-enable triggering by using the MQSET call or the ALTER QLOCAL command.

**TriggerDepth**

The number of messages on a queue that causes a trigger event when using triggering by depth.

The conditions that must be satisfied for a queue manager to create a trigger message are described in “Conditions for a trigger event” on page 198.

**Example of the use of trigger type EVERY**

Consider an application that generates requests for motor insurance. The application might send request messages to a number of insurance companies, specifying the same reply-to queue each time. It could set a trigger of type EVERY on this reply-to queue so that each time a reply arrives, the reply could trigger an instance of the server to process the reply.

**Example of the use of trigger type FIRST**

Consider an organization with a number of branch offices that each transmit details of the day’s business to the head office. They all do this at the same time, at the end of the working day, and at the head office there is an application that processes the details from all the branch offices. The first message to arrive at the head office could cause a trigger event which starts this application. This application would continue processing until there are no more messages on its queue.

**Example of the use of trigger type DEPTH**

Consider a travel agency application that creates a single request to confirm a flight reservation, to confirm a reservation for a hotel room, to rent a car, and to order some travelers’ checks. The application could separate these items into four request messages, sending each to a separate destination. It could set a trigger of type DEPTH on its reply-to queue (with the depth set to the value 4), so that it is restarted only when all four replies have arrived.

If another message (possibly from a different request) arrives on the reply-to queue before the last of the four replies, the requesting application is triggered early. To avoid this, when DEPTH triggering is being used to collect multiple replies to a request, you should always use a new reply-to queue for each request.
Controlling trigger events

Special case of trigger type FIRST

With trigger type FIRST, if there is already a message on the application queue when another message arrives, the queue manager does not usually create another trigger message. However, the application serving the queue might not actually open the queue (for example, the application might end, possibly because of a system problem). If an incorrect application name has been put into the process definition object, the application serving the queue will not pick up any of the messages. In these situations, if another message arrives on the application queue, there is no server running to process this message (and any other messages on the queue).

To deal with this, the queue manager creates another trigger message if another message arrives on the application queue, but only if a predefined time interval has elapsed since the queue manager created the last trigger message for that queue. This time interval is defined in the queue manager attribute TriggerInterval. Its default value is 999 999 999 milliseconds.

You should consider the following points when deciding on a value for the trigger interval to be used in your application:

- If TriggerInterval is set to a low value, and there is no application serving the application queue, trigger type FIRST might behave like trigger type EVERY (this depends on the rate that messages are being put onto the application queue, which in turn may depend on other system activity). This is because, if the trigger interval is very small, another trigger message is generated each time a message is put onto the application queue, even though the trigger type is FIRST, not EVERY. (Trigger type FIRST with a trigger interval of zero is equivalent to trigger type EVERY.)

- If a unit of work is backed out (see "Trigger messages and units of work") and the trigger interval has been set to a high value (or the default value), one trigger message is generated when the unit of work is backed out. However, if you have set the trigger interval to a low value or to zero (causing trigger type FIRST to behave like trigger type EVERY) many trigger messages can be generated. If the unit of work is backed out, all the trigger messages are still made available. The number of trigger messages generated depends on the trigger interval, the maximum number being reached when trigger interval has been set to zero.

Designing an application that uses triggered queues

You have seen how to set up, and control, triggering for your applications. Here are some tips you should consider when you design your application.

Trigger messages and units of work

Trigger messages created because of trigger events that are not part of a unit of work are put on the initiation queue, outside any unit of work, with no dependence on any other messages, and are available for retrieval by the trigger monitor immediately.

Trigger messages created because of trigger events that are part of a unit of work are put on the initiation queue as part of the same unit of work. Trigger monitors cannot retrieve these trigger messages until the unit of work completes. This applies whether the unit of work is committed or backed out.
If the queue manager fails to put a trigger message on an initiation queue, it will be put on the dead-letter (undelivered-message) queue.

Notes:

1. The queue manager counts both committed and uncommitted messages when it assesses whether the conditions for a trigger event exist.

With triggering of type FIRST or DEPTH, trigger messages are made available even if the unit of work is backed out so that a trigger message is always available when the required conditions are met. For example, consider a put request within a unit of work for a queue that is triggered with trigger type FIRST. This causes the queue manager to create a trigger message. If another put request occurs, from another unit of work, this does not cause another trigger event because the number of messages on the application queue has now changed from one to two, which does not satisfy the conditions for a trigger event. Now if the first unit of work is backed out, but the second is committed, a trigger message is still created.

However, this does mean that trigger messages are sometimes created when the conditions for a trigger event are not satisfied. Applications that use triggering must always be prepared to handle this situation. It is recommended that you use the wait option with the MQGET call, setting the *WaitInterval* to a suitable value.

2. For local shared queues (that is, shared queues in a queue-sharing group) the queue manager counts committed messages only.

Getting messages from a triggered queue

When you design applications that use triggering, you must be aware that there may be a delay between a program being started by a trigger monitor, and other messages becoming available on the application queue. This can happen when the message that causes the trigger event is committed before the others.

To allow time for messages to arrive, always use the wait option when you use the MQGET call to remove messages from a queue for which trigger conditions are set. The *WaitInterval* should be sufficient to allow for the longest reasonable time between a message being put and that put call being committed. If the message is arriving from a remote queue manager, this time is affected by:

- The number of messages that are put before being committed
- The speed and availability of the communication link
- The sizes of the messages

For an example of a situation where you should use the MQGET call with the wait option, consider the same example we used when describing units of work. This was a put request within a unit of work for a queue that is triggered with trigger type FIRST. This event causes the queue manager to create a trigger message. If another put request occurs, from another unit of work, this does not cause another trigger event because the number of messages on the application queue has not changed from zero to one. Now if the first unit of work is backed out, but the second is committed, a trigger message is still created. So the trigger message is created at the time the first unit of work is backed out. If there is a significant delay before the second message is committed, the triggered application may need to wait for it.

With triggering of type DEPTH, a delay can occur even if all relevant messages are eventually committed. Suppose that the *TriggerDepth* queue attribute has the value 2. When two messages arrive on the queue, the second causes a trigger message to be created. However, if the second message is the first to be committed, it is at that
Using triggered queues

time the trigger message becomes available. The trigger monitor starts the server program, but the program can retrieve only the second message until the first one is committed. So the program may need to wait for the first message to be made available.

You should design your application so that it terminates if no messages are available for retrieval when your wait interval expires. If one or more messages arrive subsequently, you should rely on your application being retriggered to process them. This method prevents applications being idle, and unnecessarily using resources.

Trigger monitors

To a queue manager, a trigger monitor is like any other application that serves a queue. However, a trigger monitor serves initiation queues.

A trigger monitor is usually a continuously-running program. When a trigger message arrives on an initiation queue, the trigger monitor retrieves that message. It uses information in the message to issue a command to start the application that is to process the messages on the application queue.

The trigger monitor must pass sufficient information to the program it is starting so that the program can perform the right actions on the right application queue.

A channel initiator is an example of a special type of trigger monitor for message channel agents. In this situation however, you must use either trigger type FIRST or DEPTH.

Trigger monitors on z/OS

The following trigger monitor is provided for CICS Transaction Server for z/OS and CICS for MVS/ESA:

CKTI You need to start one instance of CKTI for each initiation queue (see WebSphere MQ for z/OS System Administration Guide for information on how to do this). CKTI passes the MQTM structure of the trigger message to the program it starts by EXEC CICS START TRANSID. The started program gets this information by using the EXEC CICS RETRIEVE command. A program can use the EXEC CICS RETRIEVE command with the RTRANSID option to determine how the program was started; if the value returned is CKTI, the program was started by WebSphere MQ for z/OS. For an example of how to use CKTI, see the source code supplied for module CSQ4CVB2 in the Credit Check sample application supplied with WebSphere MQ for z/OS. See “The Credit Check sample” on page 501 for a full description.

The following trigger monitor is provided for IMS/ESA:

CSQQTRMN You need to start one instance of CSQQTRMN for each initiation queue (see WebSphere MQ for z/OS System Administration Guide for information on how to do this). CSQQTRMN passes the MQTMC2 structure of the trigger message to the programs it starts.
The following trigger monitors are provided for the server environment:

**amqstrg0**

This is a sample trigger monitor that provides a subset of the function provided by `runmqtrm`. See Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405 for more information on `amqstrg0`.

**runmqtrm**

`runmqtrm [-m QMgrName] [-q InitQ]` is the command. The default is `SYSTEM.DEFAULT.INITIATION.QUEUE` on the default queue manager. It calls programs for the appropriate trigger messages. This trigger monitor supports the default application type.

The command string passed by the trigger monitor to the operating system is built as follows:

1. The `AppId` from the relevant PROCESS definition (if created)
2. The MQTMC2 structure, enclosed in quotation marks
3. The `EnvData` from the relevant PROCESS definition (if created)

where `AppId` is the name of the program to run - as it would be entered on the command line.

The parameter passed is the MQTMC2 character structure. A command string is invoked which has this string, exactly as provided, in ‘quotation marks’, in order that the system command will accept it as one parameter.

The trigger monitor will not look to see if there is another message on the initiation queue until the completion of the application it has just started. If the application has a lot of processing to do, this may mean that the trigger monitor cannot keep up with the number of trigger messages arriving. You have two options:

- Have more trigger monitors running
- Run the started applications in the background

If you choose to have more trigger monitors running you have control over the maximum number of applications that can run at any one time. If you choose to run applications in the background, there is no restriction imposed by WebSphere MQ on the number of applications that can run.

To run the started application in the background under OS/2 or Windows systems, within the `AppId` field you must prefix the name of your application with a START command. For example:

```text
START AMQSECHA /B
```

To run the started application in the background on UNIX systems, you must put an ‘&’ at the end of the `EnvData` of the PROCESS definition.

The following trigger monitors are provided for the WebSphere MQ client:

**runmqtmc**

This is the same as `runmqtrm` except that it links with the WebSphere MQ client libraries.
Trigger monitors

For CICS:
The amqltm0 trigger monitor is provided for CICS. It works in the same way as the standard trigger monitor, runmqtrm, but you run it in a different way and it triggers CICS transactions.

It is supplied as a CICS program and you must define it with a 4-character transaction name. Enter the 4-character name to start the trigger monitor. It uses the default queue manager (as named in the qm.ini file or, on WebSphere MQ for Windows, the registry), and the SYSTEM.CICS.INITIATION.QUEUE.

If you want to use a different queue manager or queue, you must build the trigger monitor the MQTMC2 structure: this requires you to write a program using the EXEC CICS START call, because the structure is too long to add as a parameter. Then, pass the MQTMC2 structure as data to the START request for the trigger monitor.

When you use the MQTMC2 structure, you only need to supply the StrucId, Version, QName, and QMgrName parameters to the trigger monitor as it does not reference any other fields.

Messages are read from the initiation queue and used to start CICS transactions, using EXEC CICS START, assuming the APPL_TYPE in the trigger message is MQAT_CICS. The reading of messages from the initiation queue is performed under CICS syncpoint control.

Messages are generated when the monitor has started and stopped as well as when an error occurs. These messages are sent to the CSMT transient data queue.

Here are the available versions of the trigger monitor:

<table>
<thead>
<tr>
<th>Version</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>amqltm0</td>
<td>CICS for OS/2 Version 2, CICS for Windows NT Version 2 TXSeries for AIX, Version 4</td>
</tr>
<tr>
<td>amqltm3</td>
<td>CICS Transaction Server for OS/2, Version 4</td>
</tr>
<tr>
<td>amqltm4</td>
<td>TXSeries for Windows NT, Version 4</td>
</tr>
</tbody>
</table>

If you need a trigger monitor for other environments, you need to write a program that can process the trigger messages that the queue manager puts on the initiation queues. Such a program should:
1. Use the MQGET call to wait for a message to arrive on the initiation queue.
2. Examine the fields of the MQTM structure of the trigger message to find the name of the application to start and the environment in which it runs.
3. Issue an environment-specific start command. For example, in z/OS batch, submit a job to the internal reader.
4. Convert the MQTM structure to the MQTMC2 structure if required.
5. Pass either the MQTMC2 or MQTM structure to the started application. This may contain user data.
6. Associate with your application queue the application that is to serve that queue. You do this by naming the process definition object (if created) in the ProcessName attribute of the queue.

Use DEFINE QLOCAL or ALTER QLOCAL. On iSeries you can also use CRTMQMQ or CHGMQMQ.
For more information on the trigger monitor interface, see *WebSphere MQ Application Programming Reference*.

**WebSphere MQ for iSeries trigger monitors**

The following are provided:

**AMQSTRG4**
This is a trigger monitor that submits an OS/400 job for the process that is to be started, but this means there is a processing overhead associated with each trigger message.

**AMQSERV4**
This is a trigger server. For each trigger message, this server runs the command for the process in its own job, and can call CICS transactions.

Both the trigger monitor and the trigger server pass an MQTMC2 structure to the programs they start. For a description of this structure, see *WebSphere MQ Application Programming Reference*. Both of these samples are delivered in both source and executable forms.

Since these trigger monitors can only invoke native OS/400 programs, they cannot trigger Java programs directly, because Java classes are located in the IFS. However, Java programs can be triggered indirectly by triggering a CL program which then invokes the Java program and passes across the TMC2 structure. The minimum size of the TMC2 structure is 732 bytes.

The source of a sample CLP is shown below:

```cl
PGM PARM(&TMC2)
DCL &TMC2 *CHAR LEN(800)
  ADDENVVAR ENVVAR(TM) VALUE(&TMC2)
  QSH CMD('java_pgmname $TM')
  RMENVVAR ENVVAR(TM)
ENDPGM
```

**Properties of trigger messages**

The following sections describe some other properties of trigger messages.

**Persistence and priority of trigger messages**

Trigger messages are not persistent as there is no requirement for them to be so. However, the conditions for generating triggering events do persist, hence trigger messages will be generated whenever these conditions are met. In the event that a trigger message is lost, the continued existence of the application message on the application queue will guarantee that the queue manager will generate a trigger message as soon as all the conditions are met.

If a unit of work is rolled back, any trigger messages it generated will always be delivered.

Trigger messages take the default priority of the initiation queue.

**Queue manager restart and trigger messages**

Following the restart of a queue manager, when an initiation queue is next opened for input, a trigger message may be put to this initiation queue if an application queue associated with it has messages on it, and is defined for triggering.
**Trigger messages and changes to object attributes**

Trigger messages are created according to the values of the trigger attributes in force at the time of the trigger event. If the trigger message is not made available to a trigger monitor until later (because the message that caused it to be generated was put within a unit of work), any changes to the trigger attributes in the meantime have no effect on the trigger message. In particular, disabling triggering does not prevent a trigger message being made available once it has been created. Also, the application queue may no longer exist at the time the trigger message is made available.

**Format of trigger messages**

The format of a trigger message is defined by the MQTM structure. This has the following fields, which the queue manager fills when it creates the trigger message, using information in the object definitions of the application queue and of the process associated with that queue:

- **StrucId**
  The structure identifier.

- **Version**
  The version of the structure.

- **QName**
  The name of the application queue on which the trigger event occurred. When the queue manager creates a trigger message, it fills this field using the `QName` attribute of the application queue.

- **ProcessName**
  The name of the process definition object that is associated with the application queue. When the queue manager creates a trigger message, it fills this field using the `ProcessName` attribute of the application queue.

- **TriggerData**
  A free-format field for use by the trigger monitor. When the queue manager creates a trigger message, it fills this field using the `TriggerData` attribute of the application queue. On any of the MQSeries or WebSphere MQ Version 5 products (except WebSphere MQ for z/OS) or on MQSeries for VSE/ESA, this field can be used to specify the name of the channel to be triggered.

- **ApplType**
  The type of the application that the trigger monitor is to start. When the queue manager creates a trigger message, it fills this field using the `ApplType` attribute of the process definition object identified in `ProcessName`.

- **ApplId**
  A character string that identifies the application that the trigger monitor is to start. When the queue manager creates a trigger message, it fills this field using the `ApplId` attribute of the process definition object identified in `ProcessName`. When you use trigger monitor CKTI or CSQQTRMN supplied by WebSphere MQ for z/OS, the `ApplId` attribute of the process definition object is a CICS or IMS transaction identifier.

- **EnvData**
  A character field containing environment-related data for use by the trigger monitor. When the queue manager creates a trigger message, it fills this field using the `EnvData` attribute of the process definition object identified in `ProcessName`. The WebSphere MQ for z/OS-supplied trigger monitors (CKTI or CSQQTRMN) do not use this field, but other trigger monitors may choose to use it.
**UserData**

A character field containing user data for use by the trigger monitor. When the queue manager creates a trigger message, it fills this field using the UserData attribute of the process definition object identified in ProcessName. This field can be used to specify the name of the channel to be triggered.

There is a full description of the trigger message structure in WebSphere MQ Application Programming Reference.

### Differences between WebSphere MQ products

**Triggering applications from MQSeries for Compaq OpenVMS Alpha**

The command file MQTRIGGER.COM is supplied with MQSeries for Compaq OpenVMS Alpha as an example of a command file designed to take the parameters supplied by the trigger monitor (RUNMQTRM) and separate the fields in the MQTMC2 structure.

The command file expects the first parameter to be the image, or command file, to invoke with selected fields from the MQTMC2 structure.

MQTRIGGER passes the following fields from the MQTMC2 structure to the invoked image or command file:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MQTMC2 Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>QName</td>
</tr>
<tr>
<td>2</td>
<td>ProcessName</td>
</tr>
<tr>
<td>3</td>
<td>TriggerData</td>
</tr>
<tr>
<td>4</td>
<td>AppIType</td>
</tr>
<tr>
<td>5</td>
<td>UserData</td>
</tr>
<tr>
<td>6</td>
<td>QMgrName</td>
</tr>
</tbody>
</table>

**Examples**

1. **To trigger the amqsech image:**
   - The ApplicId field of the trigger process definition is specified as follows:
     ```
     APPLICID('@mqs_examples:mqtrigger $mqbin:amqsech')
     ```
   - This example assumes that the MQBIN logical directory has been defined as:
     ```
     SYSSYSROOT:[SYSHLP.EXAMPLES.MQSERIES.BIN]
     ```

2. **To invoke a command file, dka200:[user]cmd.com:**
   - The ApplicId field of the trigger process definition is specified as follows:
     ```
     APPLICID('@mqs_examples:mqtrigger @dka200:[user]cmd')
     ```
Triggering applications from MQSeries for Compaq NonStop Kernel

Applications triggered by MQSeries for Compaq NonStop Kernel receive user data through environment variables set up in the TACL process that is running. This is because there is a limit to the length of the argument list that can be passed to a C process running under Compaq NonStop Kernel.

In order to access this information, triggered applications should contain code similar to the following (see the supplied sample amqsinqa for more details):

```c
MQTMC2 *trig; /* trigger message structure */
MQTMC2 trigdata; /* trigger message structure */
char *applId;
char *envData;
char *usrData;
char *qmName;

(serializer)

/* Set the program argument into the trigger message */
trig = (MQTMC2*)argv[1]; /* -> trigger message */

/* get the environment variables and load the rest of the trigger */
memcpy(&trigdata, trig, sizeof(trigdata));
memset(trigdata.ApplId, ' ', sizeof(trigdata.ApplId));
memset(trigdata.EnvData, ' ', sizeof(trigdata.EnvData));
memset(trigdata.UserData, ' ', sizeof(trigdata.UserData));
memset(trigdata.QMgrName, ' ', sizeof(trigdata.QMgrName));

if( (applId = getenv("TRIGAPPLID")) != 0)
{
  strncpy( trigdata.ApplId ,applId, strlen(applId) );
}
if( (envData = getenv("TRIGENVDATA")) != 0)
{
  strncpy( trigdata.EnvData , envData, strlen(envData) );
}
if( (usrData = getenv("TRIGUSERDATA")) != 0)
{
  strncpy( trigdata.UserData, usrData, strlen(usrData) );
}
if( (qmName = getenv("TRIGQMGRNAME")) != 0)
{
  strncpy( trigdata.QMgrName, qmName, strlen(qmName) );
}
trig = &trigdata;
```
When triggering does not work

A program is not triggered if the trigger monitor cannot start the program or the queue manager cannot deliver the trigger message. For example, the ApplId in the process object must specify that the program is to be started in the background; if this is not done, the trigger monitor cannot start the program.

If a trigger message is created but cannot be put on the initiation queue (for example, because the queue is full or the length of the trigger message is greater than the maximum message length specified for the initiation queue), the trigger message is put instead on the dead-letter (undelivered message) queue.

If the put operation to the dead-letter queue cannot complete successfully, the trigger message is discarded and a warning message is sent to the console (z/OS) or to the system operator (iSeries), or put on the error log.

Putting the trigger message on the dead-letter queue may generate a trigger message for that queue. This second trigger message is discarded if it adds a message to the dead-letter queue.

If the program is triggered successfully but abends before it gets the message from the queue, use a trace utility (for example, CICS AUXTRACE if the program is running under CICS) to find out the cause of the failure.

How CKTI detects errors

If the CKTI trigger monitor in WebSphere MQ for z/OS detects an error in the structure of a trigger message, or if it cannot start a program, it puts the trigger message on the dead-letter (undelivered message) queue. CKTI adds a dead-letter header structure (MQDLH) to the trigger message. It uses a feedback code in the Reason field of this structure to explain why it put the message on the dead-letter (undelivered message) queue.

An instance of CKTI stops serving an initiation queue if it attempts to get a trigger message from the queue and finds that the attributes of the queue have changed since it last accessed that queue. The attributes could have been changed by another program, or by an operator using the commands or operations and control panels of WebSphere MQ. CKTI produces an error message, which includes a reason code, explaining the action it has taken.

How CSQQTRMN detects errors

If the CSQQTRMN trigger monitor in WebSphere MQ for z/OS detects an error in the structure of a trigger message, or if it cannot start a program, it puts the trigger message on the dead-letter (undelivered message) queue and sends a diagnostic message to a user specified LTERM (the default is MASTER). CSQQTRMN adds a dead-letter header structure (MQDLH) to the trigger message. It uses a feedback code in the Reason field of this structure to explain why it put the message on the dead-letter (undelivered message) queue. If any other errors are detected, CSQQTRMN sends a diagnostic message to the specified LTERM, and then terminates.

How RUNMQTRM detects errors

If the RUNMQTRM trigger monitor in MQSeries for OS/2 Warp and WebSphere MQ on UNIX systems detects an error in either the:

- Structure of a trigger message
Triggering failure

- Application type is unsupported
- or it either:
- Cannot start a program
- Detects a data-conversion error

It puts the trigger message on the dead-letter (undelivered message) queue, having added a dead-letter header structure (MQDLH) to the message. It uses a feedback code in the Reason field of this structure to explain why it put the message on the dead-letter (undelivered message) queue.
Chapter 15. Using and writing API exits

Introducing API exits

Not supported in WebSphere MQ for z/OS.

API exits let you write code that changes the behavior of WebSphere MQ API calls, such as MQPUT and MQGET, and then insert that code immediately before or immediately after those calls. Once you have written an exit program and identified it to WebSphere MQ, the queue manager automatically invokes your exit code at the registered points.

This chapter tells you how to write API exits, and how to set up WebSphere MQ to enable them. This section explains how you might use them and introduces the tasks involved. This chapter also contains the following major sections:

- “Compiling API exits” on page 217
- “Reference information” on page 218

Why use API exits

There are many reasons why you might want to insert code that modifies the behavior of applications at the level of the queue manager. Each of your applications has a specific job to do, and its code should do that task as efficiently as possible. At a higher level, you might want to apply standards or business processes to a particular queue manager for all the applications that use that queue manager. It is more efficient to do this above the level of individual applications, and thus without having to change the code of each application affected.

Here are a few suggestions of areas in which API exits might be useful:

- For security, you can provide authentication, checking that applications are authorized to access a queue or queue manager. You can also police use of the API by applications by authenticating the individual API calls, or even the parameters they use.
- For flexibility, you can respond to rapid changes in your business environment without changing the applications that rely on the data in that environment. You could, for example, have API exits that respond to changes in interest rates, currency exchange rates, or the price of components in a manufacturing environment.
- For monitoring use of a queue or queue manager, you can trace the flow of applications and messages, log errors in the API calls, set up audit trails for accounting purposes, or collect usage statistics for planning purposes.

How you use API exits

This section gives a brief overview of the tasks involved in setting up API exits. Each subsection here is supported by detailed information in the chapters in the rest of this information.
How to configure WebSphere MQ for API exits

You configure WebSphere MQ to enable API exits either by changing the Windows registry, or by editing the WebSphere MQ configuration files, mqs.ini and qm.ini, and adding new stanzas that:

- Name the API exit
- Identify the module and entry point of the API exit code to run
- Optionally pass data with the exit
- Identify the sequence of each exit in relation to other exits

For detailed information on this configuration, see the WebSphere MQ System Administration Guide. For a description of how API exits run, see “What happens when an API exit runs?”

How to write an API exit

You write exits using the C programming language. To help you do so, we provide the source of a sample exit, amqsaxe0.c, that generates trace entries to a file you specify. Use this as your starting point when writing exits.

Exits are available for every API call. Within API exits, the calls take the general form:

MQ_call_EXIT (parameters, context, ApiCallParameters)

where call is the MQI call name without the “MQ” prefix; for example, PUT, GET, and so on. The parameters control the function of the exit, context describes the context in which the ApiExit was called, and ApiCallParameters represent the parameters to the MQI call.

For more information about using the sample exit we supply, see “The API exit sample program” on page 468. For reference information on the API exit calls, external control blocks, and associated topics, see “Reference information” on page 218.

What happens when an API exit runs?

The API exit routines to run are specified in stanzas in .ini files or in the Windows registry. There are three ways to specify an exit routine:

1. ApiExitCommon, in the mqs.ini file, identifies routines, for the whole of WebSphere MQ, applied when queue managers start up. These can be overridden by routines defined for individual queue managers (see item 3 in this list).

2. ApiExitTemplate, in the mqs.ini file, identifies routines, for the whole of WebSphere MQ, copied to the ApiExitLocal set (see item 3 in this list) when a new queue manager is created.

3. ApiExitLocal, in the qm.ini file, identifies routines applicable to a particular queue manager.

When a new queue manager is created, the ApiExitTemplate definitions in mqs.ini are copied to the ApiExitLocal definitions in qm.ini for the new queue manager. When a queue manager is started, both the ApiExitCommon and ApiExitLocal definitions are used. The ApiExitLocal definitions replace the ApiExitCommon definitions if both identify a routine of the same name. The Sequence attribute, described in the WebSphere MQ System Administration Guide determines the order in which the routines defined in the stanzas run.
Compiling API exits

Once you have written an exit, you need to compile and link it as follows. The following examples show commands used for the sample program described in "The API exit sample program" on page 468. For platforms other than Windows systems, you can find the sample API exit code in install-dir/samp and the compiled and linked shared library in install-dir/samp/bin. For Windows systems, you can find the sample API exit code in install-dir\Tools\c\Samples. install-dir is the directory in which WebSphere MQ was installed.

On Solaris

1. export LIB=/opt/mqm/lib:.:$LIB
2. Ensure that the environment is set to use the correct versions of the compiler software and man pages:
   export PATH=/opt/SUNWspro/bin:$PATH
   export MANPATH=/opt/SUNWspro/man:/usr/man:$MANPATH
   export LD_LIBRARY_PATH = \\
   /opt/SUNWspro/lib:/openwinhome/lib:$LD_LIBRARY_PATH
3. Compile the API exit source code:
   cc -KPIC -mt -o amqsaxe.o amqsaxe0.c \\
   -L/opt/mqm/lib -dy -G \\
   -lmqmzf -lmqm -lmqmcs -lmqmzse
4. Link the output from the compilation as a shared object:
   ld -L$LIB -dy -G -lmqmzf amqsaxe.o -o amqsaxe

On AIX

A file called amqsaxe.exp is supplied and contains the following:

#!/usr/bin/echo

EntryPoint
MQStart
1. Compile the ApiExit source code:
   cc -c amqsaxe0.c
2. Link the output from the compilation as non-threaded and threaded shared objects
   export myldflags=-bE:amqsaxe.exp -H512 -e MQStart -bM:SRE
   export mylibs=-lmqm -lmqmzf -lc
   export mylibs_r=-lmqm_r -lmqmzf_r -lpthreads_compat -lpthreads -lc_r
   ld amqsaxe0.o -o amqsaxe $myldflags $mylibs
   ld amqsaxe0.o -o amqsaxe_r $myldflags $mylibs_r

On HP-UX

1. Compile the ApiExit source code:
   export myinclude="-I/opt/mqm/inc -I. -I/usr/include -I/usr/include/sys"
   export myccflags="-D_HPUX_SOURCE +DAportable -c +e +z"
   c89 $myccflags $myinclude -o amqsaxe.o amqsaxe0.c
2. Link the output from the compilation
   export myldpath="-L -L /opt/mqm/lib"
   export myldflags="-b -z +IMQStart +eMQStart +b :"
   ld -o amqsaxe $myldflags amqsaxe0.o $myldpath-lmzmzf
   ld -o amqsaxe_r $myldflags amqsaxe0.o $myldpath -lmzmzf_r
   ld -o amqsaxe_d $myldflags amqsaxe0.o $myldpath -lmzmzf_d
Compiling API exits

On Linux

Compile and link the ApiExit source code as non-threaded and threaded shared objects:

```
gcc -o amqsaxe -L/usr/lib -lmqm -lmqmz1f -shared -I/usr/include amqsaxe0.c
gcc -o amqsaxe_r -L/usr/lib -lmqm_r -lmqmz1f_r -shared -I/use/include amqsaxe0.c
```

On Windows systems

1. Create a file named amqsaxe.lnk containing the following:
   
   amqsaxe0.obj
   amqsaxe.exp
   mqm.lib mqmz1f.lib
   msvcr1.lib oldnames.lib kernel32.lib user32

   `amqsaxe.def` is provided.

2. Compile the ApiExit source code:
   
   ```
   set myccflags=-c -W3 -Gs- -Z7 -Od -nologo -LD -D_X86_=1
   set mydefines=-DWIN32 -D_WIN32 -D_MT -D_DLL
   cl %myccflags% %mydefines% amqsaxe0.c
   ```

3. Link the output from the compilation:
   
   ```
   link -nod -nologo -debug:full -d11 @amqsaxe.lnk -out:amqsaxe.dll
   ```

On OS/400

An exit is created as follows (for a C language example):

1. Create a module using CRTCMOD. Make sure that it is compiled to use teraspace, that is including the parameter TERA(SPACE(*YES *TSIFC)).

2. Create a service program from the module using CRTSRVPGM. You must bind it to the service program QMQM/LIBMQMZF_R for multithreaded API exits.

   For information on configuring API exits, see the [WebSphere MQ System Administration Guide](#).

Reference information

This section contains reference information, mainly of interest to the programmer writing API exits. It covers:

1. “External control blocks”
2. “The exit chain area and exit chain area header (MQACH)” on page 226
3. “External constants” on page 228
4. “C language typedefs” on page 229
5. “The exit entry point registration call (MQXEP)” on page 230
6. “Invoking exit functions” on page 232

External control blocks

Here we describe the structure of the external control blocks, MQAXP and MQAXC.

**WebSphere MQ API exit parameter structure (MQAXP)**

The MQAXP structure is used as an input/output parameter to the API exit. MQAXP has the following C declaration:

```
typedef struct tagMQAXP {
  MQCHAR4  StrucId;  /* Structure identifier */
  MQLONG   Version;  /* Structure version number */
} MQAXP;
```
The parameter list described below is passed when functions in an API exit are invoked:

**StrucId (MQCHAR4) - input**
- The exit parameter structure identifier, with a value of:
  - MQAXP_STRUC_ID.

  The exit handler sets this field on entry to each exit function.

**Version (MQLONG) - input**
- The structure version number, with a value of:
  - MQAXP_VERSION_1
    - Version number for the exit parameter structure.
  - MQAXP_CURRENT_VERSION
    - Current version number for the exit parameter structure.

  The exit handler sets this field on entry to each exit function.

**ExitId (MQLONG) - input**
- The exit identifier, set on entry to the exit routine, indicating the type of exit:
  - MQXT_API_EXIT
    - API exit.

**ExitReason (MQLONG) - input**
- The reason for invoking the exit, set on entry to each exit function:
  - MQXR_CONNECTION
    - The exit is being invoked to initialize itself before an MQCONN or MQCONNX call, or to end itself after an MQDISC call.
  - MQXR_BEFORE
    - The exit is being invoked before executing an API call, or before converting data on an MQGET.
  - MQXR_AFTER
    - The exit is being invoked after executing an API call.

**ExitResponse (MQLONG) - output**
- The response from the exit, initialized on entry to each exit function to:
  - MQXCC_OK
    - Continue normally.
This field must be set by the exit function, to communicate to the queue
manager the result of executing the exit function. The value must be one of
the following:

**MQXCC_OK**

The exit function completed successfully. Continue normally.

This value can be set by all MQXR_* exit functions. ExitResponse2
is used to decide whether exit functions later in the chain should
be invoked.

**MQXCC_FAILED**

The exit function failed because of some error.

This value can be set by all MQXR_* exit functions. The queue
manager sets CompCode to MQCC_FAILED, and Reason to:

- MQRC_API_EXIT_INIT_ERROR if the function is
  MQ_INIT_EXIT
- MQRC_API_EXIT_TERM_ERROR if the function is
  MQ_TERM_EXIT
- MQRC_API_EXIT_ERROR for all other exit functions

The values set can be altered by an exit function later in the chain.

ExitResponse2 is ignored; the queue manager continues processing
as though MQXR2_SUPPRESS_CHAIN had been returned.

**MQXCC_SUPPRESS_FUNCTION**

Suppress WebSphere MQ API function.

This value can be set only by an MQXR_BEFORE exit function. It
bypasses the API call. If it is returned by the
MQ_DATA_CONV_ON_GET_EXIT, data conversion is bypassed.
The queue manager sets CompCode to MQCC_FAILED, and
Reason to MQRC_SUPPRESSED_BY_EXIT, but the values set can
be altered by an exit function later in the chain. Other parameters
for the call remain as the exit left them. ExitResponse2 is used to
decide whether exit functions later in the chain should be invoked.

If this value is set by an MQXR_AFTER or MQXR_CONNECTION
exit function, the queue manager continues processing as though
MQXCC_FAILED had been returned.

**MQXCC_SKIP_FUNCTION**

Skip WebSphere MQ API function.

This value can be set only by an MQXR_BEFORE exit function. It
bypasses the API call. If it is returned by the
MQ_DATA_CONV_ON_GET_EXIT, data conversion is bypassed.
The exit function must set CompCode and Reason to the values to
be returned to the application, but the values set can be altered by
an exit function later in the chain. Other parameters for the call
remain as the exit left them. ExitResponse2 is used to decide
whether exit functions later in the chain should be invoked.

If this value is set by an MQXR_AFTER or MQXR_CONNECTION
exit function, the queue manager continues processing as though
MQXCC_FAILED had been returned.

**MQXCC_SUPPRESS_EXIT**

Suppress all exit functions belonging to the set of exits.
This value can be set only by the MQXR_BEFORE and MQXR_AFTER exit functions. It bypasses all subsequent invocations of exit functions belonging to this set of exits for this logical connection. This bypassing continues until the logical disconnect request occurs, when MQ_TERM_EXIT function is invoked with an ExitReason of MQXR_CONNECTION.

The exit function must set CompCode and Reason to the values to be returned to the application, but the values set can be altered by an exit function later in the chain. Other parameters for the call remain as the exit left them. ExitResponse2 is ignored.

If this value is set by an MQXR_CONNECTION exit function, the queue manager continues processing as though MQXCC_FAILED had been returned.

ExitResponse2 (MQLONG) - output

This is a secondary exit response code that qualifies the primary exit response code for MQXR_BEFORE exit functions. It is initialized to:

MQXR2_DEFAULT_CONTINUATION

on entry to a WebSphere MQ API call exit function. It can then be set to one of the values:

MQXR2_DEFAULT_CONTINUATION
Whether to continue with the next exit in the chain, depending on the value of ExitResponse.

If ExitResponse is MQXCC_SUPPRESS_FUNCTION or MQXCC_SKIP_FUNCTION, bypass exit functions later in the MQXR_BEFORE chain and the matching exit functions in the MQXR_AFTER chain. Invoke exit functions in the MQXR_AFTER chain that match exit functions earlier in the MQXR_BEFORE chain.

Otherwise, invoke the next exit in the chain.

MQXR2_SUPPRESS_CHAIN
Suppress the chain.

Bypass exit functions later in the MQXR_BEFORE chain and the matching exit functions in the MQXR_AFTER chain for this API call invocation. Invoke exit functions in the MQXR_AFTER chain that match exit functions earlier in the MQXR_BEFORE chain.

MQXR2_CONTINUE_CHAIN
Continue with the next exit in the chain.

Feedback (MQLONG) - input/output

Communicate feedback codes between exit function invocations. This is initialized to:

MQFB_NONE (0)
MQAXP structure

before invocation of the first function of the first exit in a chain.

Exits can set this field to any value, including any valid MQFB_* or
MQRC_* value. Exits can also set this field to a user-defined feedback
value in the range MQFB_APPL_FIRST to MQFB_APPL_LAST.

APICallerType (MQLONG) - input
The API caller type, indicating whether the WebSphere MQ API caller is
external or internal to the queue manager: MQXACT_EXTERNAL or
MQXACT_INTERNAL.

ExitUserArea (MQBYTE16) - input/output
A user area, available to all the exits associated with a particular
ExitInfoObject. It is initialized to MQXUA_NONE (binary zeros for the
length of the ExitUserArea) before invoking the first exit function
(MQ_INIT_EXIT) for the hconn. From then on, any changes made to this
field by an exit function are preserved across invocations of functions of
the same exit.

This field is aligned to a multiple of 4 MQLONGs.

Exits can also anchor any storage that they allocate from this area.

For each hconn, each exit in a chain of exits has a different ExitUserArea.
The ExitUserArea cannot be shared by exits in a chain, and the contents of
the ExitUserArea for one exit are not available to another exit in a chain.

For C programs, the constant MQXUA_NONE_ARRAY is also defined with
the same value as MQXUA_NONE, but as an array of characters instead of
a string.

The length of this field is given by MQ_EXIT_USER_AREA_LENGTH.

ExitData (MQCHAR32) - input
Exit data, set, on input to each exit function, to the 32 characters of
exit-specific data that is provided in the exit. If you define no value in the
exit this field is all blanks.

The length of this field is given by MQ_EXIT_DATA_LENGTH.

ExitInfoName (MQCHAR48) - input
The exit information name, set, on input to each exit function, to the
ApiExit_name specified in the exit definitions in the stanzas.

ExitPDArea (MQBYTE48) - input/output
A problem determination area, initialized to MQXPDA_NONE (binary zeros for
the length of the field) for each invocation of an exit function.

For C programs, the constant MQXPDA_NONE_ARRAY is also defined with
the same value as MQXPDA_NONE, but as an array of characters
instead of a string.

The exit handler always writes this area to the WebSphere MQ trace at the
end of an exit, even when the function is successful.

The length of this field is given by MQ_EXIT_PD_AREA_LENGTH.

QMgrName (MQCHAR48) - input
The name of the local queue manager that has invoked an exit as a result
of processing a WebSphere MQ API call.

If the name of a queue manager supplied on an MQCONN or MQCONNX
calls is blank, this field is still set to the name of the local or default queue
manager.
The exit handler sets this field on entry to each exit function.

The length of this field is given by MQ_Q_MGR_NAME_LENGTH.

**ExitChainAreaPtr (PMQACH) - input/output**

This is used to communicate data across invocations of different exits in a chain. It is set to a NULL pointer before invoking the first function (MQ_INIT_EXIT with ExitReason MQXR_CONNECTION) of the first exit in a chain of exits. The value returned by the exit on one invocation is passed on to the next invocation.

Refer to “The exit chain area and exit chain area header (MQACH)” on page 226 for more details about how to use the exit chain area.

**Hconfig (MQHCONFIG) - input**

The configuration handle, representing the set of functions being initialized. This value is generated by the queue manager on the MQ_INIT_EXIT function, and is subsequently passed to the API exit function. It is set on entry to each exit function.

**Function (MQLONG) - input**

The function identifier, valid values for which are the MQXF_* constants described in “External constants” on page 228.

The exit handler sets this field to the correct value, on entry to each exit function, depending on the WebSphere MQ API call that resulted in the exit being invoked.

**How queue managers process exit functions:** The processing performed by the queue manager on return from an exit function depends on both ExitResponse and ExitResponse2. Table 9 on page 224 below summarizes the possible combinations and their effects for an MQXR_BEFORE exit function, showing:

- Who sets the CompCode and Reason parameters of the API call
- Whether the remaining exit functions in the MQXR_BEFORE chain and the matching exit functions in the MQXR_AFTER chain are invoked
- Whether the API call is invoked

For an MQXR_AFTER exit function:
- CompCode and Reason are set in the same way as MQXR_BEFORE
- ExitResponse2 is ignored (the remaining exit functions in the MQXR_AFTER chain are always invoked)
- MQXCC_SUPPRESS_FUNCTION and MQXCC_SKIP_FUNCTION are not valid

For an MQXR_CONNECTION exit function:
- CompCode and Reason are set in the same way as MQXR_BEFORE
- ExitResponse2 is ignored
- MQXCC_SUPPRESS_FUNCTION, MQXCC_SKIP_FUNCTION, MQXCC_SUPPRESS_EXIT are not valid

In all cases, where an exit or the queue manager sets CompCode and Reason, the values set can be changed by an exit invoked later, or by the API call (if the API call is invoked later).
Table 9. MQXR_Before exit processing

<table>
<thead>
<tr>
<th>Value of ExitResponse</th>
<th>CompCode and Reason set by Chain</th>
<th>Value of ExitResponse2 (default continuation) API</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQXCC_OK</td>
<td>exit</td>
<td>Y</td>
</tr>
<tr>
<td>MQXCC_SUPPRESS_EXIT</td>
<td>exit</td>
<td>Y</td>
</tr>
<tr>
<td>MQXCC_SUPPRESS_FUNCTION</td>
<td>queue manager</td>
<td>N</td>
</tr>
<tr>
<td>MQXCC_SKIP_FUNCTION</td>
<td>exit</td>
<td>N</td>
</tr>
<tr>
<td>MQXCC_FAILED</td>
<td>queue manager</td>
<td>N</td>
</tr>
</tbody>
</table>

WebSphere MQ API exit context structure (MQAXC)

The MQAXC structure is used as an input parameter to an API exit. MQAXC has the following C declaration:

```c
typedef struct tagMQAXC {
    MQCHAR4 StrucId; /* Structure identifier */
    MQLONG Version; /* Structure version number */
    MQLONG Environment; /* Environment */
    MQCHAR12 UserId; /* UserId associated with appl */
    MQBYTE40 SecurityId /* Extension to UserId running appl */
    MQCHAR264 ConnectionName; /* Connection name */
    MQLONG LongMCAUserIdLength; /* long MCA user identifier length */
    MQLONG LongRemoteUserIIdLength; /* long remote user identifier length */
    MQPTR LongMCAUserIdPtr; /* long MCA user identifier address */
    MQPTR LongRemoteUserIIdPtr; /* long remote user identifier address */
    MQCHAR28 ApplName; /* Application name */
    MQLONG ApplType; /* Application type */
    MQPID ProcessId; /* Process identifier */
    MQTID ThreadId; /* Thread identifier */
};
```

The parameters to MQAXC are:

**StrucId (MQCHAR4) - input**

The exit context structure identifier, with a value of MQAXC_STRUC_ID. For C programs, the constant MQAXC_STRUC_ID_ARRAY is also defined, with the same value as MQAXC_STRUC_ID, but as an array of characters instead of a string.

The exit handler sets this field on entry to each exit function.

**Version (MQLONG) - input**

The structure version number, with a value of:

- MQAXC_VERSION_1: Version number for the exit context structure.
- MQAXC_CURRENT_VERSION: Current version number for the exit context structure.

The exit handler sets this field on entry to each exit function.

**Environment (MQLONG) - input**

The environment from which a WebSphere MQ API call was issued that resulted in an exit function being driven. Valid values for this field are:

- MQXE_OTHER: An unrecognizable environment
MQXE_MCA
Message Channel Agent.

MQXE_MCA_SVRCONN
A Message Channel Agent acting on behalf of a client.

MQXE_COMMAND_SERVER
The Command Server.

MQXE_MQSC
The runmqsc command interpreter

The exit handler sets this field on entry to each exit function.

UserId (MQCHAR12) - input
The UserId associated with the application. In particular, in the case of client connections, this field contains the UserId of the adopted user as opposed to the UserId under which the channel code is running.

The exit handler sets this field on entry to each exit function. The length of this field is given by MQ_USER_ID_LENGTH.

SecurityId (MQBYTE40) - input
An extension to the userid running the application. Its length is given by MQ_SECURITY_ID_LENGTH.

ConnectionName (MQCHAR264) - input
The connection name field, set to the address of the client. For example, for TCP/IP, it would be the client IP address.

The length of this field is given by MQ_CONN_NAME_LENGTH.

LongMCAUserIdLength (MQLONG) - input
The length of the long MCA user identifier.

When MCA connects to the queue manager this field is set to the length of the long MCA user identifier (or zero if there is no such identifier).

LongRemoteUserIdLength (MQLONG) - input
The length of the long remote user identifier.

When MCA connects to the queue manager this field will be set to the length of the long remote user identifier. Otherwise this field will be set to zero.

LongMCAUserIdPtr (MQPTR) - input
Address of long MCA user identifier.

When MCA connects to the queue manager this field is set to the address of the long MCA user identifier (or to a null pointer if there is no such identifier).

LongRemoteUserIdPtr (MQPTR) - input
The address of the long remote user identifier.

When MCA connects to the queue manager this field is set to the address of the long remote user identifier (or to a null pointer if there is no such identifier).

ApplName (MQCHAR28) - input
The name of the application or component that issued the WebSphere MQ API call.

The rules for generating the ApplName are the same as for generating the default name for an MQPUT.
The value of this field is found by querying the operating system for the
program name. Its length is given by MQ_APPL_NAME_LENGTH.

**AppType (MQLONG) - input**
The type of application or component that issued the WebSphere MQ API
call.
The value is MQAT_DEFAULT for the platform on which the application is
compiled, or it equates to one of the defined MQAT_* values.
The exit handler sets this field on entry to each exit function.

**ProcessId (MQPID) - input**
The operating system process identifier.
Where applicable, the exit handler sets this field on entry to each exit
function.

**ThreadId (MQTID) - input**
The MQ thread identifier. This is the same identifier used in MQ trace and
FFST™ dumps, but may be different from the operating system thread
identifier.
Where applicable, the exit handler sets this field on entry to each exit
function.

---

### The exit chain area and exit chain area header (MQACH)

If required, an exit function can acquire storage for an exit chain area and set the
ExitChainAreaPtr in MQAXP to point to this storage.

Exits (either the same or different exit functions) can acquire multiple exit chain
areas and link them together. Exit chain areas must only be added or removed
from this list while called from the exit handler. This ensures there are no
serialization issues caused by different threads adding or removing areas from the
list at the same time.

An exit chain area must start with an MQACH header structure, the C declaration
for which is:

```c
typedef struct tagMQACH {
    MQCHAR4 StrucId;   /* Structure identifier */
    MQLONG Version;    /* Structure version number */
    MQLONG StrucLength; /* Length of the MQACH structure */
    MQLONG ChainAreaLength; /* Exit chain area length */
    MQCHAR48 ExitInfoName /* Exit information name */
    PMQACH NextChainAreaPtr; /* Pointer to next exit chain area */
} MQACH;
```

The fields in the exit chain area header are:

**StrucId (MQCHAR4) - input**
The exit chain area structure identifier, with an initial value, defined by
MQACH_DEFAULT, of MQACH_STRUC_ID.
For C programs, the constant MQACH_STRUC_ID_ARRAY is also defined;
this has the same value as MQACH_STRUC_ID, but as an array of
characters instead of a string.

**Version (MQLONG) - input**
The structure version number, as follows:

- **MQACH_VERSION_1**
The version number for the exit parameter structure.
Exit chain area header (MQACH)

MQACH_CURRENT_VERSION
The current version number for the exit context structure.

The initial value of this field, defined by MQACH_DEFAULT, is MQACH_CURRENT_VERSION.

Note: If you introduce a new version of this structure, the layout of the existing part does not change. Exit functions need to check that the version number is equal to or greater than the lowest version containing the fields that the exit function needs to use.

StrucLength (MQLONG) - input
The length of the MQACH structure. Exits can use this field to determine the start of the exit data, setting it to the length of the structure created by the exit.

The initial value of this field, defined by MQACH_DEFAULT, is MQACH_CURRENT_LENGTH.

ChainAreaLength (MQLONG) - input
The exit chain area length, set to the overall length of the current exit chain area, including the MQACH header.

The initial value of this field, defined by MQACH_DEFAULT, is zero.

ExitInfoName (MQCHAR48) - input
The exit information name.

When an exit creates an MQACH structure, it must initialize this field with its own ExitInfoName, so that later this MQACH structure can be found by either another instance of this exit, or by a cooperating exit.

The initial value of this field, defined by MQACH_DEFAULT, is a zero length string (""").

NextChainAreaPtr (PMQACH) - input
A pointer to the next exit chain area with an initial value, defined by MQACH_DEFAULT, of null pointer (NULL).

Exit functions must release the storage for any exit chain areas that they acquire, and manipulate the chain pointers to remove their exit chain areas from the list.

An exit chain area can be constructed as follows:

```
MQAXP.ExitChainAreaPtr

ACH 1 80 First exit's chain area

ACH 1 64 Second exit's chain area

... etc.
```
External constants

The following new external constants are available for API exits:

**MQXF_* (exit function identifiers)**

- MQXF_INIT 1 X'00000001'
- MQXF_TERM 2 X'00000002'
- MQXF_CONN 3 X'00000003'
- MQXF_CONNX 4 X'00000004'
- MQXF_DISC 5 X'00000005'
- MQXF_OPEN 6 X'00000006'
- MQXF_CLOSE 7 X'00000007'
- MQXF_PUTI 8 X'00000008'
- MQXF_PUT 9 X'00000009'
- MQXF_GET 10 X'0000000A'
- MQXF_DATA_CONV_ON_GET 11 X'0000000B'
- MQXF_INQ 12 X'0000000C'
- MQXF_SET 13 X'0000000D'
- MQXF_BEGIN 14 X'0000000E'
- MQXF_CMIT 15 X'0000000F'
- MQXF_BACK 16 X'00000010'

**MQXR_* (exit reasons)**

- MQXR_BEFORE 1 X'00000001'
- MQXR_AFTER 2 X'00000002'
- MQXR_CONNECTION 3 X'00000003'

**MQXE_* (environments)**

- MQXE_OTHER 0 X'00000000'
- MQXE_MCA 1 X'00000001'
- MQXE_MCA_SVRCONN 2 X'00000002'
- MQXE_COMMAND_SERVER 3 X'00000003'
- MQXE_MQSC 4 X'00000004'

**MQ*_* (additional constants)**

- MQAQP_VERSION_1 1
- MQAQC_VERSION_1 1
- MQACH_VERSION_1 1
- MQAQP_CURRENT_VERSION 1
- MQAQC_CURRENT_VERSION 1
- MQACH_CURRENT_VERSION 1
- MQXACT_EXTERNAL 1
- MQXACT_INTERNAL 2
- MQXT_API_EXIT 2
- MQACH_LENGTH_1 68 (32-bit platforms)
  72 (64-bit platforms)
  80 (128-bit platforms)
- MQACH_CURRENT_LENGTH 68 (32-bit platforms)
  72 (64-bit platforms)
  80 (128-bit platforms)

**MQ*_* (null constants)**

- MQXPDA_NONE X'00...00' (48 nulls)
- MQXPDA_NONE_ARRAY '"',"",...,"","

**MQXCC_* (completion codes)**

- MQXCC_FAILED -8

**MQRC_* (reason codes)**
MQRC_API_EXIT_ERROR 2374 X'00000946'

An exit function invocation has returned an invalid response code, or has failed in some way, and the queue manager cannot determine the next action to take.

Examine both the ExitResponse and ExitResponse2 fields of the MQAXP to determine the bad response code, and change the exit to return a valid response code.

MQRC_API_EXIT_INIT_ERROR 2375 X'00000947'

The queue manager encountered an error while initializing the execution environment for an API exit function.

MQRC_API_EXIT_TERM_ERROR 2376 X'00000948'

The queue manager encountered an error while closing the execution environment for an API exit function.

MQRC_EXIT_REASON_ERROR 2377 X'00000949'

The value of the ExitReason field supplied on an exit entry point registration call (MQXEP) call is in error.

Examine the value of the ExitReason field to determine and correct the bad exit reason value.

MQRC_RESERVED_VALUE_ERROR 2378 X'0000094A'

The value of the Reserved field is in error.

Examine the value of the Reserved field to determine and correct the Reserved value.

C language typedefs

Here are the C language typedefs associated with the API exits:

```c
typedef PMQLONG MQPOINTER PPMQLONG;
typedef PMQBYTE MQPOINTER PPMQBYTE;
typedef PMQHOBJ MQPOINTER PPMQHOBJ;
typedef PMQOD MQPOINTER PPMQOD;
typedef PMQMD MQPOINTER PPMQMD;
typedef PMQPMO MQPOINTER PPMQPMO;
typedef PMQGMO MQPOINTER PPMQGMO;
typedef PMQCNO MQPOINTER PPMQCNO;
typedef PMQBO MQPOINTER PPMQBO;
typedef MQAXP MQPOINTER PMQAXP;
typedef MQACH MQPOINTER PMQACH;
typedef MQAXC MQPOINTER PMQAXC;
typedef MQCHAR MQCHAR16[16];
typedef MQCHAR16 MQPOINTER PMQCHAR16;
typedef MQLONG MQPID;
typedef MQLONG MQTID;
```
The exit entry point registration call (MQXEP)

Use the MQXEP call to:

1. Register the before and after WebSphere MQ API exit invocation points at which exit functions are to be invoked
2. Specify the exit function entry points
3. Deregister the exit function entry points

You would usually code the MQXEP calls in the MQ_INIT_EXIT exit function, but you can specify them in any subsequent exit function.

If you use an MQXEP call to register an already registered exit function, the second MQXEP call completes successfully, replacing the registered exit function.

If you use an MQXEP call to register a NULL exit function, the MQXEP call will complete successfully and the exit function is deregistered.

If MQXEP calls are used to register, deregister, and reregister a given exit function during the life of a connection request, the previously registered exit function is reactivated. Any storage still allocated and associated with this exit function instance is available for use by the exit’s functions. (This storage is usually released during the invocation of the termination exit function).

The interface to MQXEP is:

MQXEP (Hconfig, ExitReason, Function, EntryPoint, Reserved, &CompCode, &Reason)

where:

Hconfig (MQHCONFIG) – input
The configuration handle, representing the API exit that includes the set of functions being initialized. This value is generated by the queue manager immediately before invoking the MQ_INIT_EXIT function, and is passed in the MQAXP to each API exit function.

ExitReason (MQLONG) – input
The reason for which the entry point is being registered, from the following:
- Connection level initialization or termination (MQXR_CONNECTION)
- Before a WebSphere MQ API call (MQXR_BEFORE)
- After a WebSphere MQ API call (MQXR_AFTER)

Function (MQLONG) – input
The function identifier, valid values for which are the MQXF_* constants (see “External constants” on page 228).

EntryPoint (PMQFUNC) - input
The address of the entry point for the exit function to be registered. The value NULL indicates either that the exit function has not been provided, or that a previous registration of the exit function is being deregistered.

Reserved (MQPTR)
This must be set to NULL and is reserved for future use.

CompCode (MQLONG) - output
The completion code, valid values for which are:
- MQCC_OK
  Successful completion.
MQCC_FAILED
Call failed.

Reason (MQLONG) - output
The reason code that qualifies the completion code.
If the completion code is MQCC_OK:

MQRC_NONE
(0, X’000’) No reason to report.

If the completion code is MQCC_FAILED:

MQRC_HCONFIG_ERROR
(2280, X’8E8’) The supplied configuration handle is invalid. Use the
configuration handle from the MQAXP.

MQRC_EXIT_REASON_ERROR
(2377, X’949’) The supplied exit function invocation reason is either
invalid or is invalid for the supplied exit function identifier.
Either use one of the valid exit function invocation reasons
(MQXR_* value), or use a valid function identifier and exit reason
combination. (See [Table 10].)

MQRC_FUNCTION_ERROR
(2281, X’8E9’) The supplied function identifier is not valid for API
exit reason. The following table shows valid combinations of
function identifiers and ExitReasons.

<table>
<thead>
<tr>
<th>Function</th>
<th>ExitReason</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQXF_INIT</td>
<td>MQXR_CONNECTION</td>
</tr>
<tr>
<td>MQXF_TERM</td>
<td></td>
</tr>
<tr>
<td>MQXF_CONN</td>
<td>MQXR_BEFORE</td>
</tr>
<tr>
<td>MQXF_CONNNX</td>
<td>MQXR_AFTER</td>
</tr>
<tr>
<td>MQXF_DISC</td>
<td></td>
</tr>
<tr>
<td>MQXF_OPEN</td>
<td></td>
</tr>
<tr>
<td>MQXF_CLOSE</td>
<td></td>
</tr>
<tr>
<td>MQXF_PUT1</td>
<td></td>
</tr>
<tr>
<td>MQXF_PUT</td>
<td></td>
</tr>
<tr>
<td>MQXF_GET</td>
<td></td>
</tr>
<tr>
<td>MQXF_INQ</td>
<td></td>
</tr>
<tr>
<td>MQXF_SET</td>
<td></td>
</tr>
<tr>
<td>MQXF_BEGIN</td>
<td></td>
</tr>
<tr>
<td>MQXF_COMMIT</td>
<td></td>
</tr>
<tr>
<td>MQXF_BACK</td>
<td></td>
</tr>
<tr>
<td>MQXF_DATA_CONV_ON_GET</td>
<td>MQXR_BEFORE</td>
</tr>
</tbody>
</table>

MQRC_RESOURCE_PROBLEM
(2102, X’836’) An attempt to register or deregister an exit function
has failed because of a resource problem.

MQRC_UNEXPECTED_ERROR
(2195, X’893’) An attempt to register or deregister an exit function
has failed unexpectedly.

MQRC_RESERVED_VALUE_ERROR
(2378, X’94A’) The reserved parameter was not null.
MQXEP registration call

MQXEP C language invocation

MQXEP (Hconfig, ExitReason, Function, EntryPoint, &CompCode, &Reason);

Declaration for parameter list:

```c
MQHCONFIG Hconfig;  /* Configuration handle */
MQLONG ExitReason;  /* Exit reason */
MQLONG Function;  /* Function identifier */
PMQFUNC EntryPoint;  /* Function entry point */
MQLONG CompCode;  /* Completion code */
MQLONG Reason;  /* Reason code qualifying completion code */
```

MQXEP C function prototype

```c
void MQXEP (MQHCONFIG Hconfig, /* Configuration handle */
        MQLONG ExitReason, /* Exit reason */
        MQLONG Function, /* Function identifier */
        PMQFUNC EntryPoint, /* Function entry point */
        PMQLONG pCompCode, /* Address of completion code */
        PMQLONG pReason); /* Address of reason code qualifying completion code */
```

Invoking exit functions

This section tells you how to invoke the exit functions available. The descriptions of the individual functions start at "The API exit functions" on page 234. This section begins with some general information to help you when using these function calls.

General rules for API exit routines

The following general rules apply when invoking API exit routines:

- In all cases, API exit functions are driven before validating API call parameters, and before any security checks (in the case of MQCONN, MQCONNX, or MQOPEN).
- The values of fields input to and output from an exit routine are:
  - On input to a before WebSphere MQ API exit function, the value of a field may be set by the application program, or by a previous exit function invocation.
  - On output from a before WebSphere MQ API exit function, the value of a field may be left unchanged, or set to some other value by the exit function.
  - On input to an after WebSphere MQ API exit function, the value of a field may be the value set by the queue manager after processing the WebSphere MQ API call, or may be set to a value by a previous exit function invocation in the chain of exit functions.
  - On output from an after WebSphere MQ API call exit function, the value of a field may be left unchanged, or set to some other value by the exit function.
- Exit functions must communicate with the queue manager by using the ExitResponse and ExitResponse2 fields.
- The CompCode and Reason code fields communicate back to the application. The queue manager and exit functions can set the CompCode and Reason code fields.
- The MQXEP call returns new reason codes to the exit functions that call MQXEP. However, exit functions may translate these new reason codes to any existing reasons codes that existing and new applications can understand.
- Each exit function prototype has similar parameters to the API function with an extra level of indirection except for the CompCode and Reason.
**Invoking exit functions**

**The execution environment:** In general, all errors from exit functions are communicated back to the exit handler using the ExitResponse and ExitResponse2 fields in MQAXP. These errors in turn are converted into MQCC_* and MQRC_* values and communicated back to the application in the CompCode and Reason fields. However, any errors encountered in the exit handler logic are communicated back to the application as MQCC_* and MQRC_* values in the CompCode and Reason fields.

If an MQ_TERM_EXIT function returns an error:
- The MQDISC call has already taken place
- There is no other opportunity to drive the *after* MQ_TERM_EXIT exit function (and thus perform exit execution environment cleanup)
- Exit execution environment cleanup is *not* performed

In other words, the exit cannot be unloaded as it may still be in use. Also, other registered exits further down in the exit chain for which the *before* exit was successful, will be driven in the reverse order.

**Setting up the exit execution environment:** While processing an explicit MQCONN or MQCONNX call, exit handling logic sets up the exit execution environment before invoking the exit initialization function (MQ_INIT_EXIT). Exit execution environment setup involves loading the exit, acquiring storage for, and initializing exit parameter structures. The exit configuration handle is also allocated at this point.

If errors occur during this phase, the MQCONN or MQCONNX call fails with CompCode MQCC_FAILED and one of the following reason codes:

**MQRC_API_EXIT_LOAD_ERROR**
An attempt to load an API exit module has failed.

**MQRC_API_EXIT_NOT_FOUND**
An API exit function could not be found in the API exit module.

**MQRC_STORAGE_NOT_AVAILABLE**
An attempt to initialize the execution environment for an API exit function failed because insufficient storage was available.

**MQRC_API_EXIT_INIT_ERROR**
An error was encountered while initializing the execution environment for an API exit function.

**Cleaning up the exit execution environment:** While processing an explicit MQDISC call, or an implicit disconnect request as a result of an application ending, exit handling logic may need to clean up the exit execution environment after invoking the exit termination function (MQ_TERM_EXIT), if registered. Cleaning up the exit execution environment involves releasing storage for exit parameter structures, possibly deleting any modules previously loaded into memory.

If errors occur during this phase, an explicit MQDISC call fails with CompCode MQCC_FAILED and the following reason code (errors will not be highlighted on implicit disconnect requests):

**MQRC_API_EXIT_TERM_ERROR**
An error was encountered while closing the execution environment for an API exit function. The exit should *not* return any failure from the MQDISC before or after the MQ_TERM* API exit function calls.
API exit functions

The API exit functions

This section describes each of the exit functions and its parameters, as follows:

- "Backout - MQ_BACK_EXIT" on page 234
- "Begin - MQ_BEGIN_EXIT" on page 235
- "Close - MQ_CLOSE_EXIT" on page 236
- "Commit - MQ_CMIT_EXIT" on page 237
- "Connect and connect extension - MQ_CONNX_EXIT" on page 238
- "Disconnect - MQ_DISC_EXIT" on page 240
- "Get - MQ_GET_EXIT" on page 241
- "Initialization - MQ_INIT_EXIT" on page 245
- "Inquire - MQ_INQ_EXIT" on page 244
- "Open - MQ_OPEN_EXIT" on page 246
- "Put - MQ_PUT_EXIT" on page 247
- "Put1 - MQ_PUT1_EXIT" on page 248
- "Set - MQ_SET_EXIT" on page 250
- "Termination - MQ_TERM_EXIT" on page 251

Backout - MQ_BACK_EXIT: MQ_BACK_EXIT provides a backout exit function to perform before and after backout processing. Use function identifier MQXF_BACK with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after backout call exit functions.

The interface to this function:

MQ_BACK_EXIT (&ExitParms, &ExitContext, &Hconn, &CompCode, &Reason)

where the parameters are:

- ExitParms (MQAXP) - input/output
  Exit parameter structure.
- ExitContext (MQAXC) - input/output
  Exit context structure.
- Hconn (MQHCONN) - input
  Connection handle.
- CompCode (MQLONG) - input/output
  Completion code, valid values for which are:
  MQCC_OK
  Successful completion.
  MQCC_WARNING
  Partial completion.
  MQCC_FAILED
  Call failed
- Reason (MQLONG) - input/output
  Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

MQRC_NONE
(0, x'000') No reason to report.
If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

**C language invocation:** The queue manager logically defines the following variables:

- MQAXP ExitParms; /* Exit parameter structure */
- MQAXC ExitContext; /* Exit context structure */
- MQHCONN Hconn; /* Connection handle */
- MQLONG CompCode; /* Completion code */
- MQLONG Reason; /* Reason code qualifying completion code */

The queue manager then logically calls the exit as follows:

MQ_BACK_EXIT (&ExitParms, &ExitContext, &Hconn, &CompCode, &Reason);

Your exit must match the following C function prototype:

```c
define void MQENTRY MQ_BACK_EXIT (  
PMQAXP pExitParms, /* Address of exit parameter structure */  
PMQAXC pExitContext, /* Address of exit context structure */  
PMQHCONN pHconn, /* Address of connection handle */  
PMQLONG pCompCode, /* Address of completion code */  
PMQLONG pReason); /* Address of reason code qualifying completion code */
```

**Begin - MQ_BEGIN_EXIT:** MQ_BEGIN_EXIT provides a begin exit function to perform before and after MQBEGIN call processing. Use function identifier MQXF_BEGIN with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQBEGIN call exit functions.

The interface to this function is:

MQ_BEGIN_EXIT (&ExitParms, &ExitContext, &Hconn, &pBeginOptions, &CompCode, &Reason)

where the parameters are:

- **ExitParms (MQAXP)** - input/output
  Exit parameter structure.
- **ExitContext (MQAXC)** - input/output
  Exit context structure.
- **Hconn (MQHCONN)** - input
  Connection handle.
- **pBeginOptions (PMQBO)** - input/output
  Pointer to begin options.
- **CompCode (MQLONG)** - input/output
  Completion code, valid values for which are:
  - MQCC_OK
  Successful completion.
  - MQCC_WARNING
  Partial completion.
  - MQCC_FAILED
  Call failed
- **Reason (MQLONG)** - input/output
  Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:
API exit functions

MQRC_NONE
(0, x'000') No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

C language invocation: The queue manager logically defines the following variables:

MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
MQHCONN Hconn; /* Connection handle */
PMQBO pBeginOptions; /* Ptr to begin options */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code qualifying completion code */

The queue manager then logically calls the exit as follows:

MQ_BEGIN_EXIT (&ExitParms, &ExitContext, &Hconn, &pBeginOptions, &CompCode, &Reason);

Your exit must match the following C function prototype:

void MQENTRY MQ_BEGIN_EXIT ( 
PMQAXP pExitParms, /* Address of exit parameter structure */
PMQAXC pExitContext, /* Address of exit context structure */
PMQHCONN pHconn, /* Address of connection handle */
PMQBO ppBeginOptions, /* Address of ptr to begin options */
PMQLONG pCompCode, /* Address of completion code */
PMQLONG pReason); /* Address of reason code qualifying completion code */

Close - MQ_CLOSE_EXIT: MQ_CLOSE_EXIT provides a close exit function to perform before and after MQCLOSE call processing. Use function identifier MQXF_CLOSE with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQCLOSE call exit functions.

The interface to this function is:

MQ_CLOSE_EXIT (&ExitParms, &ExitContext, &Hconn, &pHobj, &Options, &CompCode, &Reason)

where the parameters are:

ExitParms (MQAXP) - input/output
Exit parameter structure.

ExitContext (MQAXC) - input/output
Exit context structure.

Hconn (MQHCONN) - input
Connection handle.

pHobj (PMQHOBJ) - input
Pointer to object handle.

Options (MQLONG) - input/output
Close options.

CompCode (MQLONG) - input/output
Completion code, valid values for which are:

MQCC_OK
Successful completion.
**MQCC_FAILED**

Call failed

**Reason (MQLONG) - input/output**

Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

**MQRC_NONE**

(0, x'000') No reason to report.

If the completion code is MQCC_FAILED, the exit function can set the reason code field to any valid MQRC_* value.

**C language invocation:** The queue manager logically defines the following variables:

- MQAXP ExitParms; /* Exit parameter structure */
- MQAXC ExitContext; /* Exit context structure */
- MQHCONN Hconn; /* Connection handle */
- PMQHOBJ pHobj; /* Ptr to object handle */
- MQLONG Options; /* Close options */
- MQLONG CompCode; /* Completion code */
- MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:

MQ_CLOSE_EXIT (&ExitParms, &ExitContext, &Hconn, &pHobj, &Options, &CompCode, &Reason);

Your exit must match the following C function prototype:

```c
void MQENTRY MQ_CLOSE_EXIT ( 
  PMQAXP pExitParms, /* Address of exit parameter structure */
  PMQAXC pExitContext, /* Address of exit context structure */
  PMQHCONN pHconn, /* Address of connection handle */
  PPMQHOBJ ppHobj, /* Address of ptr to object handle */
  PMQLONG pOptions, /* Address of close options */
  PMQLONG pCompCode, /* Address of completion code */
  PMQLONG pReason); /* Address of reason code qualifying completion code */
```

**Commit - MQ_CMIT_EXIT:** MQ_CMIT_EXIT provides a commit exit function to perform before and after commit processing. Use function identifier MQXF_CMIT with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after commit call exit functions.

If a commit operation fails, and the transaction is backed out, the MQCMIT call fails with MQCC_WARNING and MQRC_BACKED_OUT. These return and reason codes are passed into any after MQCMIT exit functions to give the exit functions an indication that the unit of work has been backed out.

The interface to this function is:

MQ_CMIT_EXIT (&ExitParms, &ExitContext, &Hconn, &CompCode, &Reason)

where the parameters are:

**ExitParms (MQAXP) - input/output**

Exit parameter structure.

**ExitContext (MQAXC) - input/output**

Exit context structure.
**API exit functions**

<table>
<thead>
<tr>
<th>Hconn (MQHCONN) - input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection handle.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CompCode (MQLONG) - input/output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completion code, valid values for which are:</td>
</tr>
<tr>
<td>MQCC_OK</td>
</tr>
<tr>
<td>Successful completion.</td>
</tr>
<tr>
<td>MQCC_WARNING</td>
</tr>
<tr>
<td>Partial completion.</td>
</tr>
<tr>
<td>MQCC_FAILED</td>
</tr>
<tr>
<td>Call failed</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Reason (MQLONG) - input/output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason code qualifying the completion code.</td>
</tr>
</tbody>
</table>

If the completion code is MQCC_OK, the only valid value is:

| MQRC_NONE |
| (0, x'000') No reason to report. |

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

**C language invocation:** The queue manager logically defines the following variables:

- MQAXP ExitParms; /* Exit parameter structure */
- MQAXC ExitContext; /* Exit context structure */
- MQHCONN Hconn; /* Connection handle */
- MQLONG CompCode; /* Completion code */
- MQLONG Reason; /* Reason code qualifying completion code */

The queue manager then logically calls the exit as follows:

MQ_CMIT_EXIT (&ExitParms, &ExitContext, &Hconn, &CompCode, &Reason);

Your exit must match the following C function prototype:

void MQENTRY MQ_CMIT_EXIT ( |
PMQAXP pExitParms, /* Address of exit parameter structure */
PMQAXC pExitContext, /* Address of exit context structure */
PMQHCONN pHconn, /* Address of connection handle */
PMQLONG pCompCode, /* Address of completion code */
PMQLONG pReason); /* Address of reason code qualifying completion code */

**Connect and connect extension - MQ_CONNX_EXIT:** MQ_CONNX_EXIT provides:

- Connection exit function to perform before and after MQCONN processing
- Connection extension exit function to perform before and after MQCONNX processing

The same interface, as described below, is invoked for both MQCONN and MQCONNX call exit functions.

When the message channel agent (MCA) responds to an inbound client connection, the MCA can connect and make a number of WebSphere MQ API calls before the client state is fully known. These API calls result in the API exit functions being called with the MQAXC based on the MCA program itself (for example in the UserId and ConnectionName fields of the MQAXC).
When the MCA responds to subsequent inbound client API calls, the MQAXC structure is based on the inbound client, setting the UserId and ConnectionName fields appropriately.

The queue manager name set by the application on an MQCONN or MQCONNX call is passed to the underlying connect call. Any attempt by a before MQ_CONNX_EXIT to change the name of the queue manager has no effect.

Use function identifiers MQXF_CONN and MQXF_CONNX with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQCONN and MQCONNX call exit functions.

An MQ_CONNX_EXIT exit called for reason MQXR_BEFORE must not issue any WebSphere MQ API calls, as the correct environment has not been set up at this time.

The interface to MQCONN and MQCONNX is identical:

```
MQ_CONNX_EXIT (&ExitParms, &ExitContext, &pQMgrName, &pConnectOpts, &pHconn, &CompCode, &Reason);
```

where the parameters are:

- **ExitParms (MQAXP)** - input/output
  Exit parameter structure.

- **ExitContext (MQAXC)** - input/output
  Exit context structure.

- **pQMgrName (PMQCHAR)** - input
  Pointer to the queue manager name supplied on the MQCONNX call. The exit must not change this name on the MQCONN or MQCONNX call.

- **pConnectOpts (PMQCNO)** - input/output
  Pointer to the options that control the action of the MQCONNX call.
  See “MQCNO - Connect options” in the WebSphere MQ Application Programming Reference for details.
  For exit function MQXF_CONN, pConnectOpts points to the default connect options structure (MQCNO_DEFAULT).

- **pHconn (PMQHCONN)** - input
  Pointer to the connection handle.

- **CompCode (MQLONG)** - input/output
  Completion code, valid values for which are:
  - **MQCC_OK**
    Successful completion.
  - **MQCC_WARNING**
    Warning (partial completion)
  - **MQCC_FAILED**
    Call failed

- **Reason (MQLONG)** - input/output
  Reason code qualifying the completion code.
  If the completion code is MQCC_OK, the only valid value is:
  - **MQRC_NONE**
    (0, x’000’) No reason to report.
API exit functions

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

C language invocation: The queue manager logically defines the following variables:

MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
PMQCHAR pQMgrName; /* Ptr to Queue manager name */
PMQCNO pConnectOpts; /* Ptr to Connection options */
PMQHCONN pHconn; /* Ptr to Connection handle */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:

MQ_CONNX_EXIT (&ExitParms, &ExitContext, &pQMgrName, &pConnectOps, &pHconn, &CompCode, &Reason);

Your exit must match the following C function prototype:

```c
void MQENTRY MQ_CONNX_EXIT (PMQAXP pExitParms, /* Address of exit parameter structure */
PMQAXC pExitContext, /* Address of exit context structure */
PPMQCHAR ppQMgrName, /* Address of ptr to queue manager name */
PPMQCNO ppConnectOpts, /* Address of ptr to connection options */
PPMQHCONN ppHconn, /* Address of ptr to connection handle */
PMQLONG pCompCode, /* Address of completion code */
PMQLONG pReason); /* Address of reason code qualifying completion code */
```

Disconnect - MQ_DISC_EXIT: MQ_DISC_EXIT provides a disconnect exit function to perform before and after MQDISC exit processing. Use function identifier MQXF_DISC with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQDISC call exit functions.

The interface to this function is

MQ_DISC_EXIT (&ExitParms, &ExitContext, &pHconn, &CompCode, &Reason);

where the parameters are:

ExitParms (MQAXP) - input/output
Exit parameter structure.

ExitContext (MQAXC) - input/output
Exit context structure.

pHconn (PMQHCONN) - input
Pointer to the connection handle.

For the before MQDISC call, the value of this field is one of:
- The connection handle returned on the MQCONN or MQCONNX call
- Zero, for environments where an environment-specific adapter has connected to the queue manager
- A value set by a previous exit function invocation

For the after MQDISC call, the value of this field is zero or a value set by a previous exit function invocation.

CompCode (MQLONG) - input/output
Completion code, valid values for which are:
**API exit functions**

MQCC_OK
- Successful completion.

MQCC_WARNING
- Partial completion

MQCC_FAILED
- Call failed

**Reason (MQLONG) - input/output**
- Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

MQRC_NONE
- (0, x’000’) No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

**C language invocation:** The queue manager logically defines the following variables:

MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
PMQHCONN pHconn; /* Ptr to Connection handle */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:

MQ_DISC_EXIT (&ExitParms, &ExitContext, &pHconn, &CompCode, &Reason);

Your exit must match the following C function prototype:

```c
void MQENTRY MQ_DISC_EXIT (
    PMQAXP pExitParms, /* Address of exit parameter structure */
    PMQAXC pExitContext, /* Address of exit context structure */
    PMQHCONN ppHconn, /* Address of ptr to connection handle */
    PMQLONG pCompCode, /* Address of completion code */
    PMQLONG pReason); /* Address of reason code qualifying completion code */
```

**Get - MQ_GET_EXIT:** MQ_GET_EXIT provides a get exit function to perform before and after MQGET call processing. There are two function identifiers:

1. Use MQXF_GET with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQGET call exit functions.
2. Use MQXF_DATA_CONV_ON_GET with exit reason MQXR_BEFORE to register a before MQGET data conversion exit function. This is invoked only if the MQGMO_CONVERT option is included in the MQGET call.

The interface to this function is:

```c
MQ_GET_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &pMsgDesc,
              &pGetMsgOpts, &BufferLength, &pBuffer, &pDataLength,
              &CompCode, &Reason)
```

where the parameters are:

**ExitParms (MQAXP) - input/output**
- Exit parameter structure.

**ExitContext (MQAXC) - input/output**
- Exit context structure.
API exit functions

Hconn (MQHCONN) - input
Connection handle.

Hobj (MQHOBJ) - input/output
Object handle.

pMsgDesc (PMQMD) - input/output
Pointer to message descriptor.

pGetMsgOpts (PMQPMO) - input/output
Pointer to get message options.

BufferLength (MQLONG) - input/output
Message buffer length.

pBuffer (PMQBYTE) - input/output
Pointer to message buffer.

pDataLength (PMQLONG) - input/output
Pointer to data length field.

CompCode (MQLONG) - input/output
Completion code, valid values for which are:

MQCC_OK
Successful completion.

MQCC_WARNING
Partial completion.

MQCC_FAILED
Call failed

Reason (MQLONG) - input/output
Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

MQRC_NONE
(0, x'000') No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit
function can set the reason code field to any valid MQRC_\* value.

C language invocation:  The queue manager logically defines the following
variables:

MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
MQHCONN Hconn; /* Connection handle */
MQHOBJ Hobj; /* Object handle */
PMQMD pMsgDesc; /* Ptr to message descriptor */
PMQPMO pGetMsgOpts; /* Ptr to get message options */
MQLONG BufferLength; /* Message buffer length */
PMQBYTE pBuffer; /* Ptr to message buffer */
PMQLONG pDataLength; /* Ptr to data length field */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:
MQ_GET_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &pMsgDesc,
   &pGetMsgOpts, &BufferLength, &pBuffer, &pDataLength,
   &CompCode, &Reason)

Your exit must match the following C function prototype:
API exit functions

Initialization - MQ_INIT_EXIT: MQ_INIT_EXIT provides connection level initialization, indicated by setting ExitReason in MQAXP to MQXR_CONNECTION. During the initialization, note the following:

- The MQ_INIT_EXIT function calls MQXEP to register the WebSphere MQ API verbs and the ENTRY and EXIT points in which it is interested.
- Exits do not need to intercept all the WebSphere MQ API verbs. Exit functions are invoked only if an interest has been registered.
- Storage that is to be used by the exit can be acquired while initializing it.
- If a call to this function fails, the MQCONN or MQCONNX call that invoked it also fails with a CompCode and Reason that depend on the value of the ExitResponse field in MQAXP.
- An MQ_INIT_EXIT exit must not issue WebSphere MQ API calls, as the correct environment has not been set up at this time.
- If an MQ_INIT_EXIT fails with MQXCC_FAILED, the queue manager returns from the MQCONN or MQCONNX call that called it with MQCC_FAILED and MQRC_API_EXIT_ERROR.
- If the queue manager encounters an error while initializing the API exit function execution environment before invoking the first MQ_INIT_EXIT, the queue manager returns from the MQCONN or MQCONNX call that invoked MQ_INIT_EXIT with MQCC_FAILED and MQRC_API_EXIT_INIT_ERROR.

The interface to MQ_INIT_EXIT is:

MQ_INIT_EXIT (&ExitParms, &ExitContext, &CompCode, &Reason)

where the parameters are:

ExitParms (MQAXP) - input/output
Exit parameter structure.

ExitContext (MQAXC) - input/output
Exit context structure.

CompCode (MQLONG) - input/output
Pointer to completion code, valid values for which are:

MQCC_OK
Successful completion.

MQCC_WARNING
Partial completion.

MQCC_FAILED
Call failed

Reason (MQLONG) - input/output
Pointer to reason code qualifying the completion code.
API exit functions

If the completion code is MQCC_OK, the only valid value is:

MQRC_NONE
(0, x'000') No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

The CompCode and Reason returned to the application depend on the value of the ExitResponse field in MQAXP.

C language invocation: The queue manager logically defines the following variables:

MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:

MQ_INIT_EXIT (&ExitParms, &ExitContext, &CompCode, &Reason)

Your exit must match the following C function prototype:

void MQENTRY MQ_INIT_EXIT (PMQAXP pExitParms, /* Address of exit parameter structure */
PMQAXC pExitContext, /* Address of exit context structure */
PMQLONG pCompCode, /* Address of completion code */
PMQLONG pReason); /* Address of reason code qualifying completion code */

Inquire - MQ_INQ_EXIT: MQ_INQ_EXIT provides an inquire exit function to perform before and after MQINQ call processing. Use function identifier MQXF_INQ with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQINQ call exit functions.

The interface to this function is:

MQ_INQ_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &SelectorCount,
&pSelectors, &IntAttrCount, &pIntAttrs, &CharAttrLength,
&pCharAttrs, &CompCode, &Reason)

where the parameters are:

ExitParms (MQAXP) - input/output
Exit parameter structure.

ExitContext (MQAXC) - input/output
Exit context structure.

Hconn (MQHCONN) - input
Connection handle.

Hobj (MQHOBJ) - input
Object handle.

SelectorCount (MQLONG) - input
Count of selectors

pSelectors (PMQLONG) - input/output
Pointer to array of selector values.

IntAttrCount (MQLONG) - input
Count of integer attributes.
pIntAttrs (PMQLONG) - input/output
   Pointer to array of integer attribute values.

CharAttrLength (MQLONG) - input/output
   Character attributes array length.

pCharAttr (PMQCHAR) - input/output
   Pointer to character attributes array.

CompCode (MQLONG) - input/output
   Completion code, valid values for which are:
   MQCC_OK
       Successful completion.

   MQCC_WARNING
       Partial completion.

   MQCC_FAILED
       Call failed

Reason (MQLONG) - input/output
   Reason code qualifying the completion code.
   If the completion code is MQCC_OK, the only valid value is:
   MQRC_NONE
       (0, x'000') No reason to report.

   If the completion code is MQCC_FAILED or MQCC_WARNING, the exit
   function can set the reason code field to any valid MQRC_* value.

C language invocation: The queue manager logically defines the following
variables:

MQAPX ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
MQHCONN Hconn; /* Connection handle */
MQOBJ Hobj; /* Object handle */
MQLONG SelectorCount; /* Count of selectors */
PMQLONG pSelectors; /* Ptr to array of attribute selectors */
MQLONG IntAttrCount; /* Count of integer attributes */
PMQLONG pIntAtts; /* Ptr to array of integer attributes */
MQLONG CharAttrLength; /* Length of char attributes array */
PMQCHAR pCharAttr; /* Ptr to character attributes */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code qualifying completion code */

The queue manager then logically calls the exit as follows:

MQ_INQ_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &SelectorCount,
   &pSelectors, &IntAttrCount, &pIntAtts, &CharAttrLength,
   &pCharAttr, &CompCode, &Reason)

Your exit must match the following C function prototype:

void MQENTRY MQ_INQ_EXIT (pmqapx,
   pmqaxc,
   pmqhconn,
   pmobj,
   pselectorcount,
   pselectors,
   pintattrcount,
   pintatts,
   pcharattrlength)
API exit functions

PMQCHAR ppCharAttrs, /* Address of ptr to character attributes array */
PMQLONG pCompCode, /* Address of completion code */
PMQLONG pReason); /* Address of reason code qualifying completion code */

Open - MQ_OPEN_EXIT: MQ_OPEN_EXIT provides an open exit function to perform before and after MQOPEN call processing. Use function identifier MQXF_OPEN with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQOPEN call exit functions.

The interface to this function is
MQ_OPEN_EXIT(&ExitParms, &ExitContext, &Hconn, &pObjDesc, &Options, &pHobj, &CompCode, &Reason)

where the parameters are:

ExitParms (MQAXP) - input/output
Exit parameter structure.

ExitContext (MQAXC) - input/output
Exit context structure.

Hconn (MQHCONN) - input
Connection handle.

pObjDesc (PMQOD) - input/output
Pointer to object descriptor.

Options (MQLONG) - input/output
Open options.

pHobj (PMQHOBJ) - input
Pointer to object handle.

CompCode (MQLONG) - input/output
Completion code, valid values for which are:

MQCC_OK
Successful completion.

MQCC_WARNING
Partial completion

MQCC_FAILED
Call failed

Reason (MQLONG) - input/output
Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

MQRC_NONE
(0, x'000') No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

C language invocation: The queue manager logically defines the following variables:

MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
MQHCONN Hconn; /* Connection handle */
PMQOD pObjDesc; /* Ptr to object descriptor */
MQLONG Options; /* Open options */
The queue manager then logically calls the exit as follows:

```c
MQ_OPEN_EXIT (&ExitParms, &ExitContext, &Hconn, &pObjDesc, &Options,
               &pHobj, &CompCode, &Reason);
```

Your exit must match the following C function prototype:

```c
void MQENTRY MQ_OPEN_EXIT(
  PMQAXP  pExitParms, /* Address of exit parameter structure */
  PMQAXC  pExitContext, /* Address of exit context structure */
  PMQHCONN pHconn, /* Address of connection handle */
  PMQOD ppObjDesc, /* Address of ptr to object descriptor */
  PMQLONG pOptions, /* Address of open options */
  PMQHOBJ ppHobj, /* Address of ptr to object handle */
  PMQLONG pCompCode, /* Address of completion code */
  PMQLONG pReason); /* Address of reason code qualifying
                      completion code */
```

**Put - MQ_PUT_EXIT:** MQ_PUT_EXIT provides a put exit function to perform before and after MQPUT call processing. Use function identifier MQXF_PUT with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQPUT call exit functions.

The interface to this function is:

```c
MQ_PUT_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &pMsgDesc,
              &pPutMsgOpts, &BufferLength, &pBuffer, &CompCode, &Reason)
```

where the parameters are:

- **ExitParms (MQAXP)** - input/output
  Exit parameter structure.

- **ExitContext (MQAXC)** - input/output
  Exit context structure.

- **Hconn (MQHCONN)** - input
  Connection handle.

- **Hobj (MQHOBJ)** - input/output
  Object handle.

- **pMsgDesc (PMQMD)** - input/output
  Pointer to message descriptor.

- **pPutMsgOpts (PMQPMO)** - input/output
  Pointer to put message options.

- **BufferLength (MQLONG)** - input/output
  Message buffer length.

- **pBuffer (PMQBYTE)** - input/output
  Pointer to message buffer.

- **CompCode (MQLONG)** - input/output
  Completion code, valid values for which are:

  - **MQCC_OK**
    Successful completion.

  - **MQCC_WARNING**
    Partial completion.
**API exit functions**

### MQCC_FAILED

Call failed

### Reason (MQLONG) - input/output

Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

**MQRC_NONE**

(0, x’000’) No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

**C language invocation:** The queue manager logically defines the following variables:

- `MQAXP ExitParms; /* Exit parameter structure */`
- `MQAXC ExitContext; /* Exit context structure */`
- `MQHCONN Hconn; /* Connection handle */`
- `MQHOBJ Hobj; /* Object handle */`
- `PMQMD pMsgDesc; /* Ptr to message descriptor */`
- `PMQPMO pPutMsgOpts; /* Ptr to put message options */`
- `MQLONG BufferLength; /* Message buffer length */`
- `PMQBYTE pBuffer; /* Ptr to message data */`
- `MQLONG CompCode; /* Completion code */`
- `MQLONG Reason; /* Reason code */`

The queue manager then logically calls the exit as follows:

`MQ_PUT_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &pMsgDesc, &pPutMsgOpts, &BufferLength, &pBuffer, &CompCode, &Reason)`

Your exit must match the following C function prototype:

```c
void MQENTRY MQ_PUT_EXIT (  
    PMQAXP pExitParms, /* Address of exit parameter structure */  
    PMQAXC pExitContext, /* Address of exit context structure */  
    PMQHCONN phconn, /* Address of connection handle */  
    PMQHOBJ pHobj, /* Address of object handle */  
    PMQMD ppMsgDesc, /* Address of ptr to message descriptor */  
    PMQPMO ppPutMsgOpts, /* Address of ptr to put message options */  
    PMQBYTE ppBuffer, /* Address of ptr to message data */  
    PMQLONG pBufferLength, /* Address of message buffer length */  
    PMQLONG pCompCode, /* Address of completion code */  
    PMQLONG pReason); /* Address of reason code qualifying completion code */
```

**Put1 - MQ_PUT1_EXIT:** `MQ_PUT1_EXIT` provides a put one exit function to perform before and after MQPUT1 call processing. Use function identifier MQXF_PUT1 with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQPUT1 call exit functions.

The interface to this function is:

`MQ_PUT1_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &pMsgDesc, &pPutMsgOpts, &BufferLength, &pBuffer, &CompCode, &Reason)`

where the parameters are:

- **ExitParms (MQAXP) - input/output**
  
  Exit parameter structure.

- **ExitContext (MQAXC) - input/output**
  
  Exit context structure.
Hconn (MQHCONN) - input
  Connection handle.

pObjDesc (PMQOD) - input/output
  Pointer to object descriptor.

pMsgDesc (PMQMD) - input/output
  Pointer to message descriptor.

pPutMsgOpts (PMQPMO) - input/output
  Pointer to put message options.

BufferLength (MQLONG) - input/output
  Message buffer length.

pBuffer (PMQBYTE) - input/output
  Pointer to message buffer.

CompCode (MQLONG) - input/output
  Completion code, valid values for which are:
  MQCC_OK
    Successful completion.
  MQCC_WARNING
    Partial completion.
  MQCC_FAILED
    Call failed

Reason (MQLONG) - input/output
  Reason code qualifying the completion code.
  If the completion code is MQCC_OK, the only valid value is:
  MQRC_NONE
    (0, x'000') No reason to report.
  If the completion code is MQCC_FAILED or MQCC_WARNING, the exit
  function can set the reason code field to any valid MQRC_* value.

C language invocation: The queue manager logically defines the following
variables:
MQAXP ExitParms; /* Exit parameter structure */
MQAXC ExitContext; /* Exit context structure */
MQHCONN Hconn; /* Connection handle */
PMQOD pObjDesc; /* Ptr to object descriptor */
PMQMD pMsgDesc; /* Ptr to message descriptor */
PMQPMO pPutMsgOpts; /* Ptr to put message options */
MQLONG BufferLength; /* Message buffer length */
PMQBYTE pBuffer; /* Ptr to message data */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:
MQ_PUT1_EXIT(&ExitParms, &ExitContext, &Hconn, &pObjDesc, &pMsgDesc,
    &pPutMsgOpts, &BufferLength, &pBuffer, &CompCode, &Reason)

Your exit must match the following C function prototype:
void MQENTRY MQ_PUT1_EXIT (
    PMQAXP pExitParms, /* Address of exit parameter structure */
    PMQAXC pExitContext, /* Address of exit context structure */
    PMQHCONN phconn, /* Address of connection handle */
    PMQOD ppObjDesc, /* Address of ptr to object descriptor */
    PMQPMO ppPutMsgOpts, /* Address of ptr to put message options */
    MQLONG pBufferLength, /* Message buffer length */
    MQLONG pReason, /* Reason code */
    MQLONG pCompCode, /* Completion code */
    PMQBYTE pBuffer, /* Message data */
)
Set - MQ_SET_EXIT: MQ_SET_EXIT provides an inquire exit function to perform before and after MQSET call processing. Use function identifier MQXF_SET with exit reasons MQXR_BEFORE and MQXR_AFTER to register before and after MQSET call exit functions.

The interface to this function is:

Set - MQ_SET_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &SelectorCount, &pSelectors, &IntAttrCount, &pIntAttrs, &CharAttrLength, &pCharAttrs, &CompCode, &Reason)

where the parameters are:

ExitParms (MQAXP) - input/output
Exit parameter structure.

ExitContext (MQAXC) - input/output
Exit context structure.

Hconn (MQHCONN) - input
Connection handle.

Hobj (MQHOBJ) - input
Object handle.

SelectorCount (MQLONG) - input
Count of selectors

pSelectors (PMQLONG) - input/output
Pointer to array of selector values.

IntAttrCount (MQLONG) - input
Count of integer attributes

pIntAttrs (PMQLONG) - input/output
Pointer to array of integer attribute values.

CharAttrLength (MQLONG) - input/output
Character attributes array length.

pCharAttrs (PMQCHAR) - input/output
Pointer to character attribute values.

CompCode (MQLONG) - input/output
Completion code, valid values for which are:

MQCC_OK
Successful completion.

MQCC_WARNING
Partial completion.

MQCC_FAILED
Call failed

Reason (MQLONG) - input/output
Reason code qualifying the completion code.
If the completion code is MQCC_OK, the only valid value is:

MQRC_NONE
(0, x'000') No reason to report.

If the completion code is MQCC_FAILED or MQCC_WARNING, the exit function can set the reason code field to any valid MQRC_* value.

C language invocation: The queue manager logically defines the following variables:

- MQAXP ExitParms; /* Exit parameter structure */
- MQAXC ExitContext; /* Exit context structure */
- MQHCONN Hconn; /* Connection handle */
- MQHOBJ Hobj; /* Object handle */
- MQLONG SelectorCount; /* Count of selectors */
- PMQLONG pSelectors; /* Ptr to array of attribute selectors */
- MQLONG IntAttrCount; /* Count of integer attributes */
- PMQLONG pIntAttrs; /* Ptr to array of integer attributes */
- MQLONG CharAttrLength; /* Length of char attributes array */
- PMQCHAR pCharAttrs; /* Ptr to character attributes */
- MQLONG CompCode; /* Completion code */
- MQLONG Reason; /* Reason code qualifying completion code */

The queue manager then logically calls the exit as follows:

MQ_SET_EXIT (&ExitParms, &ExitContext, &Hconn, &Hobj, &SelectorCount, &pSelectors, &IntAttrCount, &pIntAttrs, &CharAttrLength, &pCharAttrs, &CompCode, &Reason)

Your exit must match the following C function prototype:

void MQENTRY MQ_SET_EXIT ( /*
- PMQAXP pExitParms, /* Address of exit parameter structure */
- PMQAXC pExitContext, /* Address of exit context structure */
- PMQHCONN pHconn, /* Address of connection handle */
- PMQHOBJ pHobj, /* Address of object handle */
- PMQLONG pSelectorCount, /* Address of selector count */
- PPMQLONG ppSelectors, /* Address of ptr to array of selectors */
- PMQLONG pIntAttrCount; /* Address of count of integer attributes */
- PPMQLONG ppIntAttrs, /* Address of ptr to array of integer attributes */
- PMQLONG pCharAttrLength, /* Address of character attribute length */
- PPMQCHAR ppCharAttrs, /* Address of ptr to character attributes array */
- PMQLONG pCompCode; /* Address of completion code */
- PMQLONG pReason); /* Address of reason code qualifying completion code */

Termination - MQ_TERM_EXIT: MQ_TERM_EXIT provides connection level termination, registered with a function identifier of MQXF_TERM and ExitReason MQXR_CONNECTION. If registered, MQ_TERM_EXIT is called once for every disconnect request.

As part of the termination, storage no longer required by the exit can be released, and any clean up required can be performed.

If an MQ_TERM_EXIT fails with MQXCC_FAILED, the queue manager returns from the MQDISC that called it with MQCC_FAILED and MQRC_API_EXIT_ERROR.

If the queue manager encounters an error while terminating the API exit function execution environment after invoking the last MQ_TERM_EXIT, the queue manager returns from the MQDISC call that invoked MQ_TERM_EXIT with MQCC_FAILED and MQRC_API_EXIT_TERM_ERROR.
The interface to this function is:

MQ_TERM_EXIT (&ExitParms, &ExitContext, &CompCode, &Reason)

where the parameters are:

**ExitParms (MQAXP) - input/output**
Exit parameter structure.

**ExitContext (MQAXC) - input/output**
Exit context structure.

**CompCode (MQLONG) - input/output**
Completion code, valid values for which are:

- **MQCC_OK**
  Successful completion.

- **MQCC_FAILED**
  Call failed

**Reason (MQLONG) - input/output**
Reason code qualifying the completion code.

If the completion code is MQCC_OK, the only valid value is:

- **MQRC_NONE**
  
  (0, x'000') No reason to report.

If the completion code is MQCC_FAILED, the exit function can set the
reason code field to any valid MQRC_* value.

The CompCode and Reason returned to the application depend on the
value of the ExitResponse field in MQAXP.

**C language invocation:** The queue manager logically defines the following
variables:

- MQAXP ExitParms; /* Exit parameter structure */
- MQAXC ExitContext; /* Exit context structure */
- MQLONG CompCode; /* Completion code */
- MQLONG Reason; /* Reason code */

The queue manager then logically calls the exit as follows:

MQ_TERM_EXIT (&ExitParms, &ExitContext, &CompCode, &Reason)

Your exit must match the following C function prototype:

void MQENTRY MQ_TERM_EXIT (PMQAXP pExitParms, /* Address of exit parameter structure */
PMQAXC pExitContext, /* Address of exit context structure */
PMQLONG pCompCode, /* Address of completion code */
PMQLONG pReason); /* Address of reason code qualifying completion code */

**General information on invoking exit functions**

This section provides some general guidance to help you plan your exits,
particularly related to handling errors and unexpected events.

**What happens when exits fail**

If an exit function abnormally terminates after a destructive, out of syncpoint,
MQGET call but before the message has been passed to the application, the exit
handler can recover from the failure and pass control to the application. In this
case, the message might be lost. This is similar to what happens when an
application fails immediately after receiving a message from a queue.

The MQGET call might complete with MQCC_FAILED and
MQRC_API_EXIT_ERROR.

If a before API call exit function terminates abnormally, the exit handler can recover
from the failure and pass control to the application without processing the API call.
In this event, the exit function must recover any resources that it owns.

If chained exits are in use, the after API call exits for any before API call exits that
had successfully been driven can themselves be driven. The API call might fail
with MQCC_FAILED and MQRC_API_EXIT_ERROR.

Example error handling for exit functions: The following diagram shows the
points (eN) at which errors can occur. It is only an example to show how exits
behave and should be read together with the following table. In this example, two
exit functions are invoked both before and after each API call to show the behavior
with chained exits.

<table>
<thead>
<tr>
<th>Application</th>
<th>ErrPt</th>
<th>Exit function</th>
<th>API call</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQCONN</td>
<td>Start</td>
<td></td>
<td>--------</td>
</tr>
<tr>
<td>e1</td>
<td>MQ_INIT_EXIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e2</td>
<td>before MQ_CONNX_EXIT 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e3</td>
<td>before MQ_CONNX_EXIT 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e4</td>
<td>--&gt; MQCONN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e5</td>
<td>after MQ_CONNX_EXIT 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e6</td>
<td>after MQ_CONNX_EXIT 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e7</td>
<td>&lt;--</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| MQOPEN      | --> |
| e8           | before MQ_OPEN_EXIT 1 |
| e9           | before MQ_OPEN_EXIT 2 |
| e10          | --> MQOPEN |
| e11          | after MQ_OPEN_EXIT 2 |
| e12          | after MQ_OPEN_EXIT 1 |
| <-- |

| MQPUT       | --> |
| e13          | before MQ_PUT_EXIT 1 |
| e14          | before MQ_PUT_EXIT 2 |
| e15          | --> MQPUT |
| e16          | after MQ_PUT_EXIT 2 |
| e17          | after MQ_PUT_EXIT 1 |
| <-- |
The following table lists the actions to be taken at each error point. Only a subset of the error points have been covered, as the rules shown here can apply to all others. It is the actions that specify the intended behavior in each case.

<table>
<thead>
<tr>
<th>ErrPt</th>
<th>Description</th>
<th>Actions</th>
</tr>
</thead>
</table>
| e1    | Error during exit execution environment setup. | 1. Undo environment setup as required  
2. Drive no exit functions  
3. Fail MQCONN with MQCC_FAILED, MQRC_API_EXIT_LOAD_ERROR |
| e2    | MQ_INIT_EXIT function completes with:  
- MQXCC_FAILED  
- MQXCC_* | For MQXCC_FAILED:  
1. Clean up environment  
2. Fail MQCONN with MQCC_FAILED, MQRC_API_EXIT_INIT_ERROR  
3. For MQXCC_*  
1. Act as for the values of MQXCC_* and MQXR2_*  
2. Drive MQ_TERM_EXIT function if required |
| e3    | Before MQ_CONNX_EXIT 1 function completes with:  
- MQXCC_FAILED  
- MQXCC_* | For MQXCC_FAILED:  
1. Drive MQ_TERM_EXIT function  
2. Clean up environment  
3. Fail MQCONN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
4. For MQXCC_*  
1. Act as for the values of MQXCC_* and MQXR2_*  
2. Drive MQ_TERM_EXIT function if required  
3. Clean up environment if required |
<table>
<thead>
<tr>
<th>ErrPt</th>
<th>Description</th>
<th>Actions</th>
</tr>
</thead>
</table>
| e4    | Before MQ_CONNX_EXIT 2 function completes with:  
      • MQXCC_FAILED  
      • MQXCC_* | For MQXCC_FAILED:  
      1. Drive after MQ_CONNX_EXIT 1 function  
      2. Drive MQ_TERM_EXIT function  
      3. Clean up environment  
      4. Fail MQCONN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
      • For MQXCC_*:  
      1. Act as for the values of MQXCC_* and MQXR2_*\(^1\)  
      2. Drive after MQ_CONNX_EXIT 1 function if exit not suppressed  
      3. Drive MQ_TERM_EXIT function if required  
      4. Clean up environment if required |
| e5    | MQCONN call fails. | 1. Pass MQCONN CompCode and Reason  
      2. Drive after MQ_CONNX_EXIT 2 function if the before MQ_CONNX_EXIT 2 succeeded and the exit is not suppressed  
      3. Drive after MQ_CONNX_EXIT 1 function if the before MQ_CONNX_EXIT 1 succeeded and the exit is not suppressed  
      4. Drive MQ_TERM_EXIT function  
      5. Clean up environment |
| e6    | After MQ_CONNX_EXIT 2 function completes with:  
      • MQXCC_FAILED  
      • MQXCC_* | For MQXCC_FAILED:  
      1. Drive after MQ_CONNX_EXIT 1 function  
      2. Complete MQCONN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
      • For MQXCC_*:  
      1. Act as for the values of MQXCC_* and MQXR2_*\(^1\)  
      2. Drive after MQ_CONNX_EXIT 1 function if required |
| e7    | After MQ_CONNX_EXIT 1 function completes with:  
      • MQXCC_FAILED  
      • MQXCC_* | For MQXCC_FAILED, complete MQCONN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
      • For MQXCC_*: act as for the values of MQXCC_* and MQXR2_*\(^1\) |
| e8    | Before MQ_OPEN_EXIT 1 function completes with:  
      • MQXCC_FAILED  
      • MQXCC_* | For MQXCC_FAILED, complete MQOPEN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
      • For MQXCC_*: act as for the values of MQXCC_* and MQXR2_*\(^1\) |
| e9    | Before MQ_OPEN_EXIT 2 function completes with:  
      • MQXCC_FAILED  
      • MQXCC_* | For MQXCC_FAILED:  
      1. Drive after MQ_OPEN_EXIT 1 function  
      2. Complete MQOPEN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
      • For MQXCC_*: act as for the values of MQXCC_* and MQXR2_*\(^1\) |
### Table 11. API exit errors and appropriate actions to take (continued)

<table>
<thead>
<tr>
<th>ErrPt</th>
<th>Description</th>
<th>Actions</th>
</tr>
</thead>
</table>
| e10   | MQOPEN call fails | 1. Pass MQOPEN CompCode and Reason  
2. Drive after MQ_OPEN_EXIT 2 function if exit not suppressed  
3. Drive after MQ_OPEN_EXIT 1 function if exit not suppressed and if chained exits not suppressed |
| e11   | After MQ_OPEN_EXIT 2 function completes with:  
• MQXCC_FAILED  
• MQXCC_* | • For MQXCC_FAILED:  
1. Drive after MQ_OPEN_EXIT 1 function  
2. Complete MQOPEN call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
• For MQXCC_*  
1. Act as for the values of MQXCC_* and MQXR2_*  
2. Drive after MQ_OPEN_EXIT 1 function if exit not suppressed |
| e25   | After MQ_DISC_EXIT 2 function completes with:  
• MQXCC_FAILED  
• MQXCC_* | • For MQXCC_FAILED:  
1. Drive after MQ_DISC_EXIT 1 function  
2. Drive MQ_TERM_EXIT function  
3. Clean up exit execution environment  
4. Complete MQDISC call with MQCC_FAILED, MQRC_API_EXIT_ERROR  
• For MQXCC_*  
1. Act as for the values of MQXCC_* and MQXR2_*  
2. Drive MQ_TERM_EXIT function  
3. Clean up exit execution environment |

**Notes:**
1. The values of MQXCC_* and MQXR2_* and their corresponding actions are defined in "How queue managers process exit functions" on page 223.

**What if the ExitResponse fields are incorrectly set**

If the ExitResponse field is set to a value other than one of the supported values, the following actions apply:

- For a **before** MQCONN or MQDISC API exit function:
  - The ExitResponse2 value is ignored.
  - No further **before** exit functions in the exit chain (if any) are invoked; the API call itself is not issued.
  - For any **before** exits that were successfully called, the **after** exits are called in reverse order.
  - If registered, the termination exit functions for those **before** MQCONN or MQDISC exit functions in the chain that were successfully invoked are driven to clean up after these exit functions.
  - The MQCONN or MQDISC call fails with MQRC_API_EXIT_ERROR.
- For a **before** WebSphere MQ API exit function other than MQCONN or MQDISC:
  - The ExitResponse2 value is ignored.
– No further before or after data conversion functions in the exit chain (if any) are invoked.
– For any before exits that were successfully called, the after exits are called in reverse order.
– The WebSphere MQ API call itself is not issued.
– The WebSphere MQ API call fails with MQRC_API_EXIT_ERROR.

• For an after MQCONN or MQDISC API exit function:
  – The ExitResponse2 value is ignored.
  – The remaining exit functions which were successfully called before the API call are called in reverse order.
  – If registered, the termination exit functions for those before or after MQCONN or MQDISC exit functions in the chain that were successfully invoked are driven to clean up after the exit.
  – A CompCode of the more severe of MQCC_WARNING and the CompCode returned by the exit is returned to the application.
  – A Reason of MQRC_API_EXIT_ERROR is returned to the application.
  – The WebSphere MQ API call is successfully issued.

• For an after WebSphere MQ API call exit function other than MQCONN or MQDISC:
  – The ExitResponse2 value is ignored.
  – The remaining exit functions which were successfully called before the API call are called in reverse order.
  – A CompCode of the more severe of MQCC_WARNING and the CompCode returned by the exit is returned to the application.
  – A Reason of MQRC_API_EXIT_ERROR is returned to the application.
  – The WebSphere MQ API call is successfully issued.

• For the before data conversion on get exit function:
  – The ExitResponse2 value is ignored.
  – The remaining exit functions which were successfully called before the API call are called in reverse order.
  – The message is not converted, and the unconverted message is returned to the application.
  – A CompCode of the more severe of MQCC_WARNING and the CompCode returned by the exit is returned to the application.
  – A Reason of MQRC_API_EXIT_ERROR is returned to the application.
  – The WebSphere MQ API call is successfully issued.

**Note:** As the error is with the exit, it is better to return MQRC_API_EXIT_ERROR than to return MQRC_NOT_CONVERTED.

If an exit function sets the ExitResponse2 field to a value other than one of the supported values, a value of MQXR2_DEFAULT_continuation is assumed instead.
Chapter 16. Using and writing applications on WebSphere MQ for z/OS

WebSphere MQ for z/OS applications can be made up from programs that run in many different environments. This means they can take advantage of the facilities available in more than one environment.

This chapter explains the WebSphere MQ facilities available to programs running in each of the supported environments. In addition,

- For information on using the WebSphere MQ-CICS bridge, see Chapter 17, “Using and writing WebSphere MQ-CICS bridge applications for z/OS”, on page 277.
- For information on using IMS and the IMS Bridge, see Chapter 18, “IMS and IMS Bridge applications on WebSphere MQ for z/OS”, on page 311.

This chapter introduces WebSphere MQ for z/OS applications, under these headings:

- “Environment-dependent WebSphere MQ for z/OS functions”
- “Program debugging facilities” on page 260
- “Syncpoint support” on page 260
- “Recovery support” on page 261
- “The WebSphere MQ for z/OS interface with the application environment” on page 261
- “Writing z/OS OpenEdition applications” on page 266
- “The API-crossing exit for z/OS” on page 267
- “WebSphere MQ Workflow” on page 271
- “Application programming with shared queues” on page 272

Important notice

Distributed queuing using CICS ISC is retained for compatibility with previous releases; there will be no further enhancements to this function. Therefore you are recommended to use the channel initiator for distributed queuing.

Environment-dependent WebSphere MQ for z/OS functions

The main differences to be considered between WebSphere MQ functions in the environments in which WebSphere MQ for z/OS runs are:

- WebSphere MQ for z/OS supplies the following trigger monitors:
  - CKTI for use in the CICS environment
  - CSQQTRMN for use in the IMS environment

You must write your own module to start applications in other environments.

- Syncpointing using two-phase commit is supported in the CICS and IMS environments. It is also supported in the z/OS batch environment using transaction management and recoverable resource manager services (RRS). Single-phase commit is supported in the z/OS environment by WebSphere MQ itself.
Environment-dependent functions

- For the batch and IMS environments, the MQI provides calls to connect programs to, and to disconnect them from, a queue manager. Programs can connect to more than one queue manager.
- A CICS system can connect to only one queue manager. This can be made to happen when CICS is initiated if the subsystem name is defined in the CICS system start-up job. The MQI connect and disconnect calls are tolerated, but have no effect, in the CICS environment.
- The API-crossing exit allows a program to intervene in the processing of all MQI calls. This exit is available in the CICS environment only.
- In CICS on multiprocessor systems, some performance advantage is gained because MQI calls can be executed under multiple z/OS TCBs. For more information, see the WebSphere MQ for z/OS Concepts and Planning Guide.

These features are summarized in Table 12.

<table>
<thead>
<tr>
<th>Feature</th>
<th>CICS</th>
<th>IMS</th>
<th>Batch/TSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger monitor supplied</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Two-phase commit</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Single-phase commit</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Connect/disconnect MQI calls</td>
<td>Tolerated</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>API-crossing exit</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Two-phase commit is supported in the Batch/TSO environment using RRS.

Program debugging facilities

WebSphere MQ for z/OS provides a trace facility that you can use to debug your programs in all environments. Additionally, in the CICS environment you can use:
- The CICS Execution Diagnostic Facility (CEDF)
- The CICS Trace Control Transaction (CETR)
- The WebSphere MQ for z/OS API-crossing exit

On the z/OS platform, you can use any available interactive debugging tool that is supported by the programming language you are using.

Syncpoint support

The synchronization of the start and end of units of work is necessary in a transaction processing environment so that transaction processing can be used safely. This is fully supported by WebSphere MQ for z/OS in the CICS and IMS environments. Full support means cooperation between resource managers so that units of work can be committed or backed out in unison, under control of CICS or IMS. Examples of resource managers are DB2, CICS File Control, IMS, and WebSphere MQ for z/OS.

z/OS batch applications can use WebSphere MQ for z/OS calls to give a single-phase commit facility. This means that an application-defined set of queue operations can be committed, or backed out, without reference to other resource managers.
Two-phase commit is also supported in the z/OS batch environment using transaction management and recoverable resource manager services (RRS). For further information see “Transaction management and recoverable resource manager services” on page 179.

Recovery support

If the connection between a queue manager and a CICS or IMS system is broken during a transaction, some units of work may not be backed out successfully. However, these units of work are resolved by the queue manager (under the control of the syncpoint manager) when its connection with the CICS or IMS system is reestablished.

The WebSphere MQ for z/OS interface with the application environment

To allow applications running in different environments to send and receive messages through a message queuing network, WebSphere MQ for z/OS provides an adapter for each of the environments it supports. These adapters are the interface between application programs and WebSphere MQ for z/OS subsystems. They allow the programs to use the MQI.

The batch adapter

The batch adapter provides access to WebSphere MQ for z/OS resources for programs running in:

- Task (TCB) mode
- Problem or Supervisor state
- Primary address space control mode

The programs must not be in cross-memory mode.

Connections between application programs and WebSphere MQ for z/OS are at the task level. The adapter provides a single connection thread from an application task control block (TCB) to WebSphere MQ for z/OS.

The adapter supports a single-phase commit protocol for changes made to resources owned by WebSphere MQ for z/OS; it does not support multiphase-commit protocols.

RRS batch adapter

The transaction management and recoverable resource manager services (RRS) adapter:

- Uses z/OS RRS for commit control.
- Supports simultaneous connections to multiple WebSphere MQ subsystems running on a single z/OS instance from a single task.
- Provides z/OS-wide coordinated commitment control (via z/OS RRS) for recoverable resources accessed via z/OS RRS compliant recoverable managers for:
  - Applications that connect to WebSphere MQ using the RRS batch adapter.
  - DB2 stored procedures executing in a DB2 stored procedures address space that is managed by a workload manager (WLM) on z/OS.
- Supports the ability to switch a WebSphere MQ batch thread between TCBs.
RRS batch adapter

WebSphere MQ for z/OS provides two RRS batch adapters:

**CSQBRSTB**
This adapter requires you to change any MQCMIT and MQBACK statements in your WebSphere MQ application to SRRCMIT and SRRBACK respectively. (If you code MQCMIT or MQBACK in an application linked with CSQBRSTB, you will receive MQRC_ENVIRONMENT_ERROR.)

**CSQBRRSI**
This adapter allows your WebSphere MQ application to use either MQCMIT and MQBACK or SRRCMIT and SRRBACK.

Note: CSQBRSTB and CSQBRRSI are shipped with linkage attributes AMODE(31) RMODE(ANY). If your application loads either stub below the 16 MB line, you must first relink the stub with RMODE(24).

Migration
It is possible to migrate existing Batch/TSO WebSphere MQ applications to exploit RRS coordination with few or no changes. If you link-edit your WebSphere MQ application with the CSQBRRSI adapter, MQCMIT and MQBACK syncpoint your unit of work across WebSphere MQ and all other RRS-enabled resource managers. If you link-edit your WebSphere MQ application with the CSQBRSTB adapter you must change MQCMIT and MQBACK to SRRCMIT and SRRBACK respectively. The latter approach may be preferable as it clearly indicates that the syncpoint is not restricted to WebSphere MQ resources only.

The CICS adapter

Note to users

If you are using the CICS adapter from a WebSphere MQ for z/OS system, ensure that CICS is able to obtain sufficient storage to accommodate messages up to 100 MB long.

A CICS system can have only one connection to a WebSphere MQ for z/OS queue manager, and this connection is managed by the WebSphere MQ for z/OS CICS adapter. The CICS adapter provides access to WebSphere MQ for z/OS resources for CICS programs.

In addition to providing access to the MQI calls, the adapter provides:

- A trigger monitor (or task initiator) program that can start programs automatically when certain trigger conditions on a queue are met. For more information, see Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191.
- An API-crossing exit that can be invoked before and after each MQI call. For more information, see “The API-crossing exit for z/OS” on page 267.
- A trace facility to help you when debugging programs.
- Facilities that allow the MQI calls to be executed under multiple z/OS TCBs. For more information, see the WebSphere MQ for z/OS Concepts and Planning Guide.

CICS adapter performance considerations
This section describes how the CICS adapter optimizes the performance of a CICS to WebSphere MQ connection.
There are a number of factors to be taken into consideration when performance is critical:

First MQI call
In general, the first MQI call of a task takes longer to perform than subsequent calls. This is because the environment must be set up. For example, the adapter must acquire storage and security information, and control blocks must be allocated and formatted.

MQGET and the SIGNAL option
Using the SIGNAL option with an MQGET call imposes an additional overhead. This is because the SIGNAL option can produce a CICS GETMAIN in the adapter, which is used to record the address of the ECB so that it can be posted if the queue manager abends.

API-crossing exit
Using the API-crossing exit also imposes a host processor overhead on each MQI call. The overhead in handling the exit parameter block and the invocations are minimal, but the exit can be invoked twice for each MQI call through EXEC CICS LINK.

CICS tracing
CICS tracing in the adapter also increases the pathlength of an MQI call. A large number of trace entries can be generated depending on how busy the system is. There is no control over the granularity of the trace entries produced in the adapter. Therefore, tracing should only be switched on if necessary.

MQGET and the WAIT option
Using MQGET with the WAIT option is less efficient if the task has been put into a wait until a message arrives. The adapter implements the wait as a form of CICS wait. When a message arrives, the adapter effectively reissues the MQGET call for the application.

Therefore, use the WAIT option with care.

MQCLOSE
Issuing an MQCLOSE call is not always necessary because WebSphere MQ automatically closes any unclosed handles when the task ends.

MQPUT1
If there is only one message to be put, MQPUT1 is more efficient than an MQOPEN-MQPUT-MQCLOSE sequence because only one flow is generated between the WebSphere MQ and the adapter, instead of three.

If there are multiple messages to be put, MQOPEN-MQPUT...MQPUT-MQCLOSE should be used.

EXEC CICS RETURN
Implicit syncpointing generated by EXEC CICS RETURN is more efficient than issuing the explicit syncpoint call EXEC CICS SYNCPOINT followed by EXEC CICS RETURN.

The EXEC CICS RETURN call accommodates all the work needed for syncpointing and task termination into one flow to WebSphere MQ instead of the two separate flows used when explicit syncpointing is used.

Two-phase commit
A two-phase commit consumes more resources than a single-phase commit, both in host processor cost and response time. This is because a two-phase commit involves one more flow to WebSphere MQ and more physical
The CICS adapter

logging. If an application is restricted to recoverable updates in WebSphere MQ and no other resource managers, CICS invokes the adapter for a single-phase commit.

Syncpoint bypassing

The adapter does not use the read-only commit feature in CICS. When a transaction is restricted to non-recoverable or non-destructive work in WebSphere MQ, syncpointing is bypassed because it is not necessary. The clean-up process is performed when the task ends.

Statistics collection

Statistics collection by connection and by task is done on a per MQI call basis and cannot be switched off. This overhead is negligible.

You can use the CKQC transaction to display statistics for the current connection.

The adapter supports a two-phase commit protocol for changes made to resources owned by WebSphere MQ for z/OS, with CICS acting as the syncpoint coordinator.

The CICS adapter also supplies facilities (for use by system programmers and administrators) for managing the CICS-WebSphere MQ for z/OS connection, and for collecting task and connection statistics. These facilities are described in the WebSphere MQ for z/OS System Administration Guide.

Adapter trace points

Application programmers can use trace points related to the MQI calls—for example, CSQCGMGD (GET Message Data)—for debugging CICS application programs. System programmers can use trace points related to system events, such as recovery and task switching, for diagnosing system-related problems. For full details of trace points in the CICS adapter, see the WebSphere MQ for z/OS Problem Determination Guide.

Some trace data addresses are passed by applications. If the address of the trace data is in the private storage area of the CICS region, the contents of the area are traced when necessary. For example, this would be done for the trace entries CSQCGMGD (GET Message Data) or CSQCPMGD (PUT Message Data). If the address is not in the private storage area, message CSQC416I is written to the CICS trace—this contains the address in error.

Abends

This section describes some of the things you must consider with regard to CICS AEY9 and QLOP abends. For information about all other abends, see the WebSphere MQ for z/OS Messages and Codes.

CICS AEY9 abends: A transaction does not abend with a CICS AEY9 code if it issues an MQI call before the adapter is enabled. Instead, it receives return code MQCC_FAILED and reason code MQRC_ADAPTER_NOT_AVAILABLE.

For more information about CICS AEY9 abends, see the CICS Messages and Codes.

QLOP abends: Tasks abend with the abend code QLOP if a second MQI call is made after a call has been returned with completion code MQCC_FAILED and one of these reason codes:

MQRC_CONNECTION_BROKEN
MQRC_Q_MGR_NAME_ERROR
MQRC_Q_MGR_NOT_AVAILABLE
This runaway mechanism can be activated only after the adapter has been enabled once. Before the adapter has been enabled, such a task will loop with reason code set to MQRC_ADAPTER_NOT_AVAILABLE. To avoid this, ensure that your applications respond to the above reason codes either by terminating abnormally or by issuing an EXEC CICS SYNCPOINT ROLLBACK and terminating normally.

If the application does not terminate at this point, it might not issue any further WebSphere MQ calls even if the connection between WebSphere MQ and CICS is reestablished. Once WebSphere MQ is reconnected to CICS, new transactions can use MQI calls as before.

Using the CICS Execution Diagnostic Facility
You can use the CICS execution diagnostic facility (CEDF) to monitor applications that use the CICS adapter. For details of how to use CEDF, see the CICS Application Programming Guide.

CEDF uses standard formatting to display MQI calls.
- Before the MQI call is executed:
  - CEDF displays the addresses of the call parameters
  - You can use the Working Storage key to verify or modify their contents
  - You can skip the call by overtyping the command with NOOP
- After the call has completed:
  - The results are returned in the program’s storage
  - The return code and reason code are displayed in the call parameter list
  - You can modify them before returning to the application program

See WebSphere MQ for z/OS Problem Determination Guide for examples of the output produced by this facility.

The IMS adapter

Note to users
If you are using the IMS adapter from a WebSphere MQ for z/OS system, ensure that IMS is able to obtain sufficient storage to accommodate messages up to 100 MB long.

The IMS adapter provides access to WebSphere MQ for z/OS resources for
- Online message processing programs (MPPs)
- Interactive Fast Path programs (IFPs)
- Batch message processing programs (BMPs)

To use these resources, the programs must be running in task (TCB) mode and problem state; they must not be in cross-memory mode or access-register mode.

The adapter provides a connection thread from an application task control block (TCB) to WebSphere MQ. The adapter supports a two-phase commit protocol for changes made to resources owned by WebSphere MQ for z/OS, with IMS acting as the syncpoint coordinator.
The adapter also provides a trigger monitor program that can start programs automatically when certain trigger conditions on a queue are met. For more information, see Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191.

If you are writing batch DL/I programs, follow the guidance given in this book for z/OS batch programs.

Writing z/OS OpenEdition applications

The batch adapter supports queue manager connections from Batch and TSO address spaces:

If we consider a Batch address space, the adapter supports connections from multiple TCBs within that address space as follows:

- Each TCB can connect to multiple queue managers via the MQCONN or MQCONNX call (but a TCB can only have one instance of a connection to a particular queue manager at any one time).
- Multiple TCBs can connect to the same queue manager (but the queue manager handle returned on any MQCONN or MQCONNX call is bound to the issuing TCB and cannot be used by any other TCB).

z/OS OpenEdition supports two types of pthread_create call:

1. Heavyweight threads, run one per TCB, that are ATTACHed and DETACHed at thread start and end by z/OS.
2. Mediumweight threads, run one per TCB, but the TCB can be one of a pool of long-running TCBs. The onus is on the application to perform all necessary application clean up, since, if it is connected to a server, the default thread termination that may be provided by the server at Task (TCB) termination, will **not** always be driven.

Lightweight threads are not supported. (If an application creates permanent threads which do their own dispatching of work requests, then the **application** is responsible for cleaning up any resources before starting the next work request.)

WebSphere MQ for z/OS supports z/OS OpenEdition threads via the Batch Adapter as follows:

1. Heavyweight threads are fully supported as Batch connections. Each thread runs in its own TCB which is ATTACHed and DETACHed at thread start and end. Should the thread end before issuing an MQDISC call, then WebSphere MQ for z/OS performs its standard task clean up which includes committing any outstanding unit of work if the thread terminated normally, or backing it out if the thread terminated abnormally.
2. Mediumweight threads are fully supported but if the TCB is going to be reused by another thread, then the application must ensure that an MQDISC call, preceded by either MQCMIT or MQBACK, is issued prior to the next thread start. This implies that if the application has established a Program Interrupt Handler, and the application then abends, then the Interrupt Handler should issue MQCMIT and MQDISC calls before reusing the TCB for another thread.

Again, lightweight threads are not supported.

**Note:** Threading models do **not** support access to common WebSphere MQ resources from multiple threads.
The API-crossing exit for z/OS

This section contains product-sensitive programming interface information.

An exit is a point in IBM-supplied code where you can run your own code. WebSphere MQ for z/OS provides an API-crossing exit that you can use to intercept calls to the MQI, and to monitor or modify the function of the MQI calls. This section describes how to use the API-crossing exit, and describes the sample exit program that is supplied with WebSphere MQ for z/OS.

Note
The API-crossing exit is invoked only by the CICS adapter of WebSphere MQ for z/OS. The exit program runs in the CICS address space.

Using the API-crossing exit
You could use the API-crossing exit to:

• Operate additional security checks by examining the contents of each message before and after each MQI call
• Replace the queue name supplied in the message with another queue name
• Cancel the call and either issue a return code of 0 to simulate a successful call, or another value to indicate that the call was not performed
• Monitor the use of MQI calls in an application
• Gather statistics
• Modify input parameters on specific calls
• Modify the results of specific calls

Defining the exit program
Before the exit can be used, an exit program load module must be available when the CICS adapter connects to WebSphere MQ for z/OS. The exit program is a CICS program that must be named CSQCAPX and reside in a library in the DFHRPL concatenation. CSQCAPX must be defined in the CICS system definition file (CSD), and the program must be enabled.

When CSQCAPX is loaded, a confirmation message is written to the CKQC adapter control panel or to the console. If the program cannot be loaded, a diagnostic message is displayed.

How the exit is invoked
When enabled, the API-crossing exit is invoked:

• By all applications that use the CICS adapter of WebSphere MQ for z/OS
• For the following MQI calls:
  – MQCLOSE
  – MQGET
  – MQINQ
  – MQOPEN
  – MQPUT
  – MQPUT1
  – MQSET
• Every time one of these MQI calls is made
• Both before and after a call
Using the API-crossing exit

This means that using the API-crossing exit degrades the performance of WebSphere MQ for z/OS, so plan your use of it carefully.

The exit program can be invoked once before a call is executed, and once after the call is executed. On the before type of exit call, the exit program can modify any of the parameters on the MQI call, suppress the call completely, or allow the call to be processed. If the call is processed, the exit is invoked again after the call has completed.

Note: The exit program is not recursive. Any MQI calls made inside the exit do not invoke the exit program for a second time.

Communicating with the exit program

After it has been invoked, the exit program is passed a parameter list in the CICS communication area pointed to by a field called DFHEICAP. The CICS Exec Interface Block field EIBCALEN shows the length of this area. The structure of this communication area is defined in the CMQXPA assembler-language macro that is supplied with WebSphere MQ for z/OS:

Field MQXP_PXPB points to the exit parameter block, MQXP.

Field MQXP_PCOPYPARAM is an array of addresses of the call parameters. For example, if the application issues an MQI call with parameters P1, P2, or P3, the communication area contains:

\[ \text{PXPB,PP1,PP2,PP3} \]

where \( P \) denotes a pointer (address) and XPB is the exit parameter block.

Writing your own exit program

You can use the sample API-crossing exit program (CSQCAPX) that is supplied with WebSphere MQ for z/OS as a framework for your own program. This is described on page 270.

When writing an exit program, to find the name of an MQI call issued by an application, examine the ExitCommand field of the MQXP structure. To find the number of parameters on the call, examine the ExitParmCount field. You can use
the 16-byte ExitUserArea field to store the address of any dynamic storage that the application obtains. This field is retained across invocations of the exit and has the same life time as a CICS task.

Your exit program can suppress execution of an MQI call by returning MQXCC_SUPPRESS_FUNCTION or MQXCC_SKIP_FUNCTION in the ExitResponse field. To allow the call to be executed (and the exit program to be reinvoked after the call has completed), your exit program must return MQXCC_OK.

When invoked after an MQI call, an exit program can inspect and modify the completion and reason codes set by the call.

Usage notes

Here are some general points you should bear in mind when writing your exit program:

- For performance reasons, you should write your program in assembler language. If you write it in any of the other languages supported by WebSphere MQ for z/OS, you must provide your own data definition file.
- Link-edit your program as AMODE(31) and RMODE(ANY).
- To define the exit parameter block to your program, use the assembler-language macro, CMQXPA.
- If you are using the CICS Transaction Server for z/OS storage protection feature, your program must run in CICS execution key. That is, you must specify EXEC(CICS) when defining both your exit program and any programs to which it passes control. For information about CICS exit programs and the CICS storage protection facility, see the CICS Customization Guide.
- Your program can use all the APIs (for example, IMS, DB2, and CICS) that a CICS task-related user exit program can use. It can also use any of the MQI calls except MQCONN, MQCONNX, and MQDISC. However, any MQI calls within the exit program do not invoke the exit program a second time.
- Your program can issue EXEC CICS SYNCPOINT or EXEC CICS SYNCPOINT ROLLBACK commands. However, these commands commit or roll back all the updates done by the task up to the point that the exit was used, and so their use is not recommended.
- Your program must end by issuing an EXEC CICS RETURN command. It must not transfer control with an XCTL command.
- Exits are written as extensions to the WebSphere MQ for z/OS code. You must take great care that your exit does not disrupt any WebSphere MQ for z/OS programs or transactions that use the MQI. These are usually indicated with a prefix of “CSQ” or “CK”.
- If CSQCAPX is defined to CICS, the CICS system will attempt to load the exit program when CICS connects to WebSphere MQ for z/OS. If this attempt is successful, message CSQC301I is sent to the CKQC panel or to the system console. If the load is unsuccessful (for example, if the load module does not exist in any of the libraries in the DFHRPL concatenation), message CSQC315 is sent to the CKQC panel or to the system console.
- Because the parameters in the communication area are addresses, the exit program must be defined as local to the CICS system (that is, not as a remote program).
The sample API-crossing exit program, CSQCAPX

The sample exit program is supplied as an assembler-language program. The source file (CSQCAPX) is supplied in the library thlqual.SCSQASMS (where thlqual is the high-level qualifier used by your installation). This source file includes pseudocode that describes the program logic.

The sample program contains initialization code and a layout that you can use when writing your own exit programs.

The sample shows how to:
- Set up the exit parameter block
- Address the call and exit parameter blocks
- Determine for which MQI call the exit is being invoked
- Determine whether the exit is being invoked before or after processing of the MQI call
- Put a message on a CICS temporary storage queue
- Use the macro DFHEIENT for dynamic storage acquisition to maintain reentrancy
- Use DFHEIBLK for the CICS exec interface control block
- Trap error conditions
- Return control to the caller

Design of the sample exit program
The sample exit program writes messages to a CICS temporary storage queue (CSQ1EXIT) to show the operation of the exit. The messages show whether the exit is being invoked before or after the MQI call. If the exit is invoked after the call, the message contains the completion code and reason code returned by the call. The sample uses named constants from the CMQXPA macro to check on the type of entry (that is, before or after the call).

The sample does not perform any monitoring function, but simply places time-stamped messages into a CICS queue indicating the type of call it is processing. This provides an indicator of the performance of the MQI, as well as the proper functioning of the exit program.

**Note:** The sample exit program issues six EXEC CICS calls for each MQI call that is made while the program is running. If you use this exit program, WebSphere MQ for z/OS performance is degraded.

Preparing and using the API-crossing exit
The sample exit is supplied in source form only. To use the sample exit, or an exit program that you have written, you must create a load library, as you would for any other CICS program, as described on page 385.
- For CICS Transaction Server for z/OS and CICS for MVS/ESA, when you update the CICS system definition (CSD) data set, the definitions you need are in the member thlqual.SCSQPROC(CSQ4B100).

**Note:** The definitions use a suffix of MQ. If this suffix is already used in your enterprise, this must be changed before the assembly stage.

If you use the default CICS program definitions supplied, the exit program CSQCAPX is installed in a disabled state. This is because using the exit program can produce a significant reduction in performance.
To activate the API-crossing exit temporarily:

1. Issue the command CEMT S PROGRAM(CSQCAPX) ENABLED from the CICS master terminal.
2. Run the CKQC transaction, and use option 3 in the Connection pull-down to alter the status of the API-crossing exit to ‘Enabled’.

If you want to run WebSphere MQ for z/OS with the API-crossing exit permanently enabled, do one of the following:

- For CICS Transaction Server for z/OS and CICS for MVS/ESA do one of the following:
  - Alter the CSQCAPX definition in member CSQ4B100, changing STATUS(DISABLED) to STATUS(ENABLED). You can update the CICS CSD definition using the CICS-supplied batch program DFHCSDUP.
  - Alter the CSQCAPX definition in the CSQCAT1 group by changing the status from DISABLED to ENABLED.

In both cases you must reinstall the group. You can do this by cold-starting your CICS system or by using the CICS CEDA transaction to reinstall the group while CICS is running.

**Note:** Using CEDA may cause an error if any of the entries in the group are currently in use.

End of product-sensitive programming interface information.

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**WebSphere MQ Workflow**

WebSphere MQ Workflow on z/OS is a tool which helps companies improve their business processes. z/OS workload manager (WLM) addresses the need for:

- Managing workload distribution
- Load balancing
- Distribution of computing resources to competing workloads

WebSphere MQ support for z/OS workload manager introduces a new type of local queue: a WLM-managed queue. It is recognized by a new value of the INDXTYPE attribute called MSGTOKEN. The initiation queue associated with a WLM-managed queue should have TRIGTYPE defined as NONE and no ordinary local queues should be associated with this initiation queue.

If a WebSphere MQ Workflow server application has the initiation queue open for input, WebSphere MQ updates a WLM worklist as part of commit processing of MQPUTs to the WLM-managed queue. The setting of TRIGGER or NOTRIGGER on the WLM-managed queue has no effect on the updating of this WLM worklist.

The PROCESS definition is used to provide the name of the application_environment associated with a WLM-managed queue. This is passed in the APPLICID attribute. You should ensure that a WLM-managed queue uniquely references an associated process and that two processes do not specify the same APPLICID value.

Messages are retrieved from a WLM-managed queue using a unique message_token which must be passed to MQGET. To do this, a new message_token value (MQGMO_MSGTOKEN) and a new get message match option (MQMO_MATCH_MSG_TOKEN) are used. Workflow does not normally issue...
WebSphere MQ Workflow

MQGET calls until the message is placed successfully on the queue. If the application needs to wait for the arrival of a message, it must set the match option to MQMO_NONE.

There are new MQRC values for MQGET (MQRC_MSG_TOKEN_ERROR) and MQPUT (MQRC_MISSING_WIH and MQRC_WIH_ERROR). MQRC_MISSING_WIH is returned if a message, MQPUT to a WLM-managed queue, does not include the new work information header (MQWIH). MQRC_WIH_ERROR is returned if the message data does not conform to an MQWIH. MQGET does not remove this header from the message.

Note: You may experience excessive CPU usage if your z/OS system is at Version 2.5 or earlier and the number of messages on WLM-managed queues exceeds 500.

For further information see IBM WebSphere MQ Workflow:Concepts and Architecture, GH12-6285 and IBM WebSphere MQ Workflow for z/OS:Customization and Administration, SC33-7030.

Application programming with shared queues

This section discusses some of the factors you need to take into account when designing new applications that will use shared queues, and when migrating existing applications to the shared-queue environment.

Serializing your applications

Certain types of applications might have to ensure that messages are retrieved from a queue in exactly the same order as they arrived on the queue. For example, if WebSphere MQ is being used to shadow database updates on to a remote system, a message describing the update to a record must be processed after a message describing the insert of that record. In a local queuing environment, this is often achieved by the application that is getting the messages opening the queue with the MQOO_INPUT_EXCLUSIVE option, thus preventing any other getting application from processing the queue at the same time.

WebSphere MQ allows applications to open shared queues exclusively in the same way. However, if the application is working from a partition of a queue (for example, all database updates are on the same queue, but those for table A have a correlation identifier of A, and those for table B a correlation identifier of B), and applications want to get messages for table A updates and table B updates concurrently, the simple mechanism of opening the queue exclusively is not possible.

If this type of application is to take advantage of the high availability of shared queues, you might decide that another instance of the application that accesses the same shared queues, running on a secondary queue manager, will take over if the primary getting application or queue manager fails.

If the primary queue manager fails, two things happen:

- Shared queue peer recovery ensures that any incomplete updates from the primary application are completed or backed out.
- The secondary application takes over processing the queue.
Programming with shared queues

The secondary application might start before all the incomplete units of work have been dealt with, which could lead to the secondary application retrieving the messages out of sequence. To solve this type of problem, the application can choose to be a serialized application.

A serialized application uses the MQCONNX call to connect to the queue manager, specifying a connection tag when it connects that is unique to that application. Any units of work performed by the application are marked with the connection tag. WebSphere MQ ensures that units of work within the queue-sharing group with the same connection tag are serialized (according to the serialization options on the MQCONNX call).

This means that, if the primary application uses the MQCONNX call with a connection tag of Database shadow retriever, and the secondary takeover application attempts to use the MQCONNX call with an identical connection tag, the secondary application will not be able to connect to the second WebSphere MQ until any outstanding primary units of work have been completed, in this case by peer recovery.

You should consider using the serialized application technique for applications that depend on the exact sequence of messages on a queue. In particular:

- Applications that must not restart after an application or queue manager failure until all commit and backout operations for the previous execution of the application are complete.
  
  In this case, the serialized application technique is only applicable if the application works in syncpoint.

- Applications that must not start while another instance of the same application is already running.
  
  In this case, the serialized application technique is only required if the application cannot open the queue for exclusive input.

**Note:** WebSphere MQ only guarantees to preserve the sequence of messages when certain criteria are met. These are described in the description of the MQGET call in the WebSphere MQ Application Programming Reference.

Applications that are not suitable for use with shared queues

Some features of WebSphere MQ are not supported when you are using shared queues, so applications that use these features are not suitable for the shared queue environment. You should consider the following points when designing your shared-queue applications:

- Messages on shared queues cannot be greater than 63 KB in size. Because Coupling Facility storage is limited, you must also consider the number of messages to be generated by the application to ensure that the messages will not fill the queue. However, remember that you can monitor the queue and start more versions of the application on different queue managers to service it if this is a problem.

- Queue indexing is limited for shared queues. If you want to use the message identifier or correlation identifier to select the message you want to get from the queue, the queue must have the correct index defined. If you do not define a queue index, applications can only get the next available message.

- You cannot use temporary dynamic queues as shared queues. You can use permanent dynamic queues however. The models for shared dynamic queues have a DEFTYPE of SHAREDYN (shared dynamic) although they are created and destroyed in the same way as PERMDYN (permanent dynamic) queues.
Deciding whether to share non-application queues

There are queues other than application queues that you might want to consider sharing:

Initiation queues
If you define a shared initiation queue, you do not need to have a trigger monitor running on every queue manager in the queue-sharing group, as long as there is at least one trigger monitor running. (You can also use a shared initiation queue even if there is a trigger monitor running on each queue manager in the queue-sharing group.)

If you have a shared application queue and use the trigger type of EVERY (or a trigger type of FIRST with a small trigger interval, which behaves like a trigger type of EVERY) your initiation queue should always be a shared queue. For more information about when to use a shared initiation queue, see Table 13 on page 275.

Dead-letter queue
You should not define your dead-letter queue as a shared queue. This is because shared queues cannot hold messages with a size greater than 63 KB.

SYSTEM.* queues
You can define the SYSTEM.ADMIN.* queues used to hold event messages as shared queues. This can be useful to check load balancing if an exception occurs. Each event message created by WebSphere MQ contains a correlation identifier indicating which queue manager produced it.

You must define the SYSTEM.QSG.* queues used for shared channels and intra-group queuing as shared queues.

You can also change the definitions of the SYSTEM.DEFAULT.LOCAL.QUEUE to be shared, or define your own default shared queue definition. This is described in the section Defining system objects in the WebSphere MQ for z/OS Concepts and Planning Guide. You cannot define any of the other SYSTEM.* queues as shared queues.

Migrating your existing applications to use shared queues

Migrating your existing queues to shared queues is described in the WebSphere MQ for z/OS System Administration Guide.

When you are migrating your existing applications, you should consider the following things, which might work in a slightly differently way in the shared queue environment.

Reason Codes
When you are migrating your existing applications to use shared queues, remember to check for the new reason codes that can be issued.

Triggering
If you are using a shared application queue, triggering works on committed messages only (on a non-shared application queue, triggering works on all messages).

If you use triggering to start applications, you might want to use a shared initiation queue. Table 13 on page 275 describes what you need to consider when deciding which type of initiation queue to use.
### Table 13. When to use a shared-initiation queue

<table>
<thead>
<tr>
<th></th>
<th>Non-shared application queue</th>
<th>Shared application queue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-shared</strong></td>
<td>As for previous releases.</td>
<td>If you are using trigger type of FIRST or DEPTH, you can use a non-shared initiation queue with a shared application queue. There is the possibility of extra trigger messages being generated, but this setup is good for triggering long-running applications (like the CICS bridge) and provides high availability. For trigger type FIRST or DEPTH, a trigger message will trigger an instance of the application on every queue manager that is running a trigger monitor and that does not already have the application queue open for input. One trigger message is generated for every queue manager; if there is more than one trigger monitor running against the non-shared local initiation queue, on a given queue manager, they will compete to process the message.</td>
</tr>
<tr>
<td><strong>initiation queue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shared initiation</strong></td>
<td>You should not use a shared initiation queue with a non-shared application queue.</td>
<td>If you have a shared application queue that has a trigger type of EVERY, you should use a shared initiation queue or you will lose trigger messages. For trigger type FIRST or DEPTH, one trigger message will be generated by each queue manager that has the named initiation queue open for input.</td>
</tr>
<tr>
<td><strong>queue</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MQINQ**

When you use the `MQINQ` call to display information about a shared queue, the values of the number of `MQOPEN` calls that have the queue open for input and output relate only to the queue manager that issued the call. No information is produced about other queue managers in the queue-sharing group that have the queue open.
Programming with shared queues
Chapter 17. Using and writing WebSphere MQ-CICS bridge applications for z/OS

Throughout this chapter the terms “CICS bridge” and “bridge” mean “WebSphere MQ-CICS bridge”.

Most CICS applications were developed when a 3270 terminal was the main way of interacting with users. To use these applications with new transport mechanisms, such as WebSphere MQ, CICS recommends that applications are written with the business logic of the application separated from the presentation logic. The business logic can be accessed by a CICS Distributed Program Link (DPL) request to run the program. However, not all applications can be restructured in this way, for example when the customer does not own the source code of the application. The CICS bridge protects the investment in these legacy applications by allowing them to be accessed from other platforms. This makes CICS resources readily available to programs not running under CICS. This can be done for DPL programs and for 3270 transactions.

A WebSphere MQ application can start a CICS application by sending a structured message to the CICS bridge request queue. Any data required by the CICS application can be included in the request message:

- For DPL programs, the data required is the CICS communication area (COMMAREA) data used by the application.
- For 3270 transactions, the data required is vectors describing the Application Data Structures (ADSs) used by the application.

Similarly, the CICS application can send data back to the WebSphere MQ application in a message that is sent to a reply queue:

- For DPL programs, the data sent back is the COMMAREA data output by the application.
- For 3270 transactions, the data sent back is vectors describing the Application Data Structures (ADSs) output by the application.

The WebSphere MQ application can run on any platform, but the bridge request queue must reside on the local z/OS queue manager that is connected to the CICS adapter.

This chapter describes how to use and design WebSphere MQ-CICS bridge applications, under these headings:

- “Using CICS DPL programs with the bridge” on page 278
- “Using CICS transactions with the bridge” on page 280
- “Programming for the distributed environment” on page 295
- “From 3270 legacy to 3270 bridge - an example” on page 296
- “Setting fields in the MQMD and MQCIH structures” on page 299
- “Setting the open options and put message options for the bridge request queue” on page 302
- “Managing_MsgId and Correlld in a unit of work” on page 302
- “Error handling by the CICS bridge” on page 304
- “Debugging CICS bridge applications” on page 306
- “Application data structure terminology” on page 308
Using CICS DPL programs with the bridge

To link to another program that has been defined to CICS, a CICS application can issue a command like this:

EXEC CICS LINK PROGRAM(name) COMMAREA(data-area)

For the complete syntax of this command, see the CICS Application Programming Reference book.

If you want a WebSphere MQ application to run a CICS application that invokes a CICS DPL program, the WebSphere MQ application must send a structured message to the bridge request queue. In the simplest case, the message data consists only of the name of a DPL program to be run. Follow this by COMMAREA data if you want to make data available to the DPL program when it starts.

If you want to run more than one DPL program within a unit of work, or you prefer a specific transaction code (overwriting the default CKBP), or you require certain levels of authorization to run the DPL program, you must supply information in an MQCIH. The MQCIH must precede the program name and any COMMAREA data that you send.

CICS DPL bridge message structure

These examples show the different structures you can use for messages that run DPL programs through the bridge.

- Use this structure for an application that runs a single DPL program using default processing options, and does not send or receive COMMAREA data:

  ![MQMD ProgName](image)

  The program specified by ProgName is invoked by CICS as a DPL program.

- Use this structure for an application that runs a single DPL program using default processing options, and sends and receives COMMAREA data:

  ![MQMD ProgName CommareaData](image)

  Use this structure for an application that runs one or more DPL programs within a unit of work, or needs specific authorization to run the program, but does not send or receive COMMAREA data:

  ![MQMD MQCIH ProgName](image)

  Use this structure for an application that invokes one or more DPL programs within a unit of work, or needs specific authorization to run the program, and sends and receives COMMAREA data:

  ![MQMD MQCIH ProgName CommareaData](image)

If a bridge task running a DPL program ends abnormally, a message is returned to the reply queue with the following structure, whether or not the inbound message preceding the failure contained an MQCIH:
CSQC* message represents an error message that indicates the error type. The value of field MQCIH.Format is set to MQFMT_STRING, so that the message can be properly converted if the final destination uses a different CCSID and encoding. The MQCIH also contains other fields that you can use to diagnose the problem.

Notes:
1. The MQMD is shown in the examples to help you visualize the overall structure of the message. This is the structure that you see if you use the general queue browser utility of WebSphere MQ SupportPac™ MA10 "MQSeries for MVS/ESA - ISPF utilities".
2. When you want to send only a program name, and no COMMAREA data, to the bridge, the program name must be 8 characters long. It must not be a name that is padded to the right with spaces, or the bridge will report a COMMAREA negative length error.
3. When you want to send COMMAREA data, you must pad the program name with spaces to the right, to give a total length of eight characters.
4. You can include control data in the message to specify unit of work management, and to provide data for security checking, when you include a WebSphere MQ CICS information header (CIH) in the message.

Application programming for the CICS DPL bridge

This C-language code fragment shows how you can construct a message buffer when you want to invoke a DPL program with COMMAREA data, and include a WebSphere MQ CICS Information Header (MQCIH).

```c
/*
 * defines */
#define PGMNAME "DPLPGM" /* DPL program name */
#define PGMNAMELEN 8
#define CALEN 100 /* Commarea length */
...
/* Data declarations */
MQMD mqmd ; /* Message descriptor */
MQCIH mqcih ; /* CICS information header */
MQCHAR * Commarea ; /* Commarea pointer */
MQCHAR * MsgBuffer ; /* Message buffer pointer */
...
/* allocate storage for the buffers */
Commarea = malloc(CALEN * sizeof(MQCHAR)) ;
MsgBuffer = malloc(sizeof(MQCIH) + PGMNAMELEN + CALEN) ;
...
/* Initialize commarea with data */
/* Initialize fields in the MQMD as required, including: */
mqmd.MsgId = MQMI_NONE ;
mqmd.CorrelId = MQCI_NEW_SESSION ;
/* Initialize fields in the MQCIH as required */
/* Copy the MQCIH to the start of the message buffer */
memcpy(MsgBuffer, &mqcih, sizeof(MQCIH)) ;
/* Set 8 bytes after the MQCIH to spaces */
```
memset(MsgBuffer + sizeof(MQCIH), ' ', PGMNAMELEN) ;
/* Append the program name to the MQCIH. If it is less than */
/* 8 characters, it is now padded to the right with spaces. */
strncpy(MsgBuffer + sizeof(MQCIH), PGMNAME, PGMNAMELEN) ;
/* Append the commarea after the program name */
memcpy(MsgBuffer + sizeof(MQCIH) + PGMNAMELEN, &Commarea
CALEN ) ;
/* The message buffer is now ready for the MQPUT */
/* to the Bridge Request Queue. */

The DPL program that is invoked must be defined to CICS with
EXECUTIONSET=DPLSUBSET, and it must conform to the DPL subset rules. See the
CICS Application Programming Guide for further details.

Managing units of work for the CICS DPL bridge
If your Bridge application is running just a single DPL program, set the value of
MQCIH.UOWControl to MQCUOWC_ONLY. However, if your application is sending
and receiving multiple messages, you must handle units of work correctly for the
CICS DPL bridge. If you want to run multiple user programs within a unit of
work, you should

- set the value of MQCIH.UOWControl to MQCUOWC_FIRST in the first request
- set MQCUOWC_MIDDLE in any intermediate requests
- set MQCUOWC_LAST in the last request

Your application can send multiple request messages within a unit of work before
receiving any response messages. At any time after the first message, you can
terminate the unit of work by sending a message with MQCIH.UOWControl set to
MQCUOWC_COMMIT or MQCUOWC_BACKOUT.

Using CICS transactions with the bridge
Without using WebSphere MQ, a CICS transaction can be started in several ways,
including:

- A terminal user can enter the transaction name, followed (optionally) by data.
The transaction can obtain any data that follows its identifier by issuing EXEC
  CICS RECEIVE when it starts.
- A preceding transaction at the terminal terminates with EXEC CICS RETURN
  TRANSID(transid), causing 3270 data stream to be sent by the terminal and start
  a new transaction. A transaction that is started in this way obtains the data in
  the 3270 data stream by issuing EXEC CICS RECEIVE MAP or EXEC CICS
  RECEIVE, depending on whether it uses BMS (Basic Mapping Support) mapping
  or terminal control.
- An application issues an EXEC CICS START command. The started transaction
  issues EXEC CICS RETRIEVE to retrieve any data that has been specified on the
  START command.

A transaction that has been invoked at a terminal can subsequently issue
commands such as EXEC CICS CONVERSE, EXEC CICS SEND MAP and EXEC
CICS RECEIVE MAP in a conversation or pseudoconversation with a terminal
user.
Using CICS transactions

The CICS bridge can emulate any of the these ways of starting CICS transactions. It can also emulate a terminal user sending and receiving screens of data from the transaction. These emulations are achieved by using CICS bridge vectors, which represent the EXEC CICS command being emulated and provide any data that is needed. The data needed by a CICS transaction accompanies inbound messages, and the data needed by a CICS bridge application accompanies outbound messages.

Using CICS bridge vectors

Use vectors to represent EXEC CICS commands in request and reply messages. Vectors are represented in bridge messages by strings of numeric characters known as vector descriptors, for example 0402. Each vector descriptor is the CICS EIBFN value of the EXEC CICS command that it represents. For example, 0402 is the EIBFN value for EXEC CICS RECEIVE, and also the vector descriptor of the RECEIVE vector. Vectors are further qualified by the letters I and O to show whether they are inbound (to the bridge) or outbound (from the bridge).

An outbound message can contain a request vector or a reply vector. These descriptions do not mean that they go to the request queue or the reply queue; all outbound messages go to the reply queue. A CICS transaction uses a request vector to request data from the WebSphere MQ bridge application that is acting as the virtual terminal. A CICS transaction uses a reply vector when it does not expect any data back. No such distinction is made for inbound vectors.

The following vectors are available. To get the CICS command that each represents, prefix the vector name with EXEC CICS.

**Outbound reply vectors (no further data is required in the next inbound message):**
- SEND
- SEND CONTROL
- SEND MAP
- SEND TEXT
- ISSUE ERASEAUP

**Outbound request vectors (further data is required in the next inbound message):**
- RECEIVE
- RECEIVE MAP
- CONVERSE

**Inbound vectors:**
- RECEIVE
- RECEIVE MAP
- CONVERSE
- RETRIEVE

Each of these vectors is an architected structure followed by variable length data. For details of the structures, refer to the CICS Internet and External Interfaces Guide for CICS V1.2, or CICS External Interfaces Guide for CICS V1.3.

**CICS 3270 bridge message structure**

The term ‘CICS 3270 bridge’ is used here to mean all non-DPL CICS transactions.
CICS 3270 bridge message structure

**Inbound messages**
These examples show the possible structures of CICS 3270 bridge inbound messages.

- Use this structure for an application that invokes a CICS transaction without any data:
  
<table>
<thead>
<tr>
<th>MQMD</th>
<th>MQCIH</th>
</tr>
</thead>
</table>

  Set the field MQCIH.TransactionId to the name of the transaction you want to start. Set the other fields in the CIH to values that are appropriate for the application.

- Use this structure for inbound messages that have zero length data:
  
<table>
<thead>
<tr>
<th>MQMD</th>
<th>MQCIH</th>
<th>BRMQ structure</th>
</tr>
</thead>
</table>

  For example, an inbound RECEIVE MAP vector can represent an action where the user has only pressed a PF key. In this case, a field within the BRMQ structure specifies which AID key had been used, but no data follows the BRMQ structure.

- Use this structure for an application that invokes a transaction that will issue an EXEC CICS command that expects data to be available:
  
<table>
<thead>
<tr>
<th>MQMD</th>
<th>MQCIH</th>
<th>BRMQ structure</th>
<th>data</th>
</tr>
</thead>
</table>

  *BRMQ structure* represents any of the inbound vector structures RECEIVE, RECEIVE MAP, CONVERSE or RETRIEVE.

**Outbound messages**
Outbound messages from the bridge have one of three structures, depending on whether an error occurred. Although only a single vector is shown in each of these examples, messages can contain several concatenated vectors, except when an error occurs.

- This structure is used when bridge processing concludes normally, no errors were detected, and no data is to be returned to the bridge application:
  
<table>
<thead>
<tr>
<th>MQMD</th>
<th>MQCIH</th>
<th>BRMQ structure</th>
</tr>
</thead>
</table>

  Even if an application abends, this is still regarded as normal completion by the bridge. The abend code issued by the application is given in the MQCIH.

- This structure is used when bridge processing concludes normally, no errors were detected, and data is to be returned to the bridge application:
  
<table>
<thead>
<tr>
<th>MQMD</th>
<th>MQCIH</th>
<th>BRMQ structure</th>
<th>data</th>
</tr>
</thead>
</table>

  *BRMQ structure* represents any of the architected outbound reply or request vector structures.

- This structure is used when bridge processing concludes abnormally, an error having been detected by the bridge monitor:
  
<table>
<thead>
<tr>
<th>MQMD</th>
<th>MQCIH</th>
<th>CSQC+ message</th>
</tr>
</thead>
</table>
**CSQC* message** represents an error message that indicates the error type. The value of field MQCIH.Format is set to MQFMT_STRING, to ensure that the message can be properly converted if the final destination uses a different CCSID and encoding. The MQCIH also contains other fields that you can use to diagnose the problem.

**Notes:**
1. The MQMD is shown in the examples to help you visualize the overall structure of the message. This is the structure that you will see if you use the general queue browser utility of WebSphere MQ SupportPac MA10 "MQSeries for MVS/ESA - ISPF utilities".
2. Only a single vector is shown associated with any message. In practice, a message might contain several vectors concatenated:
   - Inbound messages can contain several RECEIVE MAP vectors in anticipation of future RECEIVE MAP requests from the CICS transaction. The application needs to know the flow of control in the transaction in order to construct the message.
   - Outbound messages can contain several vectors, for example as a result of successive EXEC CICS SEND MAP commands being issued by a transaction. The CICS transaction does not have control over whether the outbound message contains a single vector or multiple vectors. If the transaction issues a command that causes a request vector to be generated, the request vector will always be the last one in the message.

**Application programming for the CICS 3270 bridge**

Application programming for the CICS 3270 bridge is usually more complex than application programming for the DPL bridge for these reasons:
- The bridge emulates all of the functions of the CICS terminal API, including minimum function BMS
- The bridge application needs to be aware of the internal logic and flow of control in the CICS transaction that is being run, and it must interpret and respond to vectors that it receives in outbound messages
- If a transaction uses BMS maps, the bridge application might not have access to the copybooks created during map assembly to help interpret data in the vectors. In this case, the data must be analyzed indirectly through the use of an application data structure (ADS) descriptor.

If you are unfamiliar with the terminology used for describing application data structures, you should now refer to the section "Application data structure terminology" on page 308.

You must make sure every inbound message that is sent to the CICS 3270 Bridge includes a vector structure after the CIH, except when you start a transaction with no data.

The vector structure definitions are available in C-language header file dfhbrmqh.h and COBOL copybook DFHBRMQO. You should include these in any application that uses the bridge. These members are only provided with CICS Transaction Server on z/OS. If you wish to create your application on another platform, you must copy them to that environment.

All the vectors have a common header, but their structures differ. Details of the structures are given in the *CICS Internet and External Interfaces Guide* for CICS V1.2,
or the CICS External Interfaces Guide for CICS V1.3. You will need to refer to these books when you are developing your bridge applications.

You are recommended also to obtain a copy of CICS SupportPac CA1E "CICS Bridge Passthrough" as an aid to analyzing the logic of your existing CICS transactions, and to help plan your WebSphere MQ CICS 3270 Bridge applications. You can use the SupportPac to test whether CICS transactions work in a Bridge environment without having to write any application code. It also enables you to display and capture the inbound and outbound data flows, to study how messages must be structured, and what values need to be inserted into fields in the MQCIH and the vectors.

This simple example illustrates how you might write applications for the CICS 3270 Bridge; it shows how to invoke a transaction that would normally be started by entering its identifier and some command line arguments at a CICS terminal:

Example: Invoking CEMT I TASK from an application

This example shows how an application can start a transaction, in this case CEMT, that expects to receive command line arguments when it is invoked.

When the CEMT task starts, it issues EXEC CICS RECEIVE to receive any command line arguments that follow its identifier. The application that emulates the command line invocation must therefore start CEMT with a RECEIVE vector that contains appropriate values in the vector structure, and also include the command line values. The following C-language code fragment shows how the inbound message can be constructed.

```c
/* #includes */
#include cmqc.h /* WebSphere MQ header */
#include dfhbrmqh.h /* Vector structures */

/* #defines */
define CMDSTRING "CEMT I TASK" /* Command string */
define RCV_VECTOR "0402" /* Vector descriptor */
define INBOUND "I" /* Inbound type */
define VERSION "0000" /* Vector version */
define YES "Y" /* YES indicator */
define NO "N" /* NO indicator */

/* Data declarations */
const char AID[4]={0x7d, ',', ',', ' '};
MQMD mqmd; /* Message descriptor */
MQCIH mqcih; /* CICS information header */
brmq_vector_header brvh; /* Standard vector header */
brmq_receive brrcv; /* RECEIVE vector structure */
MQCHAR *MsgBuffer; /* Message buffer pointer */

allocate storage for the message buffer. Note that the
/* RECEIVE vector structure includes space for the standard*/
/* vector header. */

MsgBuffer = malloc(sizeof(MQCIH) + sizeof(brrcv) + strlen(CMDSTRING));

/* Initialize fields in the MQMD as required */
/* Initialize fields in the MQCIH as required, including: */

strcpy(MQCIH.TransactionId, "CEMT", strlen("CEMT"));

/* Initialize fields in the RECEIVE vector header: */
```

This page was generated from the following page(s) in the source documents.
brvh.brmq_vector_length = sizeof(brrcv) + strlen(CMDSTRING) ;
strncpy(brvh.brmq_vector_descriptor, RCV_VECTOR, strlen(RCV_VECTOR)) ;
strncpy(brvh.brmq_vector_type, INBOUND, strlen(INBOUND)) ;
strncpy(brvh.brmq_vector_version, VERSION, strlen(VERSION)) ;
/* Initialize fields in the RECEIVE vector structure: */
strncpy(brrcv.brmq_re_transmit_send_areas, YES, strlen(YES)) ;
strncpy(brrcv.brmq_re_buffer_indicator, NO, strlen(NO)) ;
strncpy(brrcv.brmq_re_aid, AID, sizeof(brrcv.brmq_re_aid)) ;
brrcv.brmq_re_data_len = strlen(CMDSTRING) ;
/* Copy the MQCIH to the start of the message buffer */
memcpy(MsgBuffer, &mqcih, sizeof(MQCIH)) ;
/* Append the RECEIVE vector to the CIH */
memcpy(MsgBuffer + sizeof(MQCIH), brrcv, sizeof(brrcv) ) ;
/* Overlay the standard vector header on the RECEIVE vector */
memcpy(MsgBuffer + sizeof(MQCIH), brvh, sizeof(brvh) ) ;
/* Append the command string to the vector structure */
strncpy(MsgBuffer + sizeof(MQCIH) + sizeof(brrcv), CMDSTRING, strlen(CMDSTRING)) ;
/* The message buffer is now ready for the MQPUT */
/* to the Bridge Request Queue. */

The outbound message that is returned to the reply queue contains a SEND reply vector with data in terminal control format – your application needs to know this when it analyzes the data that it receives.

Managing units of work for the CICS 3270 bridge
If your bridge application is running just a single transaction, you should set the value of MQCIH.UOWControl to MQCUOWC_ONLY. However, if your application is sending and receiving multiple messages, you must handle unit of work management differently for the CICS 3270 bridge.

A transaction can split itself into multiple units of work by issuing EXEC CICS SYNCPOINT, but you cannot group transactions into a single unit of work. Always set the value of MQCIH.UOWControl to MQCUOWC_ONLY in the first message, even when many messages are sent by your application. You should set MQCUOWC_CONTINUE in messages supplying additional data to the transaction. If you wish to terminate the transaction, set the value of MQCIH.CancelCode to a four-character abend code.

Writing applications using CICS Basic Mapping Support
CICS Basic Mapping Support (BMS) provides a way for CICS applications to support a number of different terminal types. When the application issues EXEC CICS SEND MAP, BMS merges terminal-specific control data with the application data to produce a 3270 data stream that can be displayed at the terminal. When the application issues EXEC CICS RECEIVE MAP, application data is extracted from an inbound 3270 data stream and returned to the application.

A BMS map for a CICS application is created by assembling a set of BMS macros that define the characteristics of fields that are required for the display. One of the
Writing CICS BMS applications

outputs from map assembly is a copybook that maps the display fields to an ADS. The CICS application must include the copybook in its data definitions so that it can address the fields in the map symbolically. The application data in a SEND MAP, and expected by a RECEIVE MAP, is mapped directly to the ADS in the copybook.

When the transaction runs under the CICS bridge, EXEC CICS SEND MAP and EXEC CICS RECEIVE MAP commands cause SEND MAP and RECEIVE MAP vectors to be generated in outbound messages. Instead of a 3270 data stream, these vectors contain ADSs equivalent to those used by the CICS application to address fields in the map.

The format of the ADS is unique for each map. It is described by a copybook created as part of map generation. Without this copybook it is difficult to interpret the data. Usually WebSphere MQ applications include the BMS copybooks so that they can create RECEIVE MAP data, and interpret SEND MAP data. However, you can write an application without the specific BMS copybooks. The format of the data is described by a structure known as the ADS Descriptor (ADSD). The ADSD is added to the end of a SEND MAP vector, and it describes the format of the ADS in the vector. The ADSD contents include the names, positions and lengths of the fields in the ADS. An ADSD can also be sent on a RECEIVE MAP Request. You can use this in conversational applications to tell the WebSphere MQ application the structure of the ADS requested by the CICS application. The WebSphere MQ application can then build a RECEIVE MAP vector with this ADS, and send it as a new request.

As an application programmer, you can choose whether you want to interpret vector data in messages using the ADS, the ADSD, or the ADSDL. In order to interpret the ADS directly, you need to include the copybook from map assembly in your WebSphere MQ Bridge application. If you want to do this, but you do not have access to the copybook or map, you should recreate the map with the CICS utility DFHBMSUP – this requires CICS Transaction Server 1.2 or later.

If you want to interpret the ADS indirectly through the ADSD or ADSDL, for example if you are creating a generic application that will handle all maps, you do not need to include the copybook in your bridge application. Instead you need to send control information to the bridge that tells it to include the ADSD or ADSDL in outbound SEND MAP and RECEIVE MAP request vectors as required.

If your application must run in the distributed environment, you need to include an ADSDL in outbound SEND MAP vectors. WebSphere MQ can then perform data conversion on the outbound message.

You can specify any of the following options by setting appropriate values in field MQCIH.ADSDescriptor in inbound messages:

• To include an ADSD (short form of the application data structure descriptor) with the SEND MAP vector, set:

  MQCIH.ADSDescriptor = MQCADSD_SEND

  If you specify this alone, you will also get the short form of the ADS (application data structure) included in the SEND MAP vector.

• To include an ADSD with the RECEIVE MAP vector, set:

  MQCIH.ADSDescriptor = MQCADSD_RECV

  The ADS is never present in an outbound RECEIVE MAP request vector.
To include an ADSDL (long form of the application data structure descriptor) in the SEND MAP or RECEIVE MAP vector, set:

MQCIH.ADSDescriptor = MQCADSD_MSGFORMAT

If you specify this, you will also get the long form of the ADS included in the SEND MAP vector.

To not include an ADS descriptor in the SEND MAP or RECEIVE MAP vector set:

MQCIH.ADSDescriptor = MQCADSD_NONE

This is the default. If you specify this, you will get the short form of the ADS included in the SEND MAP vector.

You can add MQCADSD_\* values together, so do this to cause the long form of the application data structure descriptor to be included in both SEND MAP and RECEIVE MAP vectors:

MQCIH.ADSDescriptor = MQCADSD_SEND + MQCADSD_RECV + MQCADSD_MSGFORMAT

The SEND MAP vector would also in this case include an ADS in long form.

**Interpreting outbound SEND MAP and RECEIVE MAP vectors**

Your bridge application should contain logic to interpret outbound SEND MAP and RECEIVE MAP request vectors, and it should build and send an inbound RECEIVE MAP vector in response to the corresponding outbound RECEIVE MAP request.

**SEND MAP vectors:**

An outbound SEND MAP vector can contain an application data structure (ADS) and an application data structure descriptor in short form (ADSD) or long form (ADSDL).

To interpret a SEND MAP vector, do this (assuming that the message contains both an ADS and an ADSD or ADSDL):

1. GET the message containing the SEND MAP vector from the bridge reply queue into a message buffer.
2. Locate the start of the outbound SEND MAP vector in the message buffer. This is appended to the CIH, and so is at an offset equal to the length of the CIH from the start of the message buffer. You can use the following code fragment as a model.

```c
/* #includes */
#include cmqc.h /* WebSphere MQ header */
#include dfhbrmqh.h /* Vector structures */

/* #defines */

MQCHAR * MsgBuffer ; /* Message buffer pointer */
brmq_send_map * pVector ; /* Vector pointer */

/* Get message from reply queue */

/* Set the vector pointer to the start of the vector */

pVector = MsgBuffer + ((MQCIH *) MsgBuffer)->StrucLength ;
```

3. Identify the starting addresses of the application data structure (ADS) and the application data structure descriptor (ADSD or ADSDL) from the SEND MAP vector.
This diagram shows the structure of an outbound SEND MAP vector (assuming that you have set a pointer called `pVector` to address the start of the `brmq_send_map` vector, as in the code fragment above).

Values in the diagram shown like this:

```
ABCD  
1234  
```

show hexadecimal values as you would see them in an ISPF editor with 'hex on'. This is equivalent to the hexadecimal value x’A1B2C3D4’.

Fields `pVector->brmq_sm_data_offset` and `pVector->brmq_sm_data_len` give the offset and length, respectively, of the ADS, and fields `pVector->brmq_sm_adsd_offset` and `pVector->brmq_sm_adsd_len` give the offset and length, respectively, of the ADSD or ADSDL.

Fields `brmq_sm_adsd_offset` and `brmq_sm_adsd_len` will both be set to zero if no ADSD or ADSDL is included in the message.

4. Identify the fields in the ADSD or ADSDL.

The ADSD and ADSDL are both mapped to structures that are defined in header file `dfhbrarh.h`, which is distributed in library `<hlq>.SDFHC370` for CICS Transaction Server for OS/390® Version 1.2 or later. You can examine the structure definitions there to see how the fields are laid out. The fields of the ADSD are also described in the `CICS Internet and External Interfaces Guide` for CICS V1.2, or the `CICS External Interfaces Guide` for CICS V1.3.

If your bridge application is to be compiled on a workstation, you will need to copy file `dfhbrarh.h` to that environment.

Both the ADSD and the ADSDL are represented by two types of structure. The first structure is the descriptor, which occurs only once at the start of the ADSD or ADSDL. These types are defined:

- **ads_descriptor**
  - Descriptor for the ADSD (short form)

- **ads_long_descriptor**
  - Descriptor for the ADSDL (long form)

The second structure is the field descriptor, which is repeated once for each field in the map. These types are defined:

- **ads_field_descriptor**
  - Field descriptor for the ADSD (short form)
**ads_long_field_descriptor**  
Field descriptor for the ADSDL (long form)

This can be shown diagrammatically like this for the ADSDL and the ADSD:

The ADSDL:

```
| ADS Descriptor | field descriptor | field descriptor | ... 
|----------------|------------------|------------------|------
↑↑ ↑
| ads_long_field_descriptor |
| ads_long_field_descriptor |
```

The ADSD:

```
| ADS Descriptor | field descriptor | field descriptor | ... 
|----------------|------------------|------------------|------
↑↑ ↑
| ads_field_descriptor |
```

Fields `adsd_field_count` and `adssl_field_count` in the descriptors identify the number of field descriptors in the ADSD and ADSDL.

You can use the following code fragment to set pointers to the start of the ADSD or ADSDL structures and process the field descriptors sequentially. It is assumed that `pVector` already addresses the start of the `brmq_send_map` vector, and that you have an MQCIH structure named `mqcih` that contains the CIH from the inbound message.

```c
/* #includes */
#include cmqc.h /* WebSphere MQ header */
#include dfhbrmqh.h /* Vector structures */
#include dfhbrarh.h /* ADSD structures */

/* Ptr to ADSD descriptor */
ads_descriptor * pADSD_D ;
/* Ptr to ADSDL descriptor */
ads_long_descriptor * pADSDL_D ;
/* Ptr to ADSD field descriptor */
ads_field_descriptor * pADSD_FD ;
/* PTR to ADSDL field descriptor */
ads_long_field_descriptor * pADSDL_FD ;

/* Initialize the pointer to the ADSDL descriptor or the ADSD descriptor depending on mqcih.ADSDescriptor */
if (mqcih.ADSDescriptor && MQCADSD_MSGFORMAT)
{
    pADSDL_D = pVector->brmq_sm_adsd_offset; /* Long form */
    pADSDL_FD = pADSDL_D + sizeof(ads_long_descriptor) ;
    
    /* Enter a loop where we process all field descriptors in the ADSDL sequentially */
    do
    {
        /* Perform some processing */
    }
```

**SEND MAP vectors**

Chapter 17. Using and writing WebSphere MQ-CICS bridge applications for z/OS 289
Identify the fields in the ADS.

The ADS itself is mapped to a structure that is generated when you assemble your map. If you include a keyword=parameter value of DSECT=ADSDL in your mapset definition macro, you will get the long form of the ADS. The output from map assembly is a union of two structures: an input structure and an output structure. This example shows part of such a union (only the first field definition is shown for each structure, and the comments have been added following map assembly).

```
union
{
    struct {
        char     dfhms1[12];    /* 12 reserved bytes */
        int      dfhms2;       /* Offset to next field */
        int      tranidl;      /* Data length of this field */
        int      tranidf;      /* Flag or attribute value */
        int      dfhms3[7];    /* Extended attributes array */
        char     tranidi[4];   /* Data value of field */
        ...
    } bmstmp1i; /* Input structure */

    struct {
        char     dfhms56[12];  /* 12 reserved bytes */
        int      dfhms57;      /* Offset to next field */
        int      dfhms58;      /* Data length of this field */
        int      tranida;      /* Flag or attribute value */
        int      tranidc;      /* Extended attribute */
        int      tranidp;      /* Extended attribute */
        int      tranidh;      /* Extended attribute */
        int      tranidv;      /* Extended attribute */
        int      tranidu;      /* Extended attribute */
        int      tranidm;      /* Extended attribute */
        char     tranido[4];   /* Data value of field */
        ...
    } bmstmp1o; /* Output structure */
}
```
The two structures are functionally identical, except that the input structure includes the extended attribute values in a seven–element array, and the output structure provides individually named fields.

You can use the following code fragment to set pointers to the start of the ADS. The structure names shown in the example DSECT above are used for illustration. Two pointers are set, the first to address inbound data and the second to address outbound data. It is assumed that pVector already addresses the start of the brmq_send_map vector.

```c
/* #includes */
#include cmqc.h /* WebSphere MQ header */
#include dfhbrmqc.h /* Vector structures */
#include dfhbrarh.h .. /* ADSD structures */
#include mydsect.h /* DSECT from map assembly */
...
bmstmpli * pADSI ; /* Pointer to the inbound ADS */
bmstmplo * pADSO ; /* Pointer to the outbound ADS */
bmstmpli * pADSI_An ; /* Inbound ADS Anchor */
bmstmplo * pADSO_An ; /* Outbound ADS Anchor */
...
/* We are dealing with an outbound vector, so we will */
/* initialize the outbound pointer to address the ADS */
pADSO = pVector->brmq_sm_adsd_offset ;
/* Save initial value as anchor */
pADSO_An = pADSO ;
/* Move to the start of the first field */
pADSO += pADSDL_FD->adsdl_field_offset ;
/* Enter a loop where we process all fields in the ADS */
/* sequentially. It is assumed that the value of pADSDL_FD */
/* is being augmented to the next field descriptor in the */
/* ADSD with every loop. A model for this is shown in a code*/
/* fragment above. Note that adsdl_field_offset contains */
/* the absolute offset of the field from the start of the */
/* ADS. */
do
{
    /* Perform some processing */
    ...
    /* Add offset of next field to ADS Anchor value */
    /* to address the next field */
    pADSO = pADSO_An + pADSDL_FD->adsdl_field_offset ;
}
while (pADSDL_FD < pADSDL_D->adsd_length ) ;
```

The general structures of the long and short forms of the ADS are given in the IBM Redbook CICS Transaction Server for OS/390 Version 1 Release 3: Web Support and 3270 Bridge.

RECEIVE MAP vectors:

A RECEIVE MAP request is a request for the client to provide a RECEIVE MAP on the next input message. Unlike a SEND MAP vector, an outbound RECEIVE MAP
request vector never contains an ADS. It contains an ADSD or ADSDL that describes the ADS data that it requires in the next inbound RECEIVE MAP vector, provided that MQCADSD_RECV has been specified in MQCIH.ADSDescriptor. The RECEIVE MAP vector structure differs from that of the SEND MAP vector. The main difference is that there are no fields giving the offset and length of the ADS.

Do this to interpret a RECEIVE MAP vector (assuming that the message contains an ADSD or ADSDL):

1. GET the message containing the RECEIVE MAP request vector from the bridge reply queue into a message buffer.
2. Locate the start of the outbound RECEIVE MAP vector in the message buffer. This is appended to the CIH and so is at an offset equal to the length of the CIH from the start of the message buffer. You can use this code fragment as a model.

```c
/* #includes */
#include cmqc.h /* WebSphere MQ header */
#include dfhbrmqh.h /* Vector structures */

/* #defines */
MQCHAR * MsgBuffer ; /* Message buffer pointer */
brmq_receive_map_request * pVector ; /* Vector pointer */

/* Get message from reply queue */
/* Set the vector pointer to the start of the vector */
pVector = MsgBuffer + ((MQCIH *) MsgBuffer)->StrucLength ;

3. Identify the starting address ADSD or ADSDL from the RECEIVE MAP vector. This following diagram shows the structure of an outbound RECEIVE MAP request vector (the diagram assumes that you have set a pointer called `pVector` to address the start of the `brmq_receive_map_request` vector, as in the code fragment above).

```
|--------x'vvvvvvvv'-----------------→|
 sizeof(brmq_receive_map_request)
 |------------------------→|
 1802 O --→ x'wwwwwwww' ←--
--------------- ... ----------------
|vvvv|FFFF|D444| |wwww| ADSD or |
|vvvv|1802|6000| |wwww| ADSDL |
--------------- ... ----------------
↑↑
pVector pVector->brmq_rmr_adsd_len
```

Values in the diagram shown like this:

ABCD
1234

show hexadecimal values as you would see them in an ISPF editor with 'hex on'. This is equivalent to the hexadecimal value x’A1B2C3D4’.

Field `pVector->brmq_rmr_adsd_len` gives the length of the ADSD or ADSDL. No offset is given since the ADSDL is appended directly to the `brmq_receive_map_request` vector.
4. Identify the fields in the ADSD or ADSDL. To do this, proceed in general as for the SEND MAP vector described above. Use the following code fragment, however, to set pointers to the start of the ADSD or ADSDL.

```c
if (mqcih.ADSDescriptor && MQCADSD_MSGFORMAT)
{
    pADSDL_D = pVector + sizeof(brmq_receive_map_request) ;
    :
}
else /* Short form */
{
    pADSD_D = pVector + sizeof(brmq_receive_map_request) ;
    :
}
:
```

The ADSD or ADSDL has exactly the same structure in the RECEIVE MAP vector as in the SEND MAP vector, so once you have identified its start address you can proceed as described for the SEND MAP vector.

**Example of an ADSDL and an ADS:**

An example showing parts of an ADSDL and an ADS is given here. For full details of all the fields, see the references already cited. Values in the diagrams shown like this:

```
ABCD
1234
```

show hexadecimal values as you would see them in an ISPF editor with “hex on”. This is equivalent to the hexadecimal value x’A1B2C3D4’.

This diagram shows the start of the ADSDL (even though the eyecatcher shows ADSL):

```
...½ADSL.............CHO  L ...............$...TRANID
00BCCED000000010000000000CD444444D40000000F0000010005400000ECDCC44... 
00581423000100030005386000000030000000E0000000000039159400...
↑                   ↑                   ↑                   ↑
|  adsdl_field_count | |  adsdl_first_field |
| adsdl_length       | | adsdl_map_columns  |
| adsdl_map_lines    |
```

The fields named in this example show the following:

- **adsdl_length**
  - This shows that this ADSDL is 0x05B8 bytes long

- **adsdl_field_count**
  - There are 0x1B (27) named fields in the ADS

- **adsdl_map_lines**
  - The map has 0x18 (24) lines

- **adsdl_map_columns**
  - The map has 0x50 (80) columns

- **adsdl_first_field**
  - This is the start of the first field description in the ADSDL.
ADSDL and ADS example

The next diagram shows the ADSDL first field descriptor and part of the next field descriptor.

```
TRANID ................L ..TERMID
EDCDCC44444444444444444444444444444400000000000000000D400ECDDCC4444444444...
3915940000000000000000000000000000060000000C00043000359494000000000000:
```

↑↑ ↑ ↑ ↑

| Offset to next field | Start of next field | Value of field |

The fields named in this example show the following:

**adsdl_field_name**
This is the name of the field in the ADS, in this case TRANID. Only the value of the field appears in the ADS, and not its name.

**adsdl_field_name_len**
This is the length of the name of the field, in this case six bytes.

**adsdl_field_offset**
This is the absolute offset of the field from the start of the ADS. The offset is given as 0x0C (twelve) bytes, even though this is the first field. The reason is that the first twelve bytes of the ADS are reserved and do not contain information for the application programmer.

**adsdl_field_data_len**
This is the data length of the named field, in this case four bytes.

**adsdl_next_field**
The start of the next field description.

The next diagram shows the start of the ADS, which is in long form. The values here relate directly to the sample ADSDL shown above and are for the field named as TRANID in `adsdl_field_name`.

```
....................................................BAAA............
0000000000000002000000000000000000000000000000000000CCCC000200000000...
000000000000000C0000000000000000000000000000000000002111000C00000000...
```

↑↑ ↑ ↑

| Offset to next field | Start of next field | Value of field |

The meanings of the values shown here are as follows:

**12 bytes reserved**
Reserved space at the start of every ADS, in both short and long form

**Offset to next field**
The information given for the current field is 0x2C bytes long, from the start of this fullword length value.

**Value of field**
The value of the field, whose name is identified as TRANID in the ADSDL, is BAAA. The offset of the data is always 0x28 bytes from the start of the field for an ADS in Long Form.

**Start of next field**
This is the start of the information for the next field in the ADS.

In this case, the field information is an exact multiple of fullwords. If this were not the case, padding bytes would appear after the data value and before the next field.
to ensure that it started on a fullword boundary. The padding bytes would be included in the ‘offset to next field’ value.

A number of attribute and extended attribute values for the field, not identified here, appear between the fullword giving the offset to the next field and the field value itself.

Transactions with start data

An application that starts a transaction that will issue an EXEC CICS RETRIEVE ... QUEUE(data-area) to retrieve its start data would send a message to the bridge with a RETRIEVE vector structure, which is defined in C as brmq_retrieve. The structure contains a character field of length eight bytes in which the application program must specify the name of the temporary storage queue that contains the data to be retrieved. A message containing a RETRIEVE vector is always the first in an exchange representing a conversation or pseudoconversation.

Programming for the distributed environment

CICS DPL programs and transactions can be driven through the CICS bridge when the client application resides on a workstation.

The main consideration when programming for the distributed environment is data conversion between the different encoding schemes and CCSID values of the workstation and z/OS. Conversion is carried out by two different routines, one for the MQCIH structure and another for the vector.

You can ensure that conversion of the MQCIH is achieved by specifying MQFMT_CICS in the MQMD.Format field. Vector conversion, however, requires a little more consideration.

CICS transactions in the distributed environment

Conversion is only supported by the CICS bridge for the outbound SEND MAP and RECEIVE MAP request vectors, and for the inbound RECEIVE MAP vector.

To achieve conversion of the SEND MAP and RECEIVE MAP vectors, do this:

- Make sure that you assemble your maps specifying DSECT=ADSDL in your DFHMSD macro. Your map must be assembled under CICS Transaction Server for OS/390 Version 1.2 or greater for the ADSD or ADSDL to be made available. If you do not have the original mapset definition, recreate the map using the CICS DFHBM SUP utility.
- Specify a value of MQCADSD_SEND+MQCADSD_MSGFORMAT in field MQCIH.ADSDescriptor. If you are using an ADSD or ADSDL to build your RECEIVE MAP ADS, you must also add in the value MQCADSD_RECV for this field.
- Specify a value of CSQCBDCI in field MQCIH.Format on every inbound message.

If you want to use vectors other than SEND MAP and RECEIVE MAP to drive transactions in the distributed environment, you must either write your own data conversion routines or create and interpret the data streams in the format required by z/OS.

The MQCIH.Format is always set to CSQCBDCO in outbound messages. If you want to specify another format type for outbound conversion, you must intercept...
the message by writing to a local reply queue. Change the value of MQCIH.Format to specify your own routine before sending it on to the remote environment.

No support is provided for conversion between workstation and mainframe formats of vectors other than SEND MAP (outbound) and RECEIVE MAP (both inbound and outbound).

**CICS DPL programs in the distributed environment**

If you are driving a DPL program that neither receives nor returns COMMAREA data, or if the COMMAREA data is purely character data, you can achieve data conversion by specifying MQFMT_STRING in field MQCIH.Format. If your COMMAREA data is not purely character data, you must write your own conversion routine.

### From 3270 legacy to 3270 bridge - an example

This Section illustrates the differences in the data flows that take place when a CICS 3270 transaction interacts with a 3270 terminal, and a CICS bridge application.

In this example, the transaction has an identifier of BAAA. It uses BMS maps, which allow the transaction to be adapted easily to run under the CICS bridge.

In the legacy environment, the transaction is started by entering its name at the CICS 3270 terminal and pressing ENTER. Logic in the transaction causes it to issue EXEC CICS SEND MAP the first time it is invoked in a pseudoconversation, and then to terminate by issuing EXEC CICS RETURN TRANSID(BAAA).

The user enters values into fields in the map that is displayed at the terminal, and then presses an AID key. Logic in the transaction the second time it is invoked causes it to issue EXEC CICS RECEIVE MAP to receive the map. It updates certain fields in the map by changing values in its own application data structure, and then issues EXEC CICS SEND MAP to redisplay the map at the user’s terminal.

The user can then update fields in the redisplayed map, and start the RECEIVE MAP - SEND MAP cycle again. The logic can be illustrated like this (where EC represent EXEC CICS):

<table>
<thead>
<tr>
<th>Terminal user</th>
<th>3270 Transaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAAA &lt;ENTER&gt;</td>
<td>&lt;Initial start&gt;</td>
</tr>
<tr>
<td></td>
<td>&lt;business logic&gt;</td>
</tr>
<tr>
<td></td>
<td>EC SEND MAP FROM(ads)</td>
</tr>
<tr>
<td></td>
<td>EC RETURN TRANSID(BAAA)</td>
</tr>
</tbody>
</table>

Update fields

<table>
<thead>
<tr>
<th>&lt;ENTER&gt;</th>
<th>EC RECEIVE MAP INTO(ads)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;ENTER&gt;</td>
<td>EC SEND MAP</td>
</tr>
<tr>
<td></td>
<td>EC RETURN TRANSID(BAAA)</td>
</tr>
</tbody>
</table>

Update fields

<table>
<thead>
<tr>
<th>&lt;ENTER&gt;</th>
<th>EC RECEIVE MAP</th>
</tr>
</thead>
</table>

When the transaction runs in the bridge environment, the physical terminal is replaced by an application. The logic of the 3270 transaction is unchanged, and the application data that it receives is the same, but the data that flows, and the means by which it is transmitted, are different. Instead of a 3270 data stream, a
WebSphere MQ message is used that contains an MQCIH structure (a CICS Information Header), a bridge vector structure, and optionally a representation of the application data structure.

Inclusion of these objects in the message depends on the direction in which the message flows (inbound to the bridge or outbound from the bridge), the sequence of the message in the exchange, and whether an application data structure descriptor has been requested by setting the appropriate value in a field in the MQCIH.

The section “Exact emulation - no optimization” shows the flows that take place when the above scheme is emulated exactly. There is scope for optimization by including more than one vector in inbound messages, as shown in the section “Improved emulation, with optimization” on page 298.

It is assumed that MQCIH.ADSDescriptor is set to MQCADSD_SEND + MQCADSD_RECV + MQCADSD_MSGFORMAT

so application data structure descriptors in long form are appended to both outbound and inbound application data structures during the exchange of messages.

For clarity, the details of messaging are omitted here. For a description of the queuing model used by the CICS bridge, see WebSphere MQ for z/OS Concepts and Planning Guide.

**Exact emulation - no optimization**

<table>
<thead>
<tr>
<th>WebSphere MQ Bridge Application</th>
<th>3270 Transaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQPUT to Bridge RequestQ</td>
<td>&lt;Initial start&gt;</td>
</tr>
<tr>
<td></td>
<td>&lt;business logic&gt;</td>
</tr>
<tr>
<td>MQGET from Bridge ReplyQ</td>
<td>EC SEND MAP FROM(ads)</td>
</tr>
<tr>
<td></td>
<td>EC RETURN TRANSID(BAAA)</td>
</tr>
<tr>
<td>MQPUT to Bridge RequestQ</td>
<td>&lt;Start&gt;</td>
</tr>
<tr>
<td></td>
<td>(Note 3)</td>
</tr>
<tr>
<td>MQGET from Bridge ReplyQ</td>
<td>EC RECEIVE MAP INTO(ads)</td>
</tr>
<tr>
<td></td>
<td>waits</td>
</tr>
<tr>
<td>Updates fields</td>
<td></td>
</tr>
<tr>
<td>MQPUT to Bridge RequestQ</td>
<td>(Note 5)</td>
</tr>
<tr>
<td>MQGET from Bridge ReplyQ</td>
<td>EC SEND MAP FROM(ads)</td>
</tr>
<tr>
<td></td>
<td>EC RETURN TRANSID(BAAA)</td>
</tr>
</tbody>
</table>
Emulation without optimization

Notes:
1. The initial flow from the application contains just an MQCIH. The MQCIH includes control information specifying which transaction is to be started.
2. The return flow from the 3270 transaction contains an MQCIH, which has important information including a facility token to be used for all subsequent flows, and diagnostic information if an error has occurred. It also contains a SEND MAP vector structure containing control information relating to the map itself, and data that represents the map. If the initiating application has requested it, an application data structure descriptor is also be included.
3. The bridge application sends a message back containing only an MQCIH. This contains control information to start the transaction once more.
4. The 3270 transaction issues EC RECEIVE MAP, as it did in the legacy environment. However, in the bridge environment the map data is not immediately available. The call is converted to a message containing an outbound RECEIVE MAP request vector. The application data structure descriptor is also included in the message. In this example, the transaction waits while the message is turned around by the bridge application. The model here is a little different to that in the legacy environment. Note, however, that the bridge architecture allows messages to contain more than one vector, so a number of requests could be satisfied by a single inbound message.
5. Having updated any fields it needs to in the application data structure, the bridge application sends an inbound RECEIVE MAP reply vector to satisfy the outbound request.
6. The 3270 transaction issues EC SEND MAP, which converts to a SEND MAP vector, and the cycle repeats.

If you examine the flows that are captured when such a transaction is run using the Passthrough tool (CICS SupportPac CA1E "CICS 3270 Bridge Passthrough"), you will be able to identify the structures with the help of the available online documentation.

Improved emulation, with optimization

<table>
<thead>
<tr>
<th>WebSphere MQ Bridge Application</th>
<th>3270 Transaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQPUT to &quot;MQCIH&quot;&lt;br&gt;Bridge RequestQ</td>
<td>&lt;Initial start&gt; &lt;business logic&gt;</td>
</tr>
<tr>
<td>MQGET from &quot;MQCIH+brmq_send_map+ADS+ADSDL&quot;&lt;br&gt;Bridge ReplyQ</td>
<td>EC SEND MAP FROM(ads)&lt;br&gt;EC RETURN&lt;br&gt;TRANSID(BAAA)</td>
</tr>
<tr>
<td>MQPUT to &quot;MQCIH+brmq_receive_map+ADS&quot;&lt;br&gt;Bridge RequestQ</td>
<td>EC RECEIVE MAP INTO(ads)&lt;br&gt;EC SEND MAP FROM(ads)&lt;br&gt;EC RETURN&lt;br&gt;TRANSID(BAAA)</td>
</tr>
<tr>
<td>MQGET from &quot;MQCIH+brmq_send_map+ADS+ADSDL&quot;&lt;br&gt;Bridge ReplyQ</td>
<td></td>
</tr>
</tbody>
</table>

If you compare this sequence with the unoptimized flows shown at the section "Exact emulation - no optimization" on page 297, you can see that the CICS...
transaction does not have to send a RECEIVE MAP request vector, because the
inbound RECEIVE MAP vector has already anticipated the requirement and the
inbound map is already available to the transaction.

### Setting fields in the MQMD and MQCIH structures

Your CICS bridge application must set a number of fields in the MQMD and the
MQCIH in order to use the bridge successfully. You need to consider the open
options and the put message options that you use for the bridge request queue if
the bridge monitor is started with authorization levels of VERIFY_UOW or
VERIFY_ALL.

#### Setting the MQMD fields

Fields in the MQMD that can affect the operation of the CICS bridge need to be
initialized in your application program:

**MQMD.Format**
- Set the value to MQCICS if you include an MQCIH in the message you
  send to the bridge request queue, otherwise set it to MQFMT_NONE.

**MQMD.MsgId**
- For MQPUTs to the request queue, set the value to MQMI_NONE in every
  message.
- For MQGETs from the reply queue, use the value of MQMD.MsgId that
  WebSphere MQ set in your message descriptor when you put your first
  message to the request queue.

**MQMD.CorrelId**
- For MQPUTs to the request queue, set the value to MQCI_NEW_SESSION
  in the first or only message in a unit of work. On subsequent messages in
  the unit of work, set the value to MQMD.MsgId that WebSphere MQ set in
  your message descriptor when you put your first message to the request
  queue.
- For MQGETs from the reply queue, use the value of MQMD.MsgId that
  WebSphere MQ set in your message descriptor when you put your most
  recent message to the request queue, or specify MQCI_NONE.

**MQMD.ReplyToQ**
- Set the value to the name of the queue where you want the bridge to send
  reply messages.

**MQMD.UserIdentifier**
- This field is only used when the bridge monitor is running with
  authorization levels of IDENTIFY, VERIFY_UOW or VERIFY_ALL. If you
  use any of these, set the value to the user ID that will be checked for
  access to the CICS DPL program.
- You must add the value MQOO_SET_IDENTITY_CONTEXT to the open
  options when you open the bridge request queue, and also add the value
  MQPMO_SET_IDENTITY_CONTEXT to the put message options when
  you send a message to the queue.
- If you use this field with one of the VERIFY_* options, the
  MQCIH.Authenticator field must also be initialized. Set it to the value of
  the password or passticket associated with the User ID.
Setting the MQCIH fields

The MQCIH contains both input and output fields. The input fields that you need to initialize in your application program when you use the CICS bridge are as follows.

MQCIH.Format
Set the value to "CSQCBDCI". This informs the bridge that any data following the MQCIH is inbound to the bridge, and may need to be converted. The bridge will set the value of MQCIH.Format in the outbound message, which is returned to the reply queue, to "CSQCBDCO".

MQCIH.UOWControl
This field controls the unit of work processing performed by the bridge. Allowed values are described in WebSphere MQ Application Programming Reference. Select the required value from the ones that are available, noting that most are valid for the DPL bridge only, and not for the 3270 bridge. See also "Managing units of work for the CICS DPL bridge" on page 280 and "Managing units of work for the CICS 3270 bridge" on page 285.

MQCIH.GetWaitInterval
If you allow this to default, the bridge task GET WAIT interval for messages within a unit of work will be the value specified on the WAIT parameter when the bridge monitor was started. If you also allow the WAIT parameter to default, the GET WAIT interval will be unlimited.

MQCIH.LinkType
You must specify MQCLT_PROGRAM if you are using the DPL bridge, or MQCLT_TRANSACTION if you are using the 3270 bridge.

MQCIH.OutputDataLength
This applies only to the DPL bridge. See WebSphere MQ Application Programming Reference for details.

MQCIH.FacilityKeepTime
This applies to the 3270 bridge only. If you are sending more than a single message in a pseudoconversation, you must set this to a non zero value in the first message for the bridge to return a facility token. Successive transactions in a pseudoconversation can use the same facility token once it has been set in this way, ensuring that associated terminal areas - for example the TCTUA - are preserved for the period of the pseudoconversation.

Note also that the value of MQCIH.Facility must be set to MQCFAC_NONE in the first message in order to receive a facility token from the bridge.

MQCIH.ADSDescriptor
This field applies only to the 3270 bridge for transactions that use BMS SEND MAP and RECEIVE MAP calls. If this is the case, and the application that is sending bridge request messages is on a workstation, you must set this value to MQCADSD_SEND + MQCADSD_RECV + MQCADSD_MSGFORMAT. This will ensure that the vectors in the bridge request and reply messages are correctly converted between the different CCSID and encoding schemes of the workstation and the mainframe.

MQCIH.ConversationalTask
This applies to the 3270 bridge only. See WebSphere MQ Application Programming Reference for details.
MQCIH.Facility
This applies to the 3270 bridge only. Ensure that this is set to MQCFAC_NONE in the first message in a pseudoconversation, and also ensure that the MQCIH.FacilityKeepTime is set to a non zero value. The bridge will return a facility token in the first message, and this value must be used in all subsequent inbound messages in the pseudoconversation.

MQCIH.Authenticator
This field only applies if you are using an authorization level of VERIFY_UOW or VERIFY_ALL. VERIFY_UOW is available to both the 3270 bridge and the DPL bridge, but VERIFY_ALL is available only to the DPL bridge.

Set the value to the password or passticket that is to be associated with the user ID in the MQMD.UserID field. Together, the values will be used by the external security manager to determine whether the user is authorized to start the 3270 transaction or link to the DPL program.

MQCIH.ReplyToFormat
Set this to MQFMT_NONE (the default value) if your application and the bridge are running in the same CCSID and encoding environment. Otherwise, set the value to MQFMT_CICS.

MQCIH.TransactionId
If you are using the DPL bridge, use the default value (four spaces) unless you want the bridge to run the DPL program under a transaction code other than the default value of CKBP. See WebSphere MQ Application Programming Reference for details of how to specify a different transaction code.

If you are using the 3270 bridge, this is the transaction identifier of the user transaction that run as the bridge task. The first message must specify the first transaction to be started. You should set this field in subsequent messages to the value of MQCIH.NextTransactionId that is returned in the preceding reply message.

MQCIH.FacilityLike
You can either use the default value of four spaces, or you can specify the name of an installed terminal. You can find the names of installed terminals by entering the CICS command CEMT I TASK or a CEMT I TERM at a CICS terminal.

MQCIH.AttentionId
Set this field to a value representing the AID key expected by the transaction, if any, otherwise accept the default value of four spaces, which will appear to the CICS transaction as the ENTER AID key.

The inbound RECEIVE, RECEIVE MAP and CONVERSE vectors also have fields in which you can specify AID values. The value in the MQCIH is the value to which EIBAID is set to when the application is started. It represents the PF key used to start the transaction. The value in the inbound vector is the value used when the data is entered. For example, this would be the value of EIBAID after the EXEC CICS RECEIVE MAP instruction.

Notes:
1. For conversational transactions there would be separate values for the initial MQCIH value and the value on the vector.
2. If the WebSphere MQ application is sending a message in response to a request vector, the value in the MQCIH is ignored.
Setting MQCIH fields

3. In the case of pseudoconversational transactions, the same value should be entered in the MQCIH and the first vector.

The first byte of this field is set to the value in the CICS copybook DFHAID.

MQCIH.StartCode

Change the value of this field from the default value of MQCSC_NONE only if you are starting a 3270 transaction. The value you use depends on the nature of the transaction. Use a value of MQCSC_START if the transaction is started by an EXEC CICS START command without data, and it does not issue EXEC CICS RETRIEVE. Use a value of MQCSC_STARTDATA if the transaction is started by an EXEC CICS START command with data, and it issues EXEC CICS RETRIEVE. Otherwise, use a value of MQCSC_TERMINPUT.

Setting the open options and put message options for the bridge request queue

If you start the bridge monitor with authorization levels of IDENTIFY, VERIFY_UOW or VERIFY_ALL, you must open the bridge request queue with open options that include MQOO_SET_IDENTITY_CONTEXT. You must also include a value of MQPMO_SET_IDENTITY_CONTEXT in your put message options.

Managing MsgId and CorrelId in a unit of work

The following diagrams summarize the values that you should use and expect in key fields in the MQMD and MQCIH in typical CICS DPL bridge and CICS 3270 bridge applications.

In Figure 16 on page 303 running more than one user program using the DPL bridge, the MsgId of the request message is set by the queue manager (to M1), and subsequently copied to the CorrelId. Figure 17 on page 304 shows a conversational 3270 transaction.
Figure 16. Setting of key fields for many CICS user programs in a unit of work
Errors detected by the CICS bridge cause the bridge to:

- Back out the unit of work
- Copy request messages to the dead-letter queue
- Send an error reply message back to the client if a reply-to queue is available
- Write a CSQC7nn message to the CICS CSMQ transient data queue or issue a transaction abend. Where it is possible to put a message on the reply-to queue, the message will contain this abend code

Any further request messages in the same unit of work are removed from the request queue and copied to the dead-letter queue, either during error processing for this unit of work or at the next initialization of the monitor. No further error messages are generated.
Unexpected messages are removed from the request queue during monitor initialization and put on the dead-letter queue, passing all context. No error reply messages are generated.

If sending a reply message fails, the CICS Bridge puts the reply on the dead-letter queue, passing identity context from the CICS bridge request queue. A unit of work is not backed out if the reply message is successfully put on the dead-letter queue. Failure to put a reply message on the dead-letter queue is treated as a request error, and the unit of work is backed out.

If the CICS bridge fails to put a request message on the dead-letter queue, the CICS bridge task abends and leaves the CICS bridge monitor to process the error. If the monitor fails to copy the request to the dead-letter queue, the monitor abends.

Failure to put an error reply is ignored by the CICS bridge. The request message has already been copied to the dead-letter queue and the unit of work has been backed out by WebSphere MQ.

Figure 18 shows what happens when an error occurs in a unit of work.

In this figure:
- The client application sends a request message to run a CICS program named P1. The queue manager used by the client receives the message.
- The monitor task browses the request queue awaiting the arrival of a message. When a message arrives, it:
Bridge error handling

- Gets the request message with browse
- Checks for any problems with the request message
- Starts a CICS bridge task
- Continues browsing the request queue

The CICS bridge task
- Gets the request message from the request queue under syncpoint control
- Takes the information in the request message and builds a COMMAREA for program P1
- Issues an EXEC CICS LINK call to program P1
- Waits for program P1 to complete

When these tasks are complete, the user program abends.

The CICS bridge task abend handler is driven, which:
- Issues an EXEC CICS SYNCPOINT ROLLBACK which:
  - Backs out all the changes made by P1
  - Reinstates the request message on the request queue
- Gets the request message a second time from the request queue, again under syncpoint control
- Copies the request to the dead-letter queue
- Puts an error reply to the reply-to queue

If the request message includes the name of a reply-to queue:
- Writes a CSQC7nn message to the CICS CSMT transient data queue

Debugging CICS bridge applications

This section describes some common symptoms when your bridge application appears not to work as you might expect, and suggests procedures for diagnosing the problem.

Message is PUT to the bridge request queue, but is not processed by the bridge monitor

1. Check that the bridge monitor is running. Issue CEMT I TASK and look for CKBR, or whatever other transaction identifier you are using for the bridge monitor.

   If it is not running and you are expecting it to be triggered, make sure that the triggering options on the bridge request queue are correct. You should use a queue attribute of TRIGTYPE(FIRST).

   If the bridge monitor was running but is no longer running, check the output in the CICS MSGUSR log to see if there has been an error that has caused the bridge monitor to terminate.

2. If the bridge request queue is defined with QSGDISP(SHARED), check that it also specifies INDXTYPE(CORRELID).

3. Browse the inbound message that is not being processed and check that the values of MQMD.MsgId and MQMD.CorrelId are correct. If this is the first message in a unit of work or a pseudoconversation, MQMD.CorrelId must be set to a value of MQCI_NEW_SESSION and MQMD.MsgId must be set to MQMI_NONE (binary zeros).
4. If this is not the first message in a unit of work or pseudoconversation, ensure that your application has checked previous reply messages adequately for possible errors. As a minimum, it should check the following fields in the MQCIH:
   - MQCIH.ReturnCode
   - MQCIH.CompCode
   - MQCIH.TaskEndStatus
   - MQCIH.AbendCode
   - MQCIH.ErrorOffset

Inbound message is taken from the request queue by the bridge monitor, but the CICS DPL program or CICS transaction fails to run

1. Check the output in the CICS MSGUSR log. This will almost always report the reason why the DPL program or transaction failed to run. The common reasons for this are:
   - Program or transaction not defined to CICS. Use CEDA to define the program or transaction and run your bridge application again.
   - Insufficient authority to run the program or transaction. Details of how to control the level of authentication used by the CICS bridge are given in WebSphere MQ for z/OS System Setup Guide.

2. Check the message that is sent to the reply queue by the bridge monitor. If an error has occurred, it is likely that MQCIH.Format is set to MQFMT_STRING and an error message is appended to the MQCIH in place of a vector.

3. Check the dead letter queue to see if a reply message has been sent there by the bridge monitor. If it has, and the values of MQMD.MsgId and MQMD.CorrelId are correct, check the value of MQDLH.Reason. This should be set to a feedback code that indicates the reason for the failure.

For information on feedback codes, including those specific to the CICS Bridge, see “MQMD - Message descriptor” in the WebSphere MQ Application Programming Reference.

Bridge task abends

Abend codes are set in outbound messages in field MQCIH.AbendCode. In addition, the output in the CICS MSGUSR log reports abend codes for failing bridge tasks.

Abends ABR*, ABS* and ABX* are CICS bridge abends, and are documented in the CICS Messages and Codes book. Abends MBR* and MQB* are WebSphere MQ bridge abends, and are documented in WebSphere MQ for z/OS Messages and Codes.

Some common abend codes can be dealt with as follows:

**ABRG** An invalid bridge facility token was specified in an inbound message. Your first inbound message must always specify a value of MQCFAC_NONE in field MQCIH.Facility, and a non zero value in MQCIH.FacilityKeepTime. CICS will return a facility token in field MQCIH.Facility, and you can use this value in all subsequent inbound messages in the pseudoconversation.

**MBRJ** The MQCIH has invalid data. Check the values in the MQCIH field by field to find the one that is out of range.

**MBRN** The message is shorter than expected. There are one or two data length fields in every vector structure. The first is the very first fullword field in
Debugging bridge applications

the standard header for all vectors, and it should be equal to the overall length of the vector including the variable length data. Some vectors also contain another fullword length field which gives just the length of the variable length data. If these values indicate more data than there actually is, the bridge task will abend MBRN.

MBRO and MBRP

There is an error in the vector structure (not the variable length data). The MQCIH field ERROROFFSET give the offset of the field in error. Check the values of the fields in the vector against the permitted values, which are described in the CICS Internet and External Interfaces Guide for CICS V1.2, or the CICS External Interfaces Guide for CICS V1.3..

Bridge monitor errors

Some errors can cause the bridge monitor transaction, CKBR, to terminate unexpectedly. If you are using triggered queues to start the monitor, and there are still messages on the bridge request queue, the CKTI transaction may attempt to restart CKBR. If the original error persists, this can lead to a loop of CKBR failures. To halt the loop you can set off the TriggerControl attribute of the request queue while you diagnose and fix the underlying problem.

The bridge monitor can fail if it does not have sufficient authority to access the queues or CICS transactions, if it is unable to write to the dead letter queue or it encounters problems when executing CICS or MQ services.

Application data structure terminology

Application data structure

The application data structure is the copybook generated during assembly of a BMS map. It has the mnemonic ADS, and it can be created in short form or long form. You will sometimes see the long form referred to as ADSL.

The short form of the ADS has fields that are not fullword aligned, whereas the long form of the ADS has all its fields fullword aligned.

The short form of the ADS is generated by default by map assembly. In order to obtain the long form of the ADS, you must assemble your BMS maps with the following parameters specified in the DFHMSD macro:

MSETNAM DFHMSD...
DSECT=ADSL, *
LANG=C, *

If you examine the DSECT that is produced on map assembly, you will see that all of the fields are fullword aligned. Be aware that this significantly increases the size of the application data structure and any message which includes it.

This option is only available for programs written in the C-language. However, it is possible to create COBOL data structures from such a DSECT by manually creating them. The redbook CICS Transaction Server for OS/390 Version 1 Release 3: Web Support and 3270 Bridge gives examples of this.


**Application data structure descriptor**

The application data structure descriptor is an architected structure that allows an application to interpret the application data structure in a vector without having access to the copybook generated during map assembly.

There are two forms of the application data structure descriptor:

- The application data structure descriptor in short form contains fields that are not fullword aligned. It has the mnemonic ADSD.
- The application data structure descriptor in long form contains fields that are all fullword aligned. It has the mnemonic ADSDL.

**ADSL – an ambiguous mnemonic**

The mnemonic ADSL is ambiguous, and is sometimes used to refer to the application data structure in long form, and sometimes the application data structure descriptor in long form. The correct mnemonic for the application data structure descriptor, long form, is ADSDL. However, if you look at the eye-catcher in the ADSDL you will see that it is ADSL, which leads to the ambiguity. The correct use of ADSL is to describe the application data structure, not its descriptor, in long form.
ADS terminology
Chapter 18. IMS and IMS Bridge applications on WebSphere MQ for z/OS

This chapter helps you to write IMS applications using WebSphere MQ.

- To use syncpoints and MQI calls in IMS applications, see “Writing IMS applications using WebSphere MQ”.
- To write applications that exploit the WebSphere MQ-IMS Bridge, see “Writing WebSphere MQ-IMS bridge applications” on page 315.

Writing IMS applications using WebSphere MQ

This section discusses the following subjects that you should consider when using WebSphere MQ in IMS applications:

- “Syncpoints in IMS applications”
- “MQI calls in IMS applications”

Syncpoints in IMS applications

In an IMS application, you establish a syncpoint by using IMS calls such as GU (get unique) to the IOPCB and CHKP (checkpoint). To back out all changes since the previous checkpoint, you can use the IMS ROLB (rollback) call. For more information, see the following:

- IMS/ESA Application Programming: Transaction Manager
- IMS/ESA Application Programming: Design Guide

The queue manager is a participant in a two-phase commit protocol; the IMS syncpoint manager is the coordinator.

All open handles are closed by the IMS adapter at a syncpoint (except in a batch-oriented BMP). This is because a different user could initiate the next unit of work and WebSphere MQ security checking is performed when the MQCONN, MQCONNX, and MQOPEN calls are made, not when the MQPUT or MQGET calls are made.

Handles are also closed after a ROLB call unless you are running IMS Version 3 or are running a batch-oriented BMP.

If an IMS application (either a BMP or an MPP) issues the MQDISC call, open queues are closed but no implicit syncpoint is taken. If the application closes down normally, any open queues are closed and an implicit commit occurs. If the application closes down abnormally, any open queues are closed and an implicit backout occurs.

MQI calls in IMS applications

This section covers the use of MQI calls in the following types of IMS applications:

- “Server applications” on page 312
- “Enquiry applications” on page 314
Server applications

Here is an outline of the MQI server application model:

Initialize/Connect

Open queue for input shared

Get message from WebSphere MQ queue

Do while Get does not fail

If expected message received
  Process the message
Else
  Process unexpected message
End if

Commit

Get next message from WebSphere MQ queue

End do

Close queue/Disconnect

END

Sample program CSQ4ICB3 shows the implementation, in C/370™, of a BMP using this model. The program establishes communication with IMS first, and then with WebSphere MQ:

main()

----

Call InitIMS

If IMS initialization successful
  Call InitMQM
    If WebSphere MQ initialization successful
      Call ProcessRequests
      Call EndMQM
    End-if
  End-if
End-if

Return

The IMS initialization determines whether the program has been called as a message-driven or a batch-oriented BMP and controls WebSphere MQ queue manager connection and queue handles accordingly:

InitIMS

-------

Get the IO, Alternate and Database PCBs
Set MessageOriented to true

Call ctdli to handle status codes rather than abend
If call is successful (status code is zero)
  While status code is zero
    Call ctdli to get next message from IMS message queue
    If message received
      Do nothing
    Else if no IOPBC
      Set MessageOriented to false
      Initialize error message
      Build 'Started as batch oriented BMP' message
      Call ReportCallError to output the message
    End-if
  Else if response is not 'no message available'
    Initialize error message

MQI calls in IMS applications
The WebSphere MQ initialization performs queue manager connection opens the queues. In a Message-driven BMP this is called after each IMS syncpoint is taken; in a batch-oriented BMP, this is only called during program start-up:

```
InitMQM
-------
```

Connect to the queue manager
```
If connect is successful
   Initialize variables for the open call
   Open the request queue
```

If open is not successful
```
Initialize error message
   Build 'open failed' message
   Call ReportCallError to output the message
   Set return code to error
```

Else
```
Initialize error message
   Build 'connect failed' message
   Call ReportCallError to output the message
   Set return code to error
```

Return to calling function

The implementation of the server model in an MPP is influenced by the fact that the MPP processes a single unit of work per invocation. This is because, when a syncpoint (GU) is taken, the connection and queue handles are closed and the next IMS message is delivered. This limitation can be partially overcome by one of the following:

- **Processing many messages within a single unit-of-work**
  This involves:
  - Reading a message
  - Processing the required updates
  - Putting the reply
  in a loop until all messages have been processed or until a set maximum number of messages has been processed, at which time a syncpoint is taken.

Only certain types of application (for example, a simple database update or inquiry) can be approached in this way. Although the MQI reply messages can be put with the authority of the originator of the MQI message being handled, the security implications of any IMS resource updates need to be addressed carefully.

- **Processing one message per invocation of the MPP and ensuring multiple scheduling of the MPP to process all available messages.**
Use the WebSphere MQ IMS trigger monitor program (CSQQTRMN) to schedule the MPP transaction when there are messages on the WebSphere MQ queue and no applications serving it.

If the MPP is started by the trigger monitor the queue manager name and queue name are be passed to the program, as shown in the following COBOL code extract:

* Data definition extract
01 WS-INPUT-MSG.
   05 IN-LL1 PIC S9(3) COMP.
   05 IN-ZZ1 PIC S9(3) COMP.
   05 WS-STRINGPARM PIC X(1000).
01 TRIGGER-MESSAGE.
   COPY CMQTMC2L.

* Code extract
GU-IOPCB SECTION.
   MOVE SPACES TO WS-STRINGPARM.
   CALL 'CBLTDL1' USING GU,
           IOPCB,
           WS-INPUT-MSG.
   IF IOPCB-STATUS = SPACES
       MOVE WS-STRINGPARM TO MQTMC.
   * ELSE handle error
   *
   * Now use the queue manager and queue names passed
   DISPLAY 'MQTMC-QMGRNAME ='
           MQTMC-QMGRNAME OF MQTMC '='.
   DISPLAY 'MQTMC-QNAME ='
           MQTMC-QNAME OF MQTMC '='.

The server model, which is expected to be a long running task, is better supported in a batch processing region, although the BMP cannot be triggered using CSQQTRMN.

**Enquiry applications**

A typical WebSphere MQ application initiating an inquiry or update works as follows:
- Gather data from the user
- Put one or more WebSphere MQ messages
- Get the reply messages (you might have to wait for them)
- Provide a response to the user

Because messages put on to WebSphere MQ queues do not become available to other WebSphere MQ applications until they are committed, they must either be put out of syncpoint, or the IMS application must be split into two transactions.

If the inquiry involves putting a single message, it is acceptable to use the “no syncpoint” option; however, if the inquiry is more complex, or resource updates are involved, you might get consistency problems if failure occurs and you don’t use syncpointing.

To overcome this, IMS MPP transactions using MQI calls could be split using a program-to-program message switch; see the *IMS/ESA Application Programming: Data Communication* for information about this. This would allow an inquiry program to be implemented in an MPP:

Initialize first program/Connect
Open queue for output
Put inquiry to WebSphere MQ queue
Switch to second WebSphere MQ program, passing necessary data in save pack area (this commits the put).

END.

Initialize second program/Connect.

Open queue for input shared.

Get results of inquiry from WebSphere MQ queue.

Return results to originator.

END.

Writing WebSphere MQ-IMS bridge applications

This section discusses writing applications to exploit the WebSphere MQ-IMS bridge. The following topics are discussed:

- “How the WebSphere MQ-IMS bridge deals with messages”
- “Writing your program” on page 321
- “Triggering” on page 322

For information about the WebSphere MQ-IMS bridge, see WebSphere MQ for z/OS Concepts and Planning Guide.

How the WebSphere MQ-IMS bridge deals with messages

When you use the WebSphere MQ-IMS bridge to send messages to an IMS application, you need to construct your messages in a special format. You must also put your messages on WebSphere MQ queues that have been defined with a storage class that specifies the XCF group and member name of the target IMS system. These are known as MQ-IMS bridge queues, or simply bridge queues.

A user does not need to sign on to IMS before sending messages to an IMS application. The user ID in the UserIdentifier field of the MQMD structure is used for security checking. The level of checking is determined when WebSphere MQ connects to IMS, and is described in the security section of WebSphere MQ for z/OS System Setup Guide. This enables a pseudo signon to be implemented.

The WebSphere MQ-IMS bridge accepts the following types of message:

- Messages containing IMS transaction data and an MQIIH structure (described in WebSphere MQ Application Programming Reference):

  MQIIH LLZZ<trancode><data>[LLZZ<data>][LLZZ<data>]

  Notes:
  1. The square brackets, [ ], represent optional multi-segments.
  2. The Format field of the MQMD structure must be set to MQFMT_IMS to use the MQIIH structure.

- Messages containing IMS transaction data but no MQIIH structure:

  LLZZ<trancode><data> \\[LLZZ<data>][LLZZ<data>]

WebSphere MQ validates the message data to ensure that the sum of the LL bytes plus the length of the MQIIH (if it is present) is equal to the message length.
How the IMS bridge deals with messages

When the WebSphere MQ-IMS bridge gets messages from the bridge queues, it processes them as follows:

- If the message contains an MQIIH structure the bridge verifies the MQIIH (see WebSphere MQ Application Programming Reference) builds the OTMA headers and sends the message to IMS. The transaction code is specified in the input message. If this is an LTERM, IMS replies with a DFS1288E message. If the transaction code represents a command, IMS executes the command, otherwise the message is queued in IMS for the transaction.

- If the message contains IMS transaction data, but no MQIIH structure, the IMS bridge makes the following assumptions:
  - The transaction code is in bytes 5 through 12 of the user data
  - The transaction is in non-conversational mode
  - The transaction is in commit mode 0 (commit-then-send)
  - The Format in the MQMD is used as the MFSMapName (on input)
  - The security mode is MQISS_CHECK

The reply message is also built without an MQIIH structure, taking the Format for the MQMD from the MFSMapName of the IMS output.

The WebSphere MQ-IMS bridge uses one or two Tpipes for each WebSphere MQ queue:

- A synchronized Tpipe is used for all messages using Commit mode 0 (COMMIT_THEN_SEND) (these show with SYN in the status field of the IMS /DIS TMEMBER client TPipe xxxx command)
- A non-synchronized Tpipe is used for all messages using Commit mode 1 (SEND_THEN_COMMIT)

The Tpipes are created by WebSphere MQ when they are first used. A non-synchronized Tpipe exists until IMS is restarted. Synchronized Tpipes exist until IMS is cold started. You cannot delete these Tpipes yourself.

Mapping WebSphere MQ messages to IMS transaction types

Table 14. Mapping WebSphere MQ messages to IMS transaction types

<table>
<thead>
<tr>
<th>WebSphere MQ message type</th>
<th>Commit-then-send (mode 0) - uses synchronized IMS Tpipes</th>
<th>Send-then-commit (mode 1) - uses non-synchronized IMS Tpipes</th>
</tr>
</thead>
</table>
| Persistent WebSphere MQ messages | • Recoverable full function transactions  
  • Irrecoverable transactions are rejected by IMS | • Fastpath transactions  
  • Conversational transactions  
  • Full function transactions |
| Nonpersistent WebSphere MQ messages | • Irrecoverable full function transactions  
  • Recoverable transactions are rejected by IMS | • Fastpath transactions  
  • Conversational transactions  
  • Full function transactions |

Note: IMS commands cannot use persistent WebSphere MQ messages with commit mode 0. See the IMS/ESA Open Transaction Manager Access User's Guide for more information.

If the message cannot be put to the IMS queue

If the message cannot be put to the IMS queue, the following action is taken by WebSphere MQ:

- If a message cannot be put to IMS because the message is invalid, the message is put to the dead-letter queue and a message is sent to the system console.
- If the message is valid, but is rejected by IMS, WebSphere MQ sends an error message to the system console, the message includes the IMS sense code, and
the WebSphere MQ message is put to the dead-letter queue. If the IMS sense code is 001A, IMS will send a WebSphere MQ message containing the reason for the failure to the reply-to queue.

Note: In the circumstances listed above, if WebSphere MQ is unable to put the message to the dead-letter queue for any reason, the message is returned to the originating WebSphere MQ queue. An error message is sent to the system console, and no further messages are sent from that queue.

To resend the messages, do one of the following:
- Stop and restart the Tpipes in IMS corresponding to the queue
- Alter the queue to GET(DISABLED), and again to GET(ENABLED)
- Stop and restart IMS or the OTMA
- Stop and restart your WebSphere MQ subsystem

• If the message is rejected by IMS for anything other than a message error, the WebSphere MQ message is returned to the originating queue, WebSphere MQ stops processing the queue, and an error message is sent to the system console.

If an exception report message is required, the bridge puts it to the reply-to queue with the authority of the originator. If the message cannot be put to the queue, the report message is put to the dead-letter queue with the authority of the bridge. If it cannot be put to the DLQ, it is discarded.

IMS bridge feedback codes
IMS sense codes are normally output in hexadecimal format in WebSphere MQ console messages such as CSQ2001I (for example, sense code 001A). WebSphere MQ feedback codes as seen in the dead-letter header of messages put to the dead-letter queue are decimal numbers.

The IMS bridge feedback codes are in the range 301 through 399. They are mapped from the IMS-OTMA sense codes as follows:
1. The IMS-OTMA sense code is converted from a hexadecimal number to a decimal number.
2. 300 is added to the number resulting from the calculation in 1, giving the WebSphere MQ Feedback code.

Refer to the IMS/ESA Open Transaction Manager Access Guide for information about IMS-OTMA sense codes.

The MQMD fields in messages from the IMS bridge
The MQMD of the originating message is carried by IMS in the User Data section of the OTMA headers. If the message originates in IMS, this is built by the IMS Destination Resolution Exit. The MQMD of a message received from IMS is built as follows:

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>StrucID</td>
<td>&quot;MD&quot;</td>
</tr>
<tr>
<td>Version</td>
<td>MQMD_VERSION_1</td>
</tr>
<tr>
<td>Report</td>
<td>MQRO_NONE</td>
</tr>
<tr>
<td>MsgType</td>
<td>MQMT_REPLY</td>
</tr>
<tr>
<td>Expiry</td>
<td>MQWI_UNLIMITED</td>
</tr>
<tr>
<td>Feedback</td>
<td>MQFB_NONE</td>
</tr>
<tr>
<td>Encoding</td>
<td>MQENC.Native (the encoding of the z/OS system)</td>
</tr>
</tbody>
</table>
How the IMS bridge deals with messages

CodedCharSetId
MQCCSI_Q_MGR (the CodedCharSetID of the z/OS system)

Format
MQFMT_IMS if the MQMD.Format of the input message is
MQFMT_IMS, otherwise IOPCB.MODNAME

Priority
MQMD.Priority of the input message

Persistence
Depends on commit mode: MQMD.Persistence of the input
message if CM-1; persistence will match recoverability of the IMS
message if CM-0

MsgId
MQMD.MsgId if MQRO_PASS_MSG_ID, otherwise New MsgId
(the default)

CorrelId
MQMD.CorrelId from the input message if
MQRO_PASS_CORREL_ID, otherwise MQMD.MsgId from the
input message (the default)

BackoutCount
0

ReplyToQ
Blanks

ReplyToQMgr
Blanks (set to local qmgr name by the queue manager during the
MQPUT)

UserIdentifier
MQMD.UserIdentifier of the input message

AccountingToken
MQMD.AccountingToken of the input message

ApplIdentityData
MQMD.ApplIdentityData of the input message

PutApplType
MQAT_XCF if no error, otherwise MQAT_BRIDGE

PutApplName
<XCFgroupName><XCFmemberName> if no error, otherwise
QMGR name

PutDate
Date when message was put

PutTime
Time when message was put

ApplOriginData
Blanks

The MQIIH fields in messages from the IMS bridge
The MQIIH of a message received from IMS is built as follows:

StrucId
"IIH "

Version
1

StrucLength
84

Encoding
MQENC_NATIVE

CodedCharSetId
MQCCSI_Q_MGR

Format
MQIIH.ReplyToFormat of the input message if
MQIIH.ReplyToFormat is not blank, otherwise IOPCB.MODNAME

Flags
0

LTermOverride
LTERM name (Tpipe) from OTMA header
How the IMS bridge deals with messages

MFSMapName
Map name from OTMA header

ReplyToFormat
Blanks

Authenticator
MQIIH.Authenticator of the input message if the reply message is being put to an MQ-IMS bridge queue, otherwise blanks.

TranInstanceId
Conversation ID / Server Token from OTMA header if in conversation, otherwise nulls

TranState
"C" if in conversation, otherwise blank

CommitMode
Commit mode from OTMA header ("0" or "1")

SecurityScope
Blank

Reserved
Blank

Reply messages from IMS
When an IMS transaction ISRTs to its IOPCB, the message is routed back to the originating LTERM or TPipe. These are seen in WebSphere MQ as reply messages. Reply messages from IMS are put onto the reply-to queue specified in the original message. If the message cannot be put onto the reply-to queue, it is put onto the dead-letter queue using the authority of the bridge. If the message cannot be put onto the dead-letter queue, a negative acknowledgement is sent to IMS to say that the message cannot be received. Responsibility for the message is then returned to IMS. If you are using commit mode 0, messages from that TPipe are not sent to the bridge, and remain on the IMS queue; that is, no further messages are sent until restart. If you are using commit mode 1, other work can continue.

If the reply has an MQIIH structure, its format type is MQFMT_IMS; if not, its format type is specified by the IMS MOD name used when inserting the message.

Using alternate response PCBs in IMS transactions
When an IMS transaction uses alternate response PCBs (ISRTs to the ALTPCB, or issues a CHNG call to a modifiable PCB), the Pre-routing Exit (DFSYPRX0) is invoked to determine if the message should be rerouted. If the message is to be rerouted, the Destination Resolution Exit (DFSYDRU0) is invoked to confirm the destination and prepare the header information. See WebSphere MQ for z/OS System Setup Guide for information about these exit programs.

Unless action is taken in the exits, all output from IMS transactions initiated from a WebSphere MQ queue manager, whether to the IOPCB or to an ALTPCB, will be returned to the same queue manager.

Sending unsolicited messages from IMS
To send messages from IMS to a WebSphere MQ queue, you need to invoke an IMS transaction that ISRTs to an ALTPCB. You need to write pre-routing and destination resolution exits to route unsolicited messages from IMS and build the OTMA user data, so that the MQMD of the message can be built correctly. See the WebSphere MQ for z/OS System Setup Guide for information about these exit programs.

Note: The WebSphere MQ-IMS bridge does not know whether a message it receives is a reply or an unsolicited message. It handles the message the same way in each case, building the MQMD and MQIIH of the reply based on the OTMA UserData that arrived with the message.
How the IMS bridge deals with messages

Unsolicited messages can create new Tpipes. For example if an existing IMS transaction switched to a new LTERM (for example PRINT01) but the implementation required that the output be delivered through OTMA; a new Tpipe (called PRINT01 in this example) would be created. By default this will be a non-synchronized Tpipe. If the implementation requires the message to be recoverable the destination resolution exit Output flag must be set. See the IMS Customization Guide for more information.

Message segmentation
IMS transactions may be defined as expecting single- or multi-segment input. The originating WebSphere MQ application must construct the user input following the MQIIH structure as one or more LLZZ-data segments. All segments of an IMS message must be contained in a single WebSphere MQ message sent with a single MQPUT.

The maximum length of any one LLZZ-data segment is defined by IMS/OTMA (32764 bytes). The total WebSphere MQ message length is the sum of the LL bytes, plus the length of the MQIIH structure.

All the segments of the reply are contained in a single WebSphere MQ message.

There is a further restriction on the 32 KB limitation on messages with format MQFMT_IMS_VAR_STRING. When the data in an ASCII mixed CCSID message is converted to an EBCDIC mixed CCSID message, a shift-in byte or a shift-out byte is added every time there is a transition between SBCS and DBCS characters. The 32 KB restriction applies to the maximum size of the message. That is, because the LL field in the message cannot exceed 32 KB, the message must not exceed 32 KB including all shift-in and shift-out characters. The application building the message must allow for this.

Data conversion
The data conversion (including the calling of any necessary exits) is performed by the distributed queuing facility when it puts a message to a destination queue that has XCF information defined for its storage class. Any exits needed must be available to the distributed queuing facility in the data set referenced by the CSQXLIB DD statement. This means that you can send messages to an IMS application using the WebSphere MQ-IMS bridge from any WebSphere MQ platform.

Note: Because the WebSphere MQ-IMS bridge does not convert messages when it gets a message, messages arriving through the CICS distributed queuing facility are not converted.

If there are conversion errors, the message is put to the queue unconverted; this results eventually in it being treated as an error by the WebSphere MQ-IMS bridge, because the bridge cannot recognize the header format. If a conversion error occurs, an error message is sent to the z/OS console.


Sending messages to the WebSphere MQ-IMS bridge: To ensure that conversion is performed correctly, you must tell the queue manager what the format of the message is. If the message has an MQIIH structure, the Format in the MQMD must be set to the built-in format MQFMT_IMS, and the Format in the MQIIH must be set to the name of the format that describes your message data. If there is no MQIIH, set the Format in the MQMD to your format name.
If your data (other than the LLZZs) is all character data (MQCHAR), use as your format name (in the MQIIH or MQMD, as appropriate) the built-in format MQFMT_IMS_VAR_STRING. Otherwise, use your own format name, in which case you must also provide a data-conversion exit for your format. The exit must handle the conversion of the LLZZs in your message, in addition to the data itself (but it does not have to handle any MQIIH at the start of the message).

If your application makes use of MFSMapName, you are recommended to use messages with the MQFMT_IMS instead, and define the map name passed to the IMS transaction in the MFSMapName field of the MQIIH.

Receiving messages from the WebSphere MQ-IMS bridge: If an MQIIH structure is present on the original message that you are sending to IMS, one is also present on the reply message.

To ensure your reply is converted correctly, follow these steps:

- If you have an MQIIH structure on your original message, specify the format you want for your reply message in the MQIIH ReplytoFormat field of the original message. This value is placed in the MQIIH Format field of the reply message. This is particularly useful if all your output data is of the form LLZZ<character data>.
- If you do not have an MQIIH structure on your original message, specify the format you want for the reply message as the MFS MOD name in the IMS application’s ISRT to the IOPCB.

Writing your program

The coding required to handle IMS transactions through WebSphere MQ is dependent on the message format required by the IMS transaction and the range of responses it may return. However, there are several points to be borne in mind when your application handles IMS screen formatting information.

When an IMS transaction is started from a 3270 screen, the message passes through IMS Message Format Services. This can remove all terminal dependency from the data stream seen by the transaction. When a transaction is started through OTMA, MFS is not involved. If application logic is implemented in MFS, this will have to be recreated in the new application.

In some IMS transactions, the end-user application can modify certain 3270 screen behavior, for example, highlighting a field which has had invalid data entered. This type of information is communicated by adding a two byte attribute field to the IMS message for each screen field needing to be modified by the program.

Thus, if you are coding an application to mimic a 3270, you need to take account of these fields when building or receiving messages.

You may need to code information in your program to process:

- Which key is pressed (Enter, PF1, ...)
- Where the cursor is when the message is passed to your application
- Whether the attribute fields have been set by the IMS application
  - High/normal/zero intensity
  - Color
  - Whether IMS is expecting the field back the next time enter is pressed
- Whether the IMS application has used null characters (X’3F’) in any fields.
Writing your IMS bridge application

If your IMS message contains only character data (apart from the LLZZ-data segment), and you are using an MQIIH structure, set the MQMD format to MQFMT_IMS and the MQIIH format to MQFMT_IMS_VAR_STRING.

If your IMS message contains only character data (apart from the LLZZ-data segment), and you are not using an MQIIH structure, set the MQMD format to MQFMT_IMS_VAR_STRING and ensure that your IMS application specifies MODname MQFMT_IMS_VAR_STRING when replying. If a problem occurs (for example, user not authorized to use the transaction) and IMS sends an error message, this will have a MODName of the form DFSMOx, where 'x' is a number between 1 and 5. This will be put in the MQMD.Format.

If your IMS message contains binary, packed, or floating point data (apart from the LLZZ-data segment), you will need to code your own data-conversion routines. Refer to the IMS/ESA Application Programming: Transaction Manager for information about IMS screen formatting.

Writing WebSphere MQ applications to invoke IMS conversational transactions

When you write an application which will invoke an IMS conversation, you should bear the following in mind:

- You must include an MQIIH structure with your application message.
- You must set the CommitMode in MQIIH to MQICM_SEND_THEN_COMMIT.
- To invoke a new conversation, set TranState in MQIIH to MQITS_NOT_IN_CONVERSATION.
- To invoke second and subsequent steps of a conversation, set TranState to MQITS_IN_CONVERSATION, and set TranInstanceId to the value of that field returned in the previous step of the conversation.
- There is no easy way in IMS to find the value of a TranInstanceId, should you lose the original message sent from IMS.
- The application must check the TranState of messages from IMS to check whether the IMS transaction has terminated the conversation.
- You can use /EXIT to end a conversation. You must also quote the TranInstanceId, set TranState to MQITS_IN_CONVERSATION, and use the WebSphere MQ queue on which the conversation is being carried out.
- You cannot use /HOLD or /REL to hold or release a conversation.
- Conversations invoked through the WebSphere MQ-IMS bridge are terminated if IMS is restarted.

Triggering

The WebSphere MQ-IMS bridge does not support trigger messages.

If you define an initiation queue that uses a storage class with XCF parameters, messages put to that queue are rejected when they get to the bridge.

Writing programs containing IMS commands

An application programme can build a WebSphere MQ message of the form LLZZ<command>, instead of a transaction, where <command> is of the form /DIS TRAN PART or /DIS POOL ALL. Most IMS commands can be issued in this way, see the IMS/ESA V6 OTMA Guide and Reference for details. The command output will be received in the WebSphere MQ reply message in the text form as would be sent to a 3270 terminal for display.
OTMA has implemented a special form of the IMS display transaction command, which will return an architected form of the output. The exact format is defined in the *IMS/ESA V6 OTMA Guide and Reference*. To invoke this form from a WebSphere MQ message, build the message data as before, for example `/DIS TRN PART`, and set the TranState field in the MQOOH to MQITS_ARCHITECTED. The command will be processed by IMS, and the reply returned in the architected form. An architected response contains all the information that could be found in the text form of the output, and one additional piece of information: whether the transaction is defined as recoverable or non-recoverable.
Writing your IMS bridge application
Chapter 19. Object-oriented programming with WebSphere MQ

WebSphere MQ provides a way of programming WebSphere MQ applications, that can be used from object-oriented programming languages. It is called the WebSphere MQ Object Model. Instead of calls and structures, the WebSphere MQ Object Model provides classes that provide the same functionality, but which are a more natural way of programming in an object-oriented environment.

What is in the WebSphere MQ Object Model?

The WebSphere MQ Object Model consists of the following:

- **Classes** representing familiar WebSphere MQ concepts such as queue managers, queues, and messages.
- **Methods** on each class corresponding to MQI calls.
- **Properties** on each class corresponding to attributes of WebSphere MQ objects.

When creating a WebSphere MQ application using the WebSphere MQ Object Model, you create instances of these classes in the program. An instance of a class in object-oriented programming is called an *object*. When an object has been created, you interact with the object by examining or setting the values of the object’s properties (the equivalent of issuing an MQINQ or MQSET call), and by making method calls against the object (the equivalent of issuing the other MQI calls).

Classes

The WebSphere MQ Object Model provides the following base set of classes. Note that the actual implementation of the model varies slightly between the different supported object-oriented environments.

**MQQueueManager**

An object of the MQQueueManager class represents a connection to a queue manager. It has methods to Connect(), Disconnect(), Commit(), and Backout() (the equivalent of MQCONN or MQCONNX, MQDISC, MQCMIT, and MQBACK). It has properties corresponding to the attributes of a queue manager. Note that accessing a queue manager attribute property implicitly connects to the queue manager if not already connected. Destroying an MQQueueManager object implicitly disconnects from the queue manager.

**MQQueue**

An object of the MQQueue class represents a queue. It has methods to Put() and Get() messages to and from the queue (the equivalent of MQPUT and MQGET). It has properties corresponding to the attributes of a queue. Note that accessing a queue attribute property, or issuing a Put() or Get() method call, implicitly opens the queue (the equivalent of MQOPEN). Destroying an MQQueue object implicitly closes the queue (the equivalent of MQCLOSE).

**MQMessage**

An object of the MQMessage class represents a message to be put on a queue or got from a queue. It contains a buffer, and encapsulates both application data and MQMD. It has properties corresponding to MQMD...
Object-oriented programming

fields, and methods that allow you to write and read user data of different types (for example, strings, long integers, short integers, single bytes) to and from the buffer.

MQPutMessageOptions
An object of the MQPutMessageOptions class represents the MQPMO structure. It has properties corresponding to MQPMO fields.

MQGetMessageOptions
An object of the MQGetMessageOptions class represents the MQGMO structure. It has properties corresponding to MQGMO fields.

MQProcess
An object of the MQProcess class represents a process definition (used with triggering). It has properties that represent the attributes of a process definition.

MQDistributionList
MQSeries or WebSphere MQ Version 5 products only, except WebSphere MQ for z/OS. An object of the MQDistributionList class represents a distribution list (used to send multiple messages with a single MQPUT). It contains a list of MQDistributionListItem objects.

MQDistributionListItem
MQSeries or WebSphere MQ Version 5 products only, except WebSphere MQ for z/OS. An object of the MQDistributionListItem class represents a single distribution list destination. It encapsulates the MQOR, MQRR, and MQPMR structures, and has properties corresponding to the fields of these structures.

Object references

In a WebSphere MQ program that uses the MQI, WebSphere MQ returns connection handles and object handles to the program. These handles must be passed as parameters on subsequent WebSphere MQ calls. With the WebSphere MQ Object Model, these handles are hidden from the application program. Instead, the creation of an object from a class results in an object reference being returned to the application program. It is this object reference that is used when making method calls and property accesses against the object.

Return codes

Issuing a method call or setting a property value results in return codes being set. These return codes are a completion code and a reason code, and are themselves properties of the object. The values of completion code and reason code are exactly the same as those defined for the MQI, with some extra values specific to the object-oriented environment.

Programming language considerations

The WebSphere MQ Object Model is implemented in C++, Java, and ActiveX.

Coding in C++
Refer to WebSphere MQ Using C++ for information about coding programs using the WebSphere MQ Object Model in C++.
Coding in Java

Refer to *WebSphere MQ Using Java* for information about coding programs using the WebSphere MQ Object Model in Java.

Coding in ActiveX

Refer to *WebSphere MQ for Windows, V5.3 Using the Component Object Model Interface* for information about coding programs using the WebSphere MQ Object Model in ActiveX.

The WebSphere MQ ActiveX is commonly known as the MQAX. The MQAX is included as part of WebSphere MQ for Windows. For earlier releases of WebSphere MQ for Windows, the MQAX and its documentation may be downloaded from the WebSphere MQ Web site as a SupportPac.
## Part 3. Building a WebSphere MQ application

<table>
<thead>
<tr>
<th>Chapter 20. Building your application on AIX</th>
<th>331</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXTSHM environment variable</td>
<td>331</td>
</tr>
<tr>
<td>Deciding if you need to set EXTSHM=ON</td>
<td>331</td>
</tr>
<tr>
<td>Preparing C programs</td>
<td>332</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>332</td>
</tr>
<tr>
<td>Preparing COBOL programs</td>
<td>333</td>
</tr>
<tr>
<td>Preparing COBOL programs using IBM COBOL</td>
<td>333</td>
</tr>
<tr>
<td>Preparing COBOL programs using Micro Focus COBOL</td>
<td>333</td>
</tr>
<tr>
<td>Preparing PL/I programs</td>
<td>334</td>
</tr>
<tr>
<td>Preparing CICS programs</td>
<td>334</td>
</tr>
<tr>
<td>CICS on Open Systems support</td>
<td>334</td>
</tr>
<tr>
<td>Preparing CICS COBOL programs using IBM COBOL</td>
<td>334</td>
</tr>
<tr>
<td>CICS on Open Systems support</td>
<td>334</td>
</tr>
<tr>
<td>Preparing CICS COBOL programs using Micro Focus COBOL</td>
<td>335</td>
</tr>
<tr>
<td>Preparing CICS C programs</td>
<td>335</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 21. Building your application on AT&amp;T GIS UNIX</th>
<th>337</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing C programs</td>
<td>337</td>
</tr>
<tr>
<td>C compiler flags</td>
<td>337</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>337</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 22. Building your application on Compaq NonStop Kernel</th>
<th>339</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit of work (transaction) management</td>
<td>339</td>
</tr>
<tr>
<td>General design considerations</td>
<td>339</td>
</tr>
<tr>
<td>Triggering applications</td>
<td>339</td>
</tr>
<tr>
<td>Supported programming languages and environments</td>
<td>339</td>
</tr>
<tr>
<td>Considerations for creating applications with threads</td>
<td>340</td>
</tr>
<tr>
<td>Compiling and binding applications</td>
<td>340</td>
</tr>
<tr>
<td>FASTPATH versus STANDARD bindings</td>
<td>341</td>
</tr>
<tr>
<td>STANDARD bindings</td>
<td>341</td>
</tr>
<tr>
<td>FASTPATH bindings</td>
<td>341</td>
</tr>
<tr>
<td>Running applications</td>
<td>342</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 23. Building your application on Compaq OpenVMS Alpha</th>
<th>343</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing C programs</td>
<td>343</td>
</tr>
<tr>
<td>C compiler version</td>
<td>343</td>
</tr>
<tr>
<td>C compiler flags</td>
<td>343</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>343</td>
</tr>
<tr>
<td>Preparing COBOL programs</td>
<td>344</td>
</tr>
<tr>
<td>COBOL compiler flags</td>
<td>344</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>344</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 24. Building your application on Compaq Tru64 UNIX</th>
<th>345</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building applications in C on Compaq Tru64 UNIX</td>
<td>345</td>
</tr>
<tr>
<td>Version 4.0</td>
<td>346</td>
</tr>
<tr>
<td>C language include files</td>
<td>346</td>
</tr>
<tr>
<td>Preparing C programs</td>
<td>347</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>347</td>
</tr>
</tbody>
</table>

| Building applications in C on Compaq Tru64 UNIX              | 347 |
| Version 5.0                                                | 348 |
| C language include files                                   | 348 |
| Preparing C++ programs                                     | 348 |
| Linking libraries                                          | 348 |

| Building applications in C++ on Compaq Tru64 UNIX           | 348 |
| UNIX Version 4.0                                           | 349 |
| C++ language include files                                 | 349 |
| Preparing C++ programs                                     | 349 |
| Linking libraries                                          | 349 |

| Building applications in C++ on Compaq Tru64 UNIX           | 349 |
| UNIX Version 5.0                                           | 350 |
| C++ language include files                                 | 350 |
| Preparing C++ programs                                     | 350 |
| Linking libraries                                          | 350 |

| Building applications in Java                              | 350 |
| Preparing Java programs                                    | 350 |

<table>
<thead>
<tr>
<th>Chapter 25. Building your application on HP-UX</th>
<th>351</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing C programs</td>
<td>351</td>
</tr>
<tr>
<td>Preparing C programs on HP-UX V11.00</td>
<td>351</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>352</td>
</tr>
<tr>
<td>Preparing COBOL programs</td>
<td>352</td>
</tr>
<tr>
<td>Programs to run in the WebSphere MQ client environment</td>
<td>353</td>
</tr>
<tr>
<td>Preparing CICS programs</td>
<td>353</td>
</tr>
<tr>
<td>CICS on Open Systems support</td>
<td>353</td>
</tr>
<tr>
<td>CICS C sample transaction</td>
<td>354</td>
</tr>
<tr>
<td>Preparing CICS COBOL programs using</td>
<td>354</td>
</tr>
<tr>
<td>Micro Focus COBOL</td>
<td>354</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 26. Building your application on Linux</th>
<th>355</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing C programs</td>
<td>355</td>
</tr>
<tr>
<td>Compiling C programs</td>
<td>355</td>
</tr>
<tr>
<td>Preparing C++ programs</td>
<td>355</td>
</tr>
<tr>
<td>Compilers for WebSphere MQ for Linux</td>
<td>355</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>356</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 27. Building your application on OS/2 Warp</th>
<th>357</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing C programs</td>
<td>357</td>
</tr>
<tr>
<td>Preparing C++ programs</td>
<td>357</td>
</tr>
<tr>
<td>Compiling C programs</td>
<td>357</td>
</tr>
<tr>
<td>Compilers for WebSphere MQ for Linux</td>
<td>357</td>
</tr>
<tr>
<td>Linking libraries</td>
<td>358</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 28. Building your application on OS/400</th>
<th>361</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing C++ programs</td>
<td>361</td>
</tr>
<tr>
<td>Preparing C programs</td>
<td>361</td>
</tr>
</tbody>
</table>

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329
Chapter 29. Building your application on SINIX or DC/OSx
Preparing C programs ........................................ 365
Preparing COBOL programs ................................. 365
Preparing CICS programs ..................................... 366
Preparing CICS programs using Micro Focus COBOL 367
Preparing CICS COBOL programs using Micro Focus COBOL . 367
Preparing CICS programs using Micro Focus COBOL . 367
Preparing CICS C programs .................................... 372
Chapter 30. Building your application on Solaris
Preparing C programs ........................................ 369
Preparing libraries ............................................ 370
Preparing COBOL programs ................................... 370
Preparing CICS programs ..................................... 371
Preparing CICS programs using Micro Focus COBOL . 372
Preparing CICS COBOL programs using Micro Focus COBOL . 372
Chapter 31. Building your application on VSE/ESA
Preparing C programs ........................................ 373
Preparing libraries ............................................ 373
Using the batch interface ..................................... 373
Preparing C programs ........................................ 373
Preparing COBOL programs ................................... 373
Preparing PL/I programs ....................................... 373
Chapter 32. Building your application on Windows systems
Preparing C programs ........................................ 375
Preparing CICS and Transaction Server programs .......... 376
Preparing COBOL programs ................................... 377
Preparing CICS and Transaction Server programs .......... 378
Preparing PL/I programs ....................................... 379
Preparing Visual Basic programs ............................ 379
Preparing Visual Basic programs ............................ 379
Preparing WebSphere MQ access control and Windows principals . 381
Chapter 33. Building your application on z/OS
Preparing your program to run ................................ 383
Building z/OS batch applications ............................ 384
Building CICS applications ................................... 385
Building IMS (BMP or MPP) applications ................. 386
Dynamically calling the WebSphere MQ stub ................ 387
Debugging your programs .................................... 391
Debugging CICS programs .................................... 392
CICS trace .................................................. 392
Chapter 34. Using lightweight directory access protocol services with WebSphere MQ for Windows
What is a directory service? .................................. 395
What is LDAP? ................................................ 395
Using LDAP with WebSphere MQ ............................ 396
LDAP sample program .......................................... 397
Building the sample program ................................ 397
Configuring the directory ...................................... 397
Configuring the IBM eNetwork LDAP server ............... 398
Configuring the Netscape directory server .................. 399
Running the sample program ................................ 399
Program design .............................................. 400
Debugging TSO programs ..................................... 394
Chapter 20. Building your application on AIX

The AIX publications describe how to build executable applications from the programs you write. This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building WebSphere MQ for AIX applications to run under AIX. C, C++, and COBOL are supported. For information about preparing your C++ programs, see the [WebSphere MQ Using C++](#).

The tasks you must perform to create an executable application using WebSphere MQ for AIX vary with the programming language your source code is written in. In addition to coding the MQI calls in your source code, you must add the appropriate language statements to include the WebSphere MQ for AIX include files for the language you are using. You should make yourself familiar with the contents of these files. See [Appendix F, “WebSphere MQ data definition files”, on page 591](#) for a full description.

When you run threaded server or threaded client applications under AIX 5.1 or AIX 4.3, set the environment variable "AIXTHREAD_SCOPE=S".

**EXTSHM environment variable**

AIX Version 4.3.1 introduced the EXTSHM environment variable to support use of the extended shared memory model. To use this memory model, export the variable “EXTSHM=ON” in the environment of the process.

WebSphere MQ makes use of the extended shared memory model. All WebSphere MQ processes automatically set EXTSHM in their environment and you should set this environment variable in the environment of all WebSphere MQ applications.

The EXTSHM environment variable must be set in the environment before the application starts. Using “putenv()” once the application has started will have no effect. For more information about the use of extended shared memory see the AIX documentation.

**Deciding if you need to set EXTSHM=ON**

By default, a program running under AIX may only attach 10 shared memory segments in the process address space. Setting the environment variable “EXTSHM=ON” allows many more segments to be attached.

A standard WebSphere MQ application tries to attach 5 shared memory segments, so even without EXTSHM set ON the application will be able to attach to a queue manager and function normally. However if the WebSphere MQ system is very busy, or if the application has many concurrent connections to the WebSphere MQ queue manager then it may need to attach more than the standard 5 shared memory segments.

Other parts of an application, for example database connections, may also use shared memory segments. If the total number of required segments exceeds 10, and EXTSHM is not set ON, then requests to the WebSphere MQ queue manager may fail.
Preparing C programs

Precompiled C programs are supplied in the /usr/mqm/samp/bin directory. Use the ANSI compiler and run the following command:

```
$ cc -o <amqsput> <amqsput>.c -lmqm
```

where <amqsput> is a sample program.

If you want to use the programs on a machine which has only the WebSphere MQ client for AIX installed, recompile the programs to link them with the client library (-lmqic) instead.

**Linking libraries**

You will need the following libraries:

- If your application is running in a DCE client environment you will need to copy the DCE library, libxdsom.a, on to your machine.
- You need to link your programs with the appropriate library provided by WebSphere MQ.

In a non-threaded environment you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm.a</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic.a</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

In a threaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm_r.a</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic_r.a</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

For example, to build a simple threaded WebSphere MQ application from a single compilation unit on AIX 4.3 run the following command:

```
$ xlc_r7 -o myapp myapp.c -lmqm_r
```

where myapp is the name of your program.

**Notes:**

1. If you are writing an installable service (see the WebSphere MQ System Administration Guide for further information), you need to link to the libmqmzf.a library in a non-threaded application and to the libmqmzf_r.a library in a threaded application.
2. If you are producing an XA switch load file for external coordination by an XA-compliant transaction manager such as IBM CICS, Transarc Encina, or Novell Tuxedo, you need to link to the libmqmx.a library in a non-threaded application and to the libmqmx_r.a library in a threaded application.
3. You need to link trusted applications to the threaded WebSphere MQ libraries. However, only one thread in a trusted application on WebSphere MQ on UNIX systems can be connected at a time.
4. To run the sample Encina program, link against the following libraries:
Preparing C programs

- libmqmxa_r.a
- libmqm_r.a

Also, link to the Encina and DCE libraries:
- libEncServer.a
- libEncina.a
- libdce.a

The sample must be compiled and linked using xlc_r4.

5. You must link WebSphere MQ libraries before any other product libraries (in this case, DCE and Encina). For example:
   
   cc -o put put.c -lmqm_r -ldce

   This ensures that any operating system functions that have been redefined by DCE are also used by WebSphere MQ.

Preparing COBOL programs

You need to link your program with one of the following:

libmqmcb.a
  Server for COBOL
libmqicb.a
  Client for COBOL
libmqmcb_r.a
  Server for COBOL (in a threaded application)

You can use the IBM COBOL Set compiler or Micro Focus COBOL compiler depending on the program:

- programs beginning amqi are suitable for the IBM COBOL Set compiler,
- programs beginning amqm are suitable for the Micro Focus COBOL compiler,

and

- programs beginning amq0 are suitable for either compiler.

Preparing COBOL programs using IBM COBOL Set for AIX

Sample COBOL programs are supplied with WebSphere MQ. To compile such a program, enter:

```
  cob2 -o amq0put0 amq0put0.cbl
  -L/usr/mqm/lib
  -lmqmcb -qLIB
  -I/usr/mqm/inc
```

Note: For threaded applications, cob2_r is used with the libmqmcb_r.a library.

Preparing COBOL programs using Micro Focus COBOL

Set environment variables before compiling your program as follows:

```
  export COBCPY=/usr/mqm/inc
  export LIB=/usr/mqm/lib;$LIB
```

To compile a COBOL program using Micro Focus COBOL, enter:

```
  cob -xvP amq0put0.cbl -lmqmcb
```

See the Micro Focus COBOL documentation for a description of the environment variables that need to be set up.
Preparing PL/I programs

Sample PL/I programs are supplied with WebSphere MQ. PL/I include files are also provided so that the C entry points in the WebSphere MQ libraries can be invoked directly.

To prepare a PL/I program:
1. Link your program with one of the libraries listed in "Linking libraries" on page 332.
2. Compile your program:
   `pli amqpput0.pli -I/usr/mqm/inc /usr/mqm/lib/libmqm.a`

Preparing CICS programs

XA switch modules are provided to enable you to link CICS with WebSphere MQ:

<table>
<thead>
<tr>
<th>Description</th>
<th>C (source)</th>
<th>C (exec) - add to your XAD.Stanza</th>
</tr>
</thead>
<tbody>
<tr>
<td>XA initialization routine</td>
<td>amqzscix.c</td>
<td>amqzsc21 - CICS for AIX</td>
</tr>
</tbody>
</table>

Always link your transactions with the thread safe WebSphere MQ library `libmqm_r.a`.

Note: On AIX Version 4, the `libmqm_r.a` library works with both native and DCE libraries.

Compile the program by typing:
```
xlC_r4 /usr/mqm/samp/amqzscix.c -I/usr/lpp/encina/include \
   -e amqzscix -o amqzscix /usr/lpp/cics/lib/regxa_swxa.o \
   -L/usr/lpp/cics/lib -L/usr/lpp/encina/lib -lmqmcics_r -lmqmxa_r -lmqm_r \
   -lcicsrt -lEncina -lEncServer -ldce
```

You can find more information about supporting CICS transactions in the WebSphere MQ System Administration Guide.

CICS on Open Systems support

WebSphere MQ on UNIX systems support CICS on Open Systems via the XA interface.

You must ensure that CICS COBOL applications are linked to the threaded version of the library. CICS on Open Systems WebSphere MQ transactions must link with `libmqm_r`, except on Solaris, where you must link with `lmqmc_sc_d`.

You can run CICS programs using IBM COBOL Set for AIX or Micro Focus COBOL. The following sections describe the difference between these.

Preparing CICS COBOL programs using IBM COBOL Set for AIX

To use IBM COBOL, follow these steps:
1. Export the following environment variable:
   ```
   export LDFLAGS="-qlIB -bI:/usr/lpp/cics/lib/cicsprIBMCOB.exp \ 
   -I/usr/mqm/inc -I/usr/lpp/cics/include \ 
   -e _iwz_cobol_main \ 
   -L/usr/lib/dce -lmqmcob_r -ldelibc_r -ldcethreads"
   ```
Preparing CICS programs

where LIB is a compiler directive.

2. Translate, compile, and link the program by typing:
   \texttt{cicstcl -l IBMCOB <yourprog>.ccp}

Preparing CICS COBOL programs using Micro Focus COBOL

To use Micro Focus COBOL, follow these steps:

1. Add the WebSphere MQ COBOL run-time library module to the run-time library using the following command:
   \texttt{cicsmkcobol -L/usr/lib/dce -L/usr/mqm/lib \\
   /usr/mqm/lib/libmqmcbrt.o -lmqm_r}

   This creates the Micro Focus COBOL language method file and enables the CICS run-time COBOL library to call WebSphere MQ on UNIX systems.

   \textbf{Note:} \texttt{cicsmkcobol} must be run only when one of the following is installed:
   \begin{itemize}
   \item New version or release of Micro Focus COBOL
   \item New version or release of CICS for AIX
   \item New version or release of any supported database product (for COBOL transactions only)
   \item CICS for AIX
   \end{itemize}

2. Export the following environment variables:
   \texttt{COBCPY=/usr/mqm/inc export COBCPY}
   \texttt{LDFLAGS=-L/usr/mqm/lib -lmqm_r export LDFLAGS}

3. Translate, compile, and link the program by typing:
   \texttt{cicstcl -l COBOL -e <yourprog>.ccp}

Preparing CICS C programs

You build CICS C programs using the standard CICS facilities:

1. Export \texttt{one} of the following environment variables:
   \begin{itemize}
   \item LDFLAGS = “-L/usr/mqm/lib -lmqm_r” export LDFLAGS
   \item USERLIB = “-L/usr/mqm/lib -lmqm_r” export USERLIB
   \end{itemize}

2. Translate, compile, and link the program by typing:
   \texttt{cicstcl -l C amqscic0.ccs}

\textbf{CICS C sample transaction:} Sample C source for a CICS WebSphere MQ transaction is provided by AMQSCIC0.CCS. The transaction reads messages from the transmission queue SYSTEM.SAMPLE.CICS.WORKQUEUE on the default queue manager and places them onto the local queue whose name is contained in the transmission header of the message. Any failures will be sent to the queue SYSTEM.SAMPLE.CICS.DLQ. The sample MQSC script AMQSCIC0.TST may be used to create these queues and sample input queues.
Chapter 21. Building your application on AT&T GIS UNIX

This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building MQSeries for AT&T GIS UNIX applications to run under AT&T GIS UNIX. C and C++ programming languages are supported.

In addition to coding the MQI calls in your source code, you must add the appropriate include files. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Preparing C programs

Precompiled C programs are found in the /opt/mqm/samp/bin directory. To build a sample from source code, use the C compiler in /bin/cc, for example:

```
/bin/cc -o <yourprog> <yourprog>.c -lmqm -lmqmcs -lmqmsze \ 
-net -lnsl -lsocket -ldl
```

Note: The backslash (\) represents the continuation of the line.

C compiler flags

The order of the libraries specified is important. The following is an example of how to build the sample program amqsput0:

```
/bin/cc -o <amqsput0> <amqsput0>.c -lmqic -lmqmcs -lmqmsze \ 
-net -lnsl -lsocket -ldl -lc
```

This links with the client library -lmqic, so allows you to use the programs on a machine which has only the WebSphere MQ client for GIS installed.

If you use the other version of the compiler (/usr/ucb/cc), your application may compile and link successfully. However when you run it, it will fail when it attempts to connect to the queue manager.

Linking libraries

You need to link your programs with the appropriate library provided by WebSphere MQ.

You must link to one or more of the following libraries:

Library file

Program/exit type

```
libmqm.so
    Server for C
libmqmzse.so
    For C
libmqic.so
    Client for C
libmqmcs.so
    Client for C
```

1. This platform has become NCR UNIX SVR4 MP-RAS, R3.0.

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Preventing C programs

Notes:

1. If you are writing an installable service (see *WebSphere MQ System Administration Guide* for further information), you need to link to the libmqmzf.so library.

2. If you are producing an XA switch load file for external coordination by an XA-compliant transaction manager such as IBM CICS, Transarc Encina, or Novell Tuxedo, you need to link to the libmqmx.a library.
Chapter 22. Building your application on Compaq NonStop Kernel

The sample programs and the sample compilation and binding scripts, provided in subvolume ZMQSSMPL, illustrate the main features of the MQI in MQSeries for Compaq NonStop Kernel, and demonstrate how to compile and bind an application.

This chapter describes some minor differences between the standard Version 2 MQI interface, as documented in WebSphere MQ Application Programming Reference and the MQI interface for MQSeries for Compaq NonStop Kernel.

Unit of work (transaction) management

Transaction management is performed under the control of the Compaq NonStop Kernel TM/MP product, rather than by MQSeries itself. See “Syncpoints in MQSeries for Compaq NonStop Kernel applications” on page 187 for details.

General design considerations

Please note that:

- The MQI library (bound into the application process) does not open $RECEIVE and does not open $TMP (TM/MP transaction pseudo-file) itself, so you may code your application to use these features.
- The MQI library uses a SERVERCLASS_SEND_() call in initial communication with the Queue Manager. While connected, it maintains two process file opens (with the LINKMON process and a Local Queue Manager Agent) and a small number of disk file opens (fewer than 10). Process opens are also made to any queue servers that support local queues that are opened for input, output or browse as a result of an MQOPEN call.
- You should ensure that there is no outstanding nowait PATHSEND I/O before calling MQCONN. MQCONN performs nowaited PATHSEND I/O and could intercept the completion of the application’s outstanding I/O, causing errors.

Triggering applications

There are some special considerations for triggering applications under MQSeries for Compaq NonStop Kernel. See “Triggering applications from MQSeries for Compaq NonStop Kernel” on page 212 for details.

Supported programming languages and environments

MQSeries for Compaq NonStop Kernel supports the languages and environments described in Table 16. The table also describes whether the application can use FASTPATH or STANDARD bindings.

Table 16. Summary of supported languages and environments

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C native</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>C non-native</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 16. Summary of supported languages and environments (continued)

<table>
<thead>
<tr>
<th>Language</th>
<th>Runs on Guardian</th>
<th>Runs on OSS?</th>
<th>Can use STANDARD binding?</th>
<th>Can use FASTPATH binding?</th>
</tr>
</thead>
<tbody>
<tr>
<td>COBOL native</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>COBOL non-native</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>C++ native</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>TAL non-native</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>NonStop Java2</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Notes:
1. The Guardian environment and FASTPATH-bound OSS applications cannot use threads. Only OSS STANDARD-bound and Java can use threads. For more information on using threads in your application, see “Considerations for creating applications with threads”.
2. NonStop Java applications use the Java Transaction Services (JTS) for transactions.
3. A native application that uses FASTPATH binding may resolve the MQI only through MQSeries for Compaq NonStop Kernel’s Shared Resource Library. A native application that uses STANDARD bindings is able to resolve the MQI using either MQSeries for Compaq NonStop Kernel’s Shared Resource Library or a static Native MQI library. For more information about FASTPATH and STANDARD binding, see “FASTPATH versus STANDARD bindings” on page 341.

Considerations for creating applications with threads

Guardian applications do not support threads. They may implement their own cooperative threading mechanism, but the rules for using the MQI from the Guardian environment must be obeyed for the process that is using it.

In the OSS environment, a thread emulation package based on POSIX threads is available. The emulation implements a cooperative scheduling mechanism where a thread must give up execution control before the code in any other thread can execute. Applications can use this threading package to organize processing into threads, but the following restrictions apply:

• The MQI does not support cooperative scheduling between threads. This means that when the MQI is called from an application thread, no other thread can obtain execution control, regardless of how long it takes. For example, if a thread calls MQGET with the “wait indefinitely” option, no other thread can execute in the application process until the MQGET returns.
• FASTPATH-bound applications running in an OSS environment cannot use threads.
• The queue manager does not support multi-threaded Local Queue Manager Agents (LQMA or MQLQMAG processes) or Message Channel Agents (MCAs).

Compiling and binding applications

The MQSeries for Compaq NonStop Kernel MQI is implemented using the Compaq wide memory model (the int datatype is 4 bytes) and the Common Runtime Environment (CRE). Applications must be compatible with this environment in order to work correctly. Refer to the sample build files for the correct options for each compiler in order to ensure compatibility.
In particular, TAL and COBOL applications must follow the rules that are required for compatibility with the CRE, documented in the Compaq books relating to the CRE.

Note that, for successful use of the MQGMO_SET_SIGNAL function of MQGET, you must set the HIGHREQUESTERS attribute to ON in object code for COBOL and TAL applications.

For an installation, three versions of the MQI library are delivered with MQSeries for Compaq NonStop Kernel, contained in ZMQSLIB. You must ensure that you use the correct library, as shown in Table 17.

### Table 17. Using the correct version of the MQI library for MQSeries for Compaq NonStop Kernel

<table>
<thead>
<tr>
<th>Programming Language</th>
<th>Nonnative</th>
<th>Native/Static</th>
<th>Native/Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAL</td>
<td>MQMLIB</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>COBOL</td>
<td>MQMLIB</td>
<td>MQMLIBN</td>
<td>MQRLLIB</td>
</tr>
<tr>
<td>C</td>
<td>MQMLIB</td>
<td>MQMLIBN</td>
<td>MQRLLIB</td>
</tr>
<tr>
<td>C++</td>
<td>Not applicable</td>
<td>MQMLIBN</td>
<td>MQRLLIB</td>
</tr>
</tbody>
</table>

**Note:** When linking C++ applications with the Native Static Library (MQMLIBN), you must link in the C++ runtime library (ZCPLSRL). This is illustrated in the sample link script (NMLDSAMP).

**FASTPATH versus STANDARD bindings**

MQSeries for Compaq NonStop Kernel supports both FASTPATH and STANDARD bindings. Table 17 describes the languages and environments that support each type of binding.

**STANDARD bindings**
Consider the following when using STANDARD bindings in an application:

- Non-native and native applications can use STANDARD bindings.
- A native application that uses STANDARD bindings can resolve the MQI using either:
  - MQSeries for Compaq NonStop Kernel’s Shared Resource Library
  - A static Native MQI library. This provides support for applications that already use a shared resource library.

**FASTPATH bindings**
Consider the following when using FASTPATH bindings in an application:

- Only native applications can use FASTPATH binding.
- A native application using a FASTPATH binding can resolve the MQI only through MQSeries for Compaq NonStop Kernel’s Shared Resource Library.
- FASTPATH-bound applications running on OSS cannot use threads.
- FASTPATH-bound applications must run under the User ID in the MQSeries for Compaq NonStop Kernel MQM Administrative User group that created the queue manager.
Running applications

Running applications

To be able to connect to a queue manager, the environment of an application program must be correctly defined:

- The PARAM MQDEFAULTPREFIX is mandatory in the environment of all applications.
- If you have chosen an alternative (nondefault) location for your MQSINI file, an application will not be able to connect to the queue manager if the PARAM MQMACHINIFILE is not set correctly.
- TAL and COBOL applications must have the PARAM SAVE-ENVIRONMENT ON defined in their environment, or they will not be able to connect to the queue manager.
- An application may run as either low-pin or high-pin. MQSeries for Compaq NonStop Kernel executables themselves are configured to run as high-pin.
- MQSeries for Compaq NonStop Kernel applications are supported in both the Guardian and OSS environments.
- An application using MQSeries for Compaq NonStop Kernel can run under PATHWAY, from TACL, or as a child process of another process. Applications can even be added to the queue manager PATHWAY configuration itself, provided they behave correctly on queue manager shutdown.
Chapter 23. Building your application on Compaq OpenVMS Alpha

This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building MQSeries for Compaq OpenVMS Alpha applications to run under Compaq OpenVMS Alpha. C and COBOL are supported.

In addition to coding the MQI calls in your source code, you must add the appropriate include files. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Note: Message Queue Interface calls cannot be made from within an AST routine. This is because MQSeries for Compaq OpenVMS Alpha uses AST routines itself and these routines cannot run while another AST routine is active.

Preparing C programs

This section explains the compiler and libraries you need to prepare your C programs.

C compiler version

You must use the DEC C compiler. To invoke the compiler, enter:

$ CC/DECC

This is the default.

C compiler flags

The include files for MQSeries for Compaq OpenVMS Alpha are located in the MQS_INCLUDE directory. The following is an example of how to build the sample program AMQSPUT0:

$ CC/INCLUDE_DIRECTORY=MQS_INCLUDE AMQSPUT0
$ LINK AMQSPUT0.OBJ,SYS$INPUT/OPTIONS
SYS$SHARE: MQM/SHAREABLE
Ctrl + Z

Linking libraries

You need to link your programs with the appropriate library provided by WebSphere MQ. The libraries are found in SYS$SHARE.

You must link to one or more of the following libraries:

Library file
Program/exit type
mqm.exe
Server for C
mqic.exe
Client for C
mqmzf.exe
Installable service exits for C
Preparing COBOL programs

This section explains the compiler and libraries you need to prepare your COBOL programs.

COBOL compiler flags

You must compile the programs in ANSI mode using the /ANSI switch to the DEC COBOL compiler. The following is an example of how to build the sample program AMQ0PUT0:

```
$ COBOL/ANSI AMQ0PUT0.COB
$ LINK AMQ0PUT0.OBJ,SY$INPUT/OPTIONS
    SY$SHARE: MQMCB/SHAREABLE
Ctrl + Z
```

Linking libraries

You need to link your program with one of the following:

- **MQMCB.EXE**
  - COBOL
- **MQICB.EXE**
  - COBOL WebSphere MQ client
Chapter 24. Building your application on Compaq Tru64 UNIX

This chapter describes how to build application programs to run with MQSeries for Compaq Tru64 UNIX.

It contains the following sections:

- “Building applications in C on Compaq Tru64 UNIX Version 4.0”
- “Building applications in C on Compaq Tru64 UNIX Version 5.0” on page 346
- “Building applications in C++ on Compaq Tru64 UNIX Version 4.0” on page 347
- “Building applications in C++ on Compaq Tru64 UNIX Version 5.0” on page 348
- “Building applications in COBOL” on page 349
- “Building applications in Java” on page 350

Throughout this chapter the \ character is used to split long commands over more than one line. Do not enter this character, enter each command as a single line.

Building applications in C on Compaq Tru64 UNIX Version 4.0

This section describes how to build application programs written in C to run under Compaq Tru64 UNIX Version 4.0.

C language include files

The WebSphere MQ C include files are listed in Table 18. They are installed in the directory /opt/mqm/inc/. The include files are symbolically linked into /usr/include.

Table 18. C include files for MQSeries (Compaq Tru64 UNIX Version 4.0)

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;cmqc.h&gt;</td>
<td>Call prototypes, data types, structures, return codes, and constants</td>
</tr>
<tr>
<td>&lt;cmqfc.h&gt;</td>
<td>Definitions for programmable commands</td>
</tr>
<tr>
<td>&lt;cmqxc.h&gt;</td>
<td>Definitions for channel exits and data-conversion exits</td>
</tr>
<tr>
<td>&lt;cmqzc.h&gt;</td>
<td>Definitions for installable services exits</td>
</tr>
</tbody>
</table>

Note: The files are protected against multiple declaration, therefore you can include them many times.

Preparing C programs

Work in your usual environment. Precompiled C programs are supplied in the /opt/mqm/samp/bin directory. Here is an example instruction for building the sample program amqsput0.c in a nonthreaded environment:

```
$ cc -std1 -o amqsput amqsput0.c -lmqm
```

Here is an example instruction for building the sample program amqsput0.c in a threaded environment:

```
$ cc -std1 -pthread -o amqsput amqsput0.c -lmqm_r
```
Building applications in C

If you want to use the programs on a machine on which only the MQSeries client for Compaq Tru64 UNIX is installed, recompile the programs to link them with the client library. Here is an example instruction for building a nonthreaded client:

```
$ cc -std1 -o amqsput amqsput0.c -lmqmic
```

Here is an example instruction for building a threaded client:

```
$ cc -std1 -pthread -o amqsput amqsput0.c -lmqmic_r
```

Linking libraries

In a nonthreaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm.so</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic.so</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

In a threaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm_r.so</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic_r.so</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

Note: If you are writing an installable service (as described in [WebSphere MQ System Administration Guide](#)), you need to link to the libmqmzf.so library.

Building applications in C on Compaq Tru64 UNIX Version 5.0

This section describes how to build application programs written in C to run under Compaq Tru64 UNIX Version 5.0.

Attention

Only one set of libraries is supplied with MQSeries for Compaq Tru64 UNIX, V5.1, on Compaq Tru64 UNIX Version 5.0. You can build threaded or nonthreaded applications by linking with these libraries.

C language include files

The WebSphere MQ C include files are listed in Table 19. They are installed in the directory /opt/mqm/inc/. The include files are symbolically linked into /usr/include.

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;cmqc.h&gt;</td>
<td>Call prototypes, data types, structures, return codes, and constants</td>
</tr>
<tr>
<td>&lt;cmqcfc.h&gt;</td>
<td>Definitions for programmable commands</td>
</tr>
<tr>
<td>&lt;cmqxc.h&gt;</td>
<td>Definitions for channel exits and data-conversion exits</td>
</tr>
<tr>
<td>&lt;cmqzc.h&gt;</td>
<td>Definitions for installable services exits</td>
</tr>
</tbody>
</table>

Note: The files are protected against multiple declaration, therefore you can include them many times.
Preparing C programs

Work in your usual environment. Precompiled C programs are supplied in the
/opt/mqm/samp/bin directory. Here is an example instruction for building the
sample program amqsput0.c:
$ cc -std1 -o -pthread amqsput amqsput0.c -lmqm

If you want to use the programs on a machine on which only the MQSeries client
for Compaq Tru64 UNIX is installed, recompile the programs to link them with the
client library. Here is an example instruction for building a client:
$ cc -std1 -o -pthread amqsput amqsput0.c -lmqnic

Linking libraries

You must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm.so</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic.so</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

Building applications in C++ on Compaq Tru64 UNIX Version 4.0

This section describes how to build application programs written in C++ to run
under Compaq Tru64 UNIX Version 4.0.

For more information on using MQSeries with C++, see the [WebSphere MQ Using C++]

C++ language include files

The WebSphere MQ C++ include files are listed in [Table 20]. They are installed in
the directory /opt/mqm/inc/. The include files are symbolically linked into
/usr/include.

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;cmqc.h&gt;</td>
<td>MQI data structures and manifest constants</td>
</tr>
<tr>
<td>&lt;imqi.hpp&gt;</td>
<td>C++ MQI classes (includes cmqc.h and imqtype.h)</td>
</tr>
<tr>
<td>&lt;imqtype.h&gt;</td>
<td>Defines the ImqBoolean data type</td>
</tr>
</tbody>
</table>

Note: The files are protected against multiple declaration, therefore you can include them
many times.
Preparing C++ programs

Work in your usual environment. Precompiled C++ programs are supplied in the /opt/mqm/samp/bin/ff directory. Here is an example instruction for building the sample program imqsput0.cpp in a nonthreaded environment:

```
$ cxx -std1 -o imqsput imqsput0.cpp -limqs23ff -limqb23ff
```

Here is an example instruction for building the sample program imqsput0.cpp in a threaded environment:

```
$ cxx -std1 -pthread -o imqsput imqsput0.cpp -limqs23ff_r -limqb23ff_r
```

If you want to use the programs on a machine on which only the MQSeries client for Compaq Tru64 UNIX is installed, recompile the programs to link them with the client library. Here is an example instruction for building the sample program imqsput0.cpp as a nonthreaded client:

```
$ cxx -std1 -o imqsput imqsput0.cpp -limqc23ff -limqb23ff
```

Here is an example instruction for building the sample program imqsput0.cpp as a threaded client:

```
$ cxx -std1 -pthread -o imqsput imqsput0.cpp -limqc23ff_r -limqb23ff_r
```

Linking libraries

In a nonthreaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libimqs23ff.so</td>
<td>Server for C++</td>
</tr>
<tr>
<td>libimqc23ff.so</td>
<td>Client for C++</td>
</tr>
</tbody>
</table>

In a threaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libimqs23ff_r.so</td>
<td>Server for C++</td>
</tr>
<tr>
<td>libimqc23ff_r.so</td>
<td>Client for C++</td>
</tr>
</tbody>
</table>

Note: If you are writing an installable service (as described in WebSphere MQ System Administration Guide), you need to link to the libmqmzf.so library.

Building applications in C++ on Compaq Tru64 UNIX Version 5.0

This section describes how to build application programs written in C++ to run under Compaq Tru64 UNIX Version 5.0.

For more information on using MQSeries with C++, see the WebSphere MQ Using C++ guide.

C++ language include files

The WebSphere MQ C++ include files are listed in Table 21 on page 349. They are installed in the directory /opt/mqm/inc/. The include files are symbolically linked into /usr/include.
### Preparing C++ programs

Work in your usual environment. Precompiled C++ programs are supplied in the `/opt/mqm/samp/bin/ff` directory. Here is an example instruction for building the sample program `imqsput0.cpp`:

```bash
$ cxx -pthread -o imqsput imqsput0.cpp -limqs23ff -limqb23ff
```

If you want to use the programs on a machine on which only the MQSeries client for Compaq Tru64 UNIX is installed, recompile the programs to link them with the client library. Here is an example instruction for building the sample program `imqsput0.cpp` as a client:

```bash
$ cxx -pthread -o imqsput imqsput0.cpp -limqc23ff -limqb23ff
```

### Linking libraries

You must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libimqs23ff.so</td>
<td>Server for C++</td>
</tr>
<tr>
<td>libimqc23ff.so</td>
<td>Client for C++</td>
</tr>
</tbody>
</table>

Note: If you are writing an installable service (as described in the `WebSphere MQ System Administration Guide`), you need to link to the `libmqmzf.so` library.

### Building applications in COBOL

This section describes how to build application programs written in COBOL to run under Compaq Tru64 UNIX.

For information on the WebSphere MQ COBOL copy files, see “COBOL copy files” on page 593.

### Preparing COBOL programs

Use the Micro Focus COBOL compiler to compile your programs. The copy files that declare the structures are in the `/opt/mqm/inc` directory.

See the Micro Focus COBOL compiler documentation for a description of the environment variables that you must set up.

```bash
$ export COBDIR=/opt/cobol
$ export COBCPY=/opt/mqm/inc
$ export LD_LIBRARY_PATH=/opt/mqm/lib:$LD_LIBRARY_PATH
```

Here is an example instruction for building the sample program `amq0put0.cbl` in a nonthreaded environment:
Building applications in COBOL

$ cob -vxP amq0put0.cbl -lqmcb

Here is an example instruction for building the sample program amq0put0.cbl in a threaded environment:
$ cob -vxP amq0put0.cbl -lqmcb_r

If you want to use the programs on a machine on which only the MQSeries client for Compaq Tru64 UNIX is installed, recompile the programs to link them with the client library. Here is an example instruction for building a nonthreaded client:
$ cob -vxP amq0put0.cbl -lqmcb

Here is an example instruction for building a threaded client:
$ cob -vxP amq0put0.cbl -lqmcb_r

Linking libraries

You must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program or exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqmcb.so</td>
<td>Server for COBOL</td>
</tr>
<tr>
<td>libmqmcb.so</td>
<td>Client for COBOL</td>
</tr>
<tr>
<td>libmqmcb_r.so</td>
<td>Threaded applications</td>
</tr>
</tbody>
</table>

Building applications in Java

This section describes how to build application programs written in Java to run under Compaq Tru64 UNIX.

Preparing Java programs

Make sure that your WebSphere MQ Client for Java or WebSphere MQ Bindings for Java installation directory is in your CLASSPATH environment variable. For example:

CLASSPATH=/usr/opt/jdk118/lib/classes.zip:/opt/mqm/java/lib: /opt/mqm/samp/mqbind/En_US:

The following environment variable is required:

LD_LIBRARY_PATH=/opt/mqm/lib

To compile the class MyClass.java, for example, use the command:

$ javac MyClass.java

Note: If your WebSphere MQ Java program handles large messages, you must increase the maximum Java heap size appropriately using the -mx option of the java command.

For more information on using Java with WebSphere MQ, see the WebSphere MQ Using Java
Chapter 25. Building your application on HP-UX

This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building WebSphere MQ for HP-UX applications to run under HP-UX. C, C++, and COBOL are supported. For information about preparing your C++ programs, see the WebSphere MQ Using C++.

The tasks you must perform to create an executable application using WebSphere MQ for HP-UX vary with the programming language your source code is written in. In addition to coding the MQI calls in your source code, you must add the appropriate language statements to include the WebSphere MQ for HP-UX include files for the language you are using. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Throughout this chapter the \ character is used to split long commands over more than one line. Do not enter this character, enter each command as a single line.

Preparing C programs

Work in your normal environment. Precompiled C programs are supplied in the /opt/mqm/samp/bin directory.

Preparing C programs on HP-UX V11.00

The following is an example of how to build the sample program amqsput0 in a non-threaded environment:

```
c89 +e -D_HPUX_SOURCE -o amqsput0 amqsput0.c -lmqm
```

The following is an example of how to build the sample program amqsput0 in a POSIX draft 10 threaded environment:

```
c89 +e -D_HPUX_SOURCE -o amqsput0 amqsput0.c -lmqm_r -lpthread
```

The following is an example of how to build the sample program amqsput0 in a POSIX draft 4 (DCE) threaded environment:

```
c89 +e -D_HPUX_SOURCE -D_PTHREADS_DRAFT -o amqsput0 \ amqsput0.c -lmqm_d -ld4r -lcma
```

If you want to use the programs on a machine that has only the WebSphere MQ client for HP-UX installed, recompile the programs to link them with the client library instead. The following is an example of how to build a non-threaded client:

```
c89 +e -D_HPUX_SOURCE -o amqsput0 amqsput0.c -lmqic
```

The following is an example of how to build a POSIX draft 10 threaded client:

```
c89 +e -D_HPUX_SOURCE -o amqsput0 amqsput0.c -lmqic_r -lpthread
```

The following is an example of how to build a POSIX draft 4 (DCE) threaded client:

```
c89 +e -D_HPUX_SOURCE -D_PTHREADS_DRAFT4 -o amqsput0 \ amqsput0.c -lmqic_d -ld4r -lcma
```
Preparation COBOL programs

Compile the programs using the Micro Focus compiler. The copy files which declare the structures are in /opt/mqm/inc:

Preparing C programs

Linking libraries

The following lists the libraries you will need.

- You need to link your programs with the appropriate library provided by WebSphere MQ.

In a non-threaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm.sl</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic.sl</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

In a threaded environment, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm_r.sl</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic_r.sl</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

In a POSIX draft 10 threaded environment on HP-UX V11.00, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm_r.sl</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic_r.sl</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

In a POSIX draft 4 (DCE) threaded environment on HP-UX V11.00, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm_d.sl</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqic_d.sl</td>
<td>Client for C</td>
</tr>
</tbody>
</table>

Notes:

1. If you are writing an installable service (see WebSphere MQ System Administration Guide for further information), you need to link to the libmqmzf.sl library.

2. If you are producing an XA switch load file for external coordination by an XA-compliant transaction manager such as IBM CICS, Transarc Encina, or Novell Tuxedo, you need to link to the libmqmxa.a library in a non-threaded application and to the libmqmxa_r.a library in a threaded application.

3. You must link WebSphere MQ libraries before any other product libraries (in this case, DCE and Encina). This ensures that any operating system functions that have been redefined by DCE are also used by WebSphere MQ.
Preparing COBOL programs

where amqsput is a sample program.

You must ensure that you have specified adequate run-time stack sizes; 16 KB is the recommended minimum.

You need to link your program with one of the following:

- **libmqmcb.sl**
  Server for COBOL

- **libmqicb.sl**
  Client for COBOL

- **amqmcb_r.sl**
  Threaded applications

Programs to run in the WebSphere MQ client environment

If you are using LU 6.2 to connect your MQI client to a server, you must link your application to libsnana.a, part of the SNAplusAPI product. Use the \-lV3 and \-lstr options on your compile and link command.

- The \-lV3 option gives your program access to the AT&T signaling library (the SNAplusAPI uses AT&T signals)
- The \-lstr option links your program to the streams component

If you are not using LU 6.2, consider linking to libsnastubs.a (in /opt/mqm/lib) to fully resolve function names. The need to link to this library varies with how you are using the \-B flag during the linking stage.

Preparing CICS programs

To build the sample CICS transaction, amqscic0.ccs, run the following command:

```
$ export USERLIB="-lmqm_r"
$ cistcl -I C amqscic0.ccs
```

An XA switch module is provided to enable you to link CICS with WebSphere MQ:

**Table 22. Essential Code for CICS applications (HP-UX)**

<table>
<thead>
<tr>
<th>Description</th>
<th>C (source)</th>
<th>C (exec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>XA initialization routine</td>
<td>amqzscix.c</td>
<td>amqzsc</td>
</tr>
</tbody>
</table>

You can find more information about supporting CICS transactions in the [WebSphere MQ System Administration Guide](link).

CICS on Open Systems support

WebSphere MQ on UNIX systems supports CICS on Open Systems via the XA interface.

It is very important to ensure that CICS COBOL applications are linked to the threaded version of the library. CICS on Open Systems WebSphere MQ transactions must link with libmqm_r, except on Solaris, where you must link with lmqmcs_d.
Preparring CICS programs

**CICS C sample transaction**
Sample C source for a CICS WebSphere MQ transaction is provided by AMQSCIC0.CCS. The transaction reads messages from the transmission queue SYSTEM.SAMPLE.CICS.WORKQUEUE on the default queue manager and places them onto the local queue whose name is contained in the transmission header of the message. Any failures will be sent to the queue SYSTEM.SAMPLE.CICS.DLQ. The sample MQSC script AMQSCIC0.TST may be used to create these queues and sample input queues.

**Preparing CICS COBOL programs using Micro Focus COBOL**
To use Micro Focus COBOL, follow these steps:

1. Add the WebSphere MQ COBOL run-time library module to the run-time library using the following command:
   ```
cicsmkcobol -L/usr/lib/dce -L/usr/mqm/lib \
    /usr/mqm/lib/libmqmcbrt.o -lmqm_r
   
   This creates the Micro Focus COBOL language method file and enables the CICS run-time COBOL library to call WebSphere MQ on UNIX systems.

   **Note:** cicsmkcobol must be run only when one of the following is installed:
   - New version or release of Micro Focus COBOL
   - New version or release of TXSeries for HP-UX
   - New version or release of any supported database product (for COBOL transactions only)
   - TXSeries for HP-UX

2. Export the following environment variables:
   ```
   COBCPY=/usr/mqm/inc export COBCPY
   LDFLAGS="-L/usr/mqm/lib -lmqm_r" export LDFLAGS
   
   3. Translate, compile, and link the program by typing:
   ```
   cicstcl -l COBOL -e <yourprog>.ccp
Chapter 26. Building your application on Linux

This chapter provides information specific to WebSphere MQ for Linux about:

- “Preparing C programs”
- “Preparing C++ programs”
- “Linking libraries” on page 356

Preparing C programs

The WebSphere MQ C include files are listed in Table 23. They are installed in the directory `/opt/mqm/inc/`. The include files are symbolically linked into `/usr/include`.

Table 23. C include files for WebSphere MQ

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;cmqc.h&gt;</code></td>
<td>Call prototypes, data types, structures, return codes, and constants</td>
</tr>
<tr>
<td><code>&lt;cmqfc.h&gt;</code></td>
<td>Definitions for programmable commands (PCFs)</td>
</tr>
<tr>
<td><code>&lt;cmqxc.h&gt;</code></td>
<td>Definitions for channel exits and data-conversion exits</td>
</tr>
<tr>
<td><code>&lt;cmqzc.h&gt;</code></td>
<td>Definitions for installable services</td>
</tr>
</tbody>
</table>

Note: The files are protected against multiple declaration, so you can include them many times.

Compiling C programs

Precompiled C programs are supplied in the `/opt/mqm/samp/bin` directory. To build a sample from source code, use the `gcc` compiler.

For example, to compile the sample program `amqsput0.c`, for single-threaded applications:

```
gcc -o amqsput0 amqsput0.c -lmqm
```

If you want to use the programs on a machine that has only the WebSphere MQ for Linux client installed, recompile the programs to link them with the client library instead. That is, for single-threaded applications:

```
gcc -o amqsput0 amqsput0.c -lmqic
```

Preparing C++ programs

For information about using C++, see [WebSphere MQ Using C++](#). Please use the following information in conjunction with the information in that book.

Compilers for WebSphere MQ for Linux

<table>
<thead>
<tr>
<th>Platform</th>
<th>Compiler</th>
<th>Libraries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux</td>
<td>g++ (GNU)</td>
<td>-lmqb23gl -lmqic -lmq(c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>libmqb23gl_r.so libmqs23gl_r.so</td>
</tr>
<tr>
<td></td>
<td></td>
<td>libmqb23gl_r.so libmqc23gl_r.so</td>
</tr>
</tbody>
</table>
Linking libraries

You must link with the WebSphere MQ libraries that are appropriate for your application type: if you want to run multi-threaded applications, you must link with a multi-threaded version of the WebSphere MQ libraries.

<table>
<thead>
<tr>
<th>Program type</th>
<th>Single-threaded library files</th>
<th>Multi-threaded library files</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server for C</td>
<td>libmqm.so</td>
<td>libmqm_r.so</td>
</tr>
<tr>
<td>Client for C</td>
<td>libmqic.so</td>
<td>libmqic_r.so</td>
</tr>
<tr>
<td>Server for C++</td>
<td>libmqb23gl.so, libmqb23gl.so</td>
<td>libmqb23gl_r.so, libmqb23gl_r.so</td>
</tr>
<tr>
<td>Client for C++</td>
<td>libmqb23gl.so, libmqb23gl.so</td>
<td>libmqb23gl_r.so, libmqb23gl_r.so</td>
</tr>
</tbody>
</table>

**Note:** If you are writing an installable service (as described in WebSphere MQ System Administration Guide) link to the libmqmz_r.so library.

The C++ Libraries provided for use with WebSphere MQ for Linux are designed to be used with the GNU v3 C++ compiler. If you wish to use a different version of the compiler this may not be compatible with the libraries provided by WebSphere MQ. Different versions of the C++ libraries for use with other versions of the GNU C++ compiler are available as a SupportPac.
Chapter 27. Building your application on OS/2 Warp

The OS/2 publications describe how to build executable applications from the programs you write. This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building MQSeries for OS/2 Warp applications to run under OS/2 Warp. C, C++, PL/I and COBOL programming languages are supported. For information about preparing your C++ programs, see [WebSphere MQ Using C++](#).

The tasks you must perform to create an executable application using MQSeries for OS/2 Warp vary with the programming language your source code is written in. In addition to coding the MQI calls in your source code, you must add the appropriate language statements to include the MQSeries for OS/2 Warp include files for the language you are using. You should make yourself familiar with the contents of these files. See [Appendix F, “WebSphere MQ data definition files”, on page 591](#) for a full description.

Preparing C programs

<table>
<thead>
<tr>
<th>For DOS and Windows 3.1 only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications must be built using the large memory model.</td>
</tr>
</tbody>
</table>

Work in your normal environment; MQSeries for OS/2 Warp requires nothing special.

- You need to link your programs with the appropriate libraries provided by MQSeries for OS/2 Warp. Link program/exit type server for 32-bit C with library file MQM.LIB. Link program/exit type client for C with library file MQIC.LIB.

The following command gives an example of compiling the sample program amqsget0:

```
icc amqsget0.c /Gm /Gd /B "/pmtype:vio" /Fe"amqsget0.exe" mqm.lib
```

Notes:

1. **If you are writing an installable service** (see [WebSphere MQ System Administration Guide](#) for further information), link to the MQMZFLIB library.
2. **If you are producing an XA switch load file** for external coordination by an XA-compliant transaction manager such as IBM CICS, Transarc Encina, or Novell Tuxedo, use the MQRMIXASwitch structure and link to the MQMXAILIB library.
3. **If you are writing a CICS exit** for use with CICS for OS/2 Version 2.0.1, link to the MQMCSILIB library. If you are writing a CICS exit for use with CICS Transaction Server for OS/2, Version 4, link to the MQMCICS3LIB library.

- **For DOS only**: Your application must also be linked with two of the following libraries, one for each protocol, indicating whether you do or do not require it. If you require TCP/IP you must also link to SOCKETL from the DOS TCP/IP product.

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQICN.LIB</td>
<td>NetBIOS required</td>
</tr>
</tbody>
</table>
Preparing C programs

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQICDN.LIB</td>
<td>NetBIOS not required</td>
</tr>
<tr>
<td>MQICT.LIB</td>
<td>TCP/IP required</td>
</tr>
<tr>
<td>MQICDT.LIB</td>
<td>TCP/IP not required</td>
</tr>
</tbody>
</table>

- You must ensure that you have specified adequate run-time stack and heap sizes:
  - You must link a trusted application with more stack than a normal application. Therefore, a stack size of 200 KB is the recommended minimum.
  - A heap size of 8 KB is the recommended minimum.
- The DLLs must be in the library path (LIBPATH) you have specified.
- If you use lowercase characters whenever possible, you can move from MQSeries for OS/2 Warp to WebSphere MQ on UNIX systems, where use of lowercase is necessary.

Preparing CICS and Transaction Server programs

Sample C source for a CICS MQSeries for OS/2 Warp transaction is provided by AMQSCIC0.CCS. You build it using the standard CICS facilities.

For CICS for OS/2 Version 2:
1. Add the following lines to the CICSENV.CMD file:
   ```
   UserWrk = 'c:\mqm\dll'
   UserInclude = 'c:\mqm\tools\c\include;c:\mqm\tools\c\samples'
   ```
   If necessary replace `c:\mqm` with the path on which you installed the sample code.
2. Compile using the command:
   ```
   CICS32TC AMQSCIC0.CCS LIBS(MQM)
   ```
   This is described in the CICS for OS/2 V2.0.1 Application Programming Guide.

For CICS Transaction Server for OS/2, Version 4:
1. Add the following lines to the CICSENV.CMD file:
   ```
   UserWrk = 'c:\mqm\dll'
   UserInclude = 'c:\mqm\tools\c\include;c:\mqm\tools\c\samples'
   ```
   If necessary replace `c:\mqm` with the path on which you installed the sample code.
2. Compile using the command:
   ```
   CICSCTCL AMQSCIC0.CCS LIBS(MQM)
   ```
   This is described in the Transaction Server for OS/2 Warp, V4 Application Programming Guide.

You can find more information about supporting CICS transactions in WebSphere MQ System Administration Guide.

Preparing COBOL programs

To prepare COBOL programs on OS/2, link your programs with one of the following libraries provided by MQSeries for OS/2 Warp:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQMxCB16</td>
<td>Server for 16-bit Micro Focus COBOL</td>
</tr>
</tbody>
</table>
To compile, for example, the sample program amq0put0, using IBM VisualAge COBOL:

1. Set the SYSLIB environment variable to include the path to the MQSeries for OS/2 Warp VisualAge COBOL copybooks:
   ```
   set SYSLIB=<drive>:\mqm\tools\cobol\copybook\VAcobol;%SYSLIB%
   ```
2. Compile and link the program:
   ```
   cob2 amq0put0.cbl -qlib <drive>:\mqm\tools\lib\mqmcbb.lib
   ```
   (for use on the WebSphere MQ server)
   ```
   cob2 amq0put0.cbl -qlib <drive>:\mqm\tools\lib\mqiccb32.lib
   ```
   (for use on the WebSphere MQ client)

   **Note:** Although the compiler option CALLINT(SYSTEM) must be used, this is the default for cob2.

To prepare Micro Focus COBOL programs, follow these steps:

1. Compile your applications with the LITLINK directive.
2. Specify adequate run-time stack sizes. You must link a trusted application with more stack than a normal application, so a stack size of 200 KB is the recommended minimum. To do this, use:
   ```
   set cobsw=xxxx
   ```
3. Link the object file to the run-time system.
   Set the LIB environment variable to point to the compiler COBOL libraries.
   ```
   cbllink amq0put0.obj mqmcb32.lib
   ```
   or
   ```
   cbllink amq0put0.obj mqiccb32.lib
   ```
4. Add the WebSphere MQ copybook directory (`\mqm\tools\cobol\copybook`) to the cobcpy environment variable.
   ```
   set cobcpy=c:\mqm\tools\cobol\copybook;%COBCPY%
   ```

---

**Library file** | **Program/exit type**
--- | ---
MQICCB16 | Client for 16-bit Micro Focus COBOL
MQMCBB | Server for 32-bit IBM VisualAge COBOL
MQMCBB32 | Server for 32-bit Micro Focus COBOL
MQICCB | Client for 32-bit IBM VisualAge COBOL
MQICCB32 | Client for 32-bit Micro Focus COBOL

---

Preparation of COBOL programs

Chapter 27. Building your application on OS/2 Warp 359
Preparing Transaction Server programs

To prepare CICS Transaction Server for OS/2, V4 programs using IBM VisualAge COBOL:

1. Add the following lines to the CICSENV.CMD file:
   ```
   UserWrk='c:\mqm\dll'
   UserCobol='IBM'
   UserCobcopy='c:\mqm\tools\cobol\copybook'
   UserCobWork='c:\mq-cics\wrk'
   ```
   Where \mq-cics\wrk is the name of a work directory for output from CICSTRAN and CICSCOMP commands (see steps 2 and 3).

2. Translate your program:
   ```
   CICSTRAN MYPROG.CPP
   ```
   This translates your program to a .CBL program.

3. Compile your program:
   ```
   CICSCOMP MYPROG.CBL
   ```

4. Link your program:
   ```
   CICSLINK MYPROG.OBJ LIBS(MQMCBB)
   ```
   For further information about this, see the CICS for OS/2 Customization V3.0, SC33-1581-00 and the Transaction Server for OS/2 Warp, V4 Application Programming Guide.

Preparing PL/I programs

Sample PL/I programs are supplied with MQSeries for OS/2 Warp. PL/I include files are also provided so that the C entry points in the MQSeries for OS/2 Warp libraries can be invoked directly.

To prepare a PL/I program:

1. Link your program with one of the libraries listed in "Preparing C programs" on page 357.
2. Ensure that \mqm\tools\pli\include is in your INCLUDE environment variable.
3. Compile your program:
   ```
   pli amqpput0.pli
   ilink amqpput0.obj mqm.lib
   ```
Chapter 28. Building your application on OS/400

The iSeries publications describe how to build executable applications from the programs you write, to run with OS/400 on iSeries or AS/400® systems. This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building WebSphere MQ for iSeries applications to run on OS/400 systems. COBOL, C, C++, Java and RPG programming languages are supported. For information about preparing your C++ programs, see the WebSphere MQ Using C++. For information about preparing your Java programs, see the WebSphere MQ Using Java.

The tasks you must perform to create an executable WebSphere MQ for iSeries application depend on the programming language the source code is written in. In addition to coding the MQI calls in your source code, you must add the appropriate language statements to include the WebSphere MQ for iSeries data definition files for the language you are using. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Preparing C programs

WebSphere MQ for iSeries supports messages up to 100 MB in size. Application programs written in ILE C, supporting WebSphere MQ messages greater than 16 MB, need to make use of the “Teraspace” compiler option in order to allocate sufficient memory for these messages.

For further information on the C compiler options, see iSeries WebSphere Development Studio ILE C/C++ Programmer’s Guide.

To compile a C module, you can use the OS/400 command, CRTCMOD. Make sure that the library containing the include files (QMQM) is in the library list when you perform the compilation.

You must then bind the output of the compiler with the service program using the CRTPGM command.

An example of the command for a nonthreaded environment is:

<table>
<thead>
<tr>
<th>Command</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRTPGM PGM(pgmname) MODULE(pgmname)</td>
<td>Server for C</td>
</tr>
<tr>
<td>BNDSRVPGM(QMQM/LIBMQM)</td>
<td></td>
</tr>
</tbody>
</table>

where pgmname is the name of your program.
Preparing C programs

An example of the command for a threaded environment is:

```
Table 25. Example of CRTPGM in the threaded environment

<table>
<thead>
<tr>
<th>Command</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRTPGM PGM(&quot;pgmname&quot;) MODULE(&quot;pgmname&quot;)</td>
<td>Server for C</td>
</tr>
<tr>
<td>BNDSRVPGM(&quot;QM/QM/LIBQM_R&quot;)</td>
<td></td>
</tr>
</tbody>
</table>
```

where `pgmname` is the name of your program.

Preparing COBOL programs

WebSphere MQ for iSeries provides two methods for accessing the MQI from within COBOL programs:

1. A dynamic call interface to programs having the names of the MQI functions, such as MQCONN and MQOPEN. This interface is intended primarily for use with the OPM (Original Program Mode) COBOL compiler, but may also be used with the ILE (Integrated Language Environment®) COBOL compiler. Some functions in WebSphere MQ for iSeries, such as MQCMIT and MQBACK, are not supported through this interface, which is provided for compatibility with previous releases.

2. A bound procedural call interface provided by service programs. This provides access to all the MQI functions in WebSphere MQ for iSeries, support for threaded applications, and potentially better performance than the dynamic call interface. This interface can only be used with the ILE COBOL compiler.

In both cases the standard COBOL CALL syntax is used to access the MQI functions.

The COBOL copy files containing the named constants and structure definitions for use with the MQI are contained in the source physical files QMQM/QLBLSRC and QMQM/QCBLLESRC. The members in these two files are identical, but are packaged twice in this way to correspond with the defaults assumed by the OPM and ILE COBOL compilers respectively.

The COBOL copy files use the single quotation mark character (') as the string delimiter. The OS/400 COBOL compilers assume the delimiter will be the double quote ("'). To prevent the compilers generating warning messages, specify OPTION(*APOST) on the commands CRTCBBLPGM, CRTBNDCBL, or CRTCBBLMOD.

To make the compiler accept the single quotation mark character (') as the string delimiter in the COBOL copy files, use the compiler option \\APOST.

Using the Dynamic Call Interface

- The QMQM library must be in your library list when you compile and when you run COBOL programs using the MQI dynamic call interface.
- Use the CRTCBBLPGM command to invoke the OPM COBOL compiler.
- Use either the CRTBNDCBL command or the two separate commands CRTCBBLMOD and CRTPGM to invoke the ILE COBOL compiler.

Using the Bound Procedure Call Interface

- First create a module using the CRTCBBLMOD compiler specifying the parameter:
  \LINKLIT(+PRC)
Preparing COBOL programs

- Then use the CRTPGM command to create the program object specifying the parameter:
  for non-threaded applications
  BNDSRVPGM(QMQM/AMQ0STUB)
  for threaded applications
  BNDSRVPGM(QMQM/AMQ0STUB_R)

  **Note:** Except for programs created using the V4R4 ILE COBOL compiler and containing the THREAD(SERIALIZE) option in the PROCESS statement, COBOL programs should not use the threaded WebSphere MQ libraries. Even if a COBOL program has been made thread safe in this manner, careful consideration should be given to the overall application design, since THREAD(SERIALIZE) forces serialization of COBOL procedures at the module level and may have an impact on overall performance.


Preparing CICS programs

To create a program that includes EXEC CICS statements and MQI calls, perform these steps:

1. If necessary, prepare maps using the CRTCICSMAP command.
2. Translate the EXEC CICS commands into native language statements. Use the CRTCICSC command for a C program. Use the CRTCICSCBL command for a COBOL program.
   - Include CICSOPT(*NOGEN) in the CRTCICSC or CRTCICSCBL command. This halts processing to enable you to include the appropriate CICS and WebSphere MQ service programs. This command puts the code, by default, into QTEMP/QACYCICS.
3. Compile the source code using the CRTCMOD command (for a C program) or the CRTCBLMOD command (for a COBOL program).
4. Use CRTPGM to link the compiled code with the appropriate CICS and WebSphere MQ service programs. This creates the executable program.

   An example of such code follows (it compiles the shipped CICS sample program):
   CRTCICSC OBJ(QTEMP/AMQSCICO) SRCFILE(/MQSAMP/QCSRC) +
     SRCMBR(AMQSCICO) OUTPUT(*PRINT) +
     CICSOPT(*SOURCE *NOGEN)
   CRTCMOD MODULE(MQTEST/AMQSCICO) +
     SRCFILE(QTEMP/QACYCICS) OUTPUT(*PRINT)
   CRTPGM PGM(MQTEST/AMQSCICO) MODULE(MQTEST/AMQSCICO) +
     BNDSRVPGM(QMQM/LIMMQIC QCICS/AEGEIPGM)

Preparing RPG programs

If you are using WebSphere MQ for iSeries, you can write your applications in RPG. For more information see “Coding in RPG” on page 78 and refer to the *WebSphere MQ for iSeries V5.3 Application Programming Reference (ILE RPG)* book.
SQL programming considerations

If your program contains EXEC SQL statements and MQI calls, perform these steps:

1. Translate the EXEC SQL commands into native language statements. Use the CRTSQLCI command for a C program. Use the CRTSQLCBLI command for a COBOL program.
   
   Include OPTION(*NOGEN) in the CRTSQLCI or CRTSQLCBLI command. This halts processing to enable you to include the appropriate WebSphere MQ service programs. This command puts the code, by default, into QTEMP/QSQLTEMP.

2. Compile the source code using the CRTCMOD command (for a C program) or the CRTCBLMOD command (for a COBOL program).

3. Use CRTPGM to link the compiled code with the appropriate WebSphere MQ service programs. This creates the executable program.

An example of such code follows (it compiles a program, SQLTEST, in library, SQLUSER):

```
CRTSQLCI OBJ(MQTEST/SQLTEST) SRCFILE(SQLUSER/QCSRC) +
   SRCMBR(SQLTEST) OUTPUT(*PRINT) OPTION(*NOGEN)
CRTCMOD MODULE(MQTEST/SQLTEST) +
   SRCFILE(QTEMP/QSQLTEMP) OUTPUT(*PRINT)
CRTPGM PGM(MQTEST/SQLTEST) +
   BNDSRVPGM(QMQM/LIBMQIC)
```

OS/400 programming considerations

If you have compiled programs for releases of WebSphere MQ for iSeries earlier than V4R4, you will have linked to AMQZSTUB and, possibly, AMQVSTUB. These libraries are provided at this release for compatibility purposes; you do not need to recompile your applications.

These libraries provide support for the default connection handle (MQHC_DEF_HCONN). This is no longer provided by the standard V4R4 libraries. However, the libraries provided at this release for compatibility purposes do not support all new features (for example, MQCONNX, MQCMIT, and MQBACK).

**QMQM activation group**

When creating your program on OS/400, the QMQM activation group should not be used. The QMQM activation group is for the use of WebSphere MQ only.
Chapter 29. Building your application on SINIX or DC/OSx

This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building MQSeries for SINIX and DC/OSx applications to run under SINIX or DC/OSx. COBOL and C programming languages are supported.

In addition to coding the MQI calls in your source code, you must add the appropriate include files. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Throughout this chapter the \ character is used to split long commands over more than one line. Do not enter this character, enter each command as a single line.

Preparing C programs

You need to link your programs with the appropriate library provided by WebSphere MQ.

If you are not working in a DCE-threaded environment or using CICS, you must link to one of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm.so</td>
<td>server for C</td>
</tr>
<tr>
<td>libmqic.so</td>
<td>client for C</td>
</tr>
</tbody>
</table>

If you are working in a DCE-threaded environment or using CICS, you must link to the C library, libmqm_r.so.

Notes:

1. If you are writing an installable service (see WebSphere MQ System Administration Guide for further information), you need to link to the libmqmzf.so library. Installable services must not use DCE.
2. If you are producing an XA switch load file for external coordination by an XA-compliant transaction manager such as IBM CICS, Transarc Encina, or Novell Tuxedo, link to the libmqmx.so library in a non-DCE threaded environment and to the libmqmx_r.so library in a DCE threaded environment.

C compiler flags

When you compile dynamic libraries, or shared objects, for use with MQSeries for SINIX and DC/OSx, you must use the cc command in the final step that creates the library or object, and not merely the ld command. This is because the cc command automatically links various initialization data that is needed for proper dynamic linking and loading.

The order of the libraries specified is important. The following is an example of how to build the sample program amqsput0 for SINIX:

```
c -o amqsput0 -lmqm -lmqmcsc -lmqmsze -luls1 \  
-lsocket -ldl -lproc -lext amqsput0.c
```
Preparing C programs

For DC/OSx Version cd087, include `-liconv -lresolv` on the above command, as shown below:

```
cc -o amqsput0 -lmqm -lmqmcs -lmqmzse -lnsl  \
   -lsocket -ldl -liconv -lresolv -lmproc -lext amqsput0.c
```

In the same way, for versions preceding cd087 of DC/OSx, include `-liconv`.

**Note:** If you are using an additional product such as ENCINA, you need to find the appropriate header files. You can do this in two ways:

1. Use the `-I` option to scan the extra include directory, for example:
   ```
   cc -c -I/opt/encina/include amqsaex.c
   ``
2. Symbolically link the header files into `/usr/include`, for example:
   ```
   ln -s /opt/encina/include/* /usr/include
   ```

Preparing COBOL programs

You must compile your COBOL programs using the Micro Focus Cobol compiler for SINIX with the LITLINK directive.

You must ensure that you have specified adequate run-time stack sizes; 16 KB is the recommended minimum.

You need to link your program with one of the following:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqmcbrt.o</td>
<td>WebSphere MQ COBOL run-time</td>
</tr>
<tr>
<td>libmqmcb.so</td>
<td>server for COBOL</td>
</tr>
<tr>
<td>libmqicb.so</td>
<td>client for COBOL</td>
</tr>
</tbody>
</table>

Export the following variables:

```
COBDIR=/usr/opt/lib/cobol  export COBDIR
COBLIB=$COBDIR/coblib      export COBLIB
COBCPY=/opt/mqm/inc        export COBCPY
LD_LIBRARY_PATH=/opt/lib/cobol/coblib  export LD_LIBRARY_PATH
```

Compiling COBOL programs

To compile a COBOL program like `amq0gbr0.cbl` on MQSeries for SINIX and DC/OSx, enter:

```
$ cob -xU -C warning=2 amq0gbr0.cbl -lmqmcbr -lmqm  \
   -lmqmcs -lmqmzse -lmproc
```

For DC/OSx Version cd087, include `-liconv -lresolv` on the above command. In the same way, for versions preceding cd087 of DC/OSx, include `-liconv`.

If you want to use the programs on a machine which only has WebSphere MQ client connections, recompile the programs and link them with the `mqicb` library instead of the `mqmcb` library.

**Note:** The `mqicb` and `mqmcb` libraries *must* come before the `mqm` library on the above command line.

If you have DCE, you can link your COBOL batch programs with either DCE threaded libraries or non-DCE threaded libraries.
Notes:
1. A single program cannot contain both DCE threaded and non-DCE threaded modules.
2. Programs running under CICS must always be DCE threaded.
3. DCE threaded libraries are referred to as *re-entrant*.

If you do not choose to use DCE threaded libraries, remove `/opt/dcelocal/bin` from your PATH environment variable before calling the COBOL compiler.

If you do choose to use DCE threaded libraries, export the following:
```
$ export COBLIBLIST="/opt/lib/cobol/coblib/liblist_r"
```

*Note:* COBLIBLIST is used only in the Micro Focus Compiler for SINIX. It is the same as the Micro Focus Compiler expression LIBLIST.

Preparing CICS programs

An XA switch module is provided to enable you to link CICS with WebSphere MQ:

*Table 26. Essential Code for CICS applications (SINIX)*

<table>
<thead>
<tr>
<th>Description</th>
<th>C (source)</th>
<th>C (exec) - add one of the following to your XAD.Stanza</th>
</tr>
</thead>
<tbody>
<tr>
<td>XA initialization routine</td>
<td>amqzscix.c</td>
<td>amqzsc - CICS for Siemens Nixdorf SINIX V2.2</td>
</tr>
</tbody>
</table>

Always link your transactions with the thread safe MQSeries library `libmqm_r.so`.

You can find more information about supporting CICS transactions in the *MQSeries for SINIX and DC/OSx System Management Guide*.

CICS on Open Systems support

MQSeries for SINIX supports CICS on Open Systems via the XA interface.

*Note:* MQSeries for DC/OSx does not support CICS.

In order to enable the CICS run-time COBOL library to call MQSeries on UNIX systems, you must add the MQSeries COBOL run-time library module to the run-time library using the following command:
```
cicsmkcobol libmqmcbrt.o -lmqm_r
```

It is important to ensure that the COBOL run-time library and CICS are linked to the same (DCE) version of the library. All CICS on Open Systems MQSeries transactions must link with `libmqm_r`.

CICS sample transaction

Sample C source for a CICS MQSeries transaction is provided by AMQSCIC0.CCS. You build it using the standard CICS facilities. Compile it using the following commands.

1. Export the following environment variables:
   ```
   export CCFLAGS="-I/opt/mqm/inc -I/opt/mqm/samp"
   export USERLIB="-L/opt/mqm/lib -L/opt/cics/lib -lmqm_r -lmqmc_r"
   ```
Preparing CICS programs

2. Unset the lib path.
3. Use the command:
   
   `cicstcl -l C amqscic0.ccs`

The transaction reads messages from the transmission queue SYSTEM.SAMPLE.CICS WORKQUEUE on the default queue manager and places them onto the local queue whose name is contained in the transmission header of the message. Any failures will be sent to the queue SYSTEM.SAMPLE.CICS.DLQ. The sample MQSC script AMQSCIC0.TST may be used to create these queues and sample input queues.

Linking libraries

You need to link your programs with the appropriate library provided by MQSeries.

You must link to one or more of the following libraries:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>libmqm.so</td>
<td>Server for C</td>
</tr>
<tr>
<td>libmqmzse.so</td>
<td>For C</td>
</tr>
<tr>
<td>libmqic.so</td>
<td>Client for C</td>
</tr>
<tr>
<td>libmqmcs.so</td>
<td>Client for C</td>
</tr>
<tr>
<td>libmqmzf.so</td>
<td>Installable service</td>
</tr>
<tr>
<td>libmqmx.a</td>
<td>XA interface</td>
</tr>
</tbody>
</table>

If you are using an additional product such as ENCINA, you need to find the run-time libraries. There are three ways (the first two are preferred, especially if the module is an exit or trigger monitor):

1. Link the libraries into `/usr/lib/`, for example:
   
   `ln -s /opt/encina/lib/*.so /usr/lib`

   **Note:** You need to check these symbolic links when you install a newer version of ENCINA.

2. Set `LD_LIBRARY_PATH` to include the ENCINA library directory (this is in the environment when you run the programs), for example:
   
   `LD_LIBRARY_PATH=/opt/encina/lib export LD_LIBRARY_PATH`

3. Set `LD_RUN_PATH` to include `/opt/encina/lib` when you compile the programs.

To compile an ENCINA program on SINIX which uses the MQI:

```
LD_RUN_PATH=/opt/encina/lib export LD_RUN_PATH
c -o amqxsaxex -I/opt/encina/include amqxsaxex.c -lmqm -lmqmcs -lmqmcs -lmqmzse -lnsi -lsocket -lencina -ldl -lmproc -lext
```

For DC/OSx, include `-liconv` on the above command line.
Chapter 30. Building your application on Solaris

This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building WebSphere MQ for Solaris applications to run under Solaris. COBOL, C, and C++ programming languages are supported. For information about preparing your C++ programs, see "WebSphere MQ Using C++".

In addition to coding the MQI calls in your source code, you must add the appropriate include files. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Solaris applications must be built threaded, regardless of how many threads the application uses. This is because WebSphere MQ will create background threads.

Do not use nonthreadsafe functions such as:

- asctime
- ctime
- qmtime
- localtime
- rand
- srand

Use their threadsafe equivalents.

Throughout this chapter the \ character is used to split long commands over more than one line. Do not enter this character, enter each command as a single line.

Preparing C programs

Precompiled C programs are supplied in the /opt/mqm/samp/bin directory. To build a sample from source code, use a supported compiler (see Appendix A, “Language compilers and assemblers”, on page 521 for more information).

To compile, for example, the sample program amqsput0:

1. `export LIB=/opt/mqm/lib:$LIB`
2. Ensure the environment is set to use the correct versions of the compiler software and man pages:
   - `export PATH=/opt/SUNWspro/bin:$PATH`
   - `export MANPATH=/opt/SUNWspro/man:/usr/man:$MANPATH`
   - `export LD_LIBRARY_PATH= /opt/SUNWspro/lib:/OPENWINHOME/lib:$LD_LIBRARY_PATH`
3. Compile the program (the order of the libraries specified is important):
   ```
   cc -o amqsput0 <amqsput0>.c -mt -lmqm -lmqmscs -lmqmzse -lsocket -lnsl -ldl
   ```

   If you wish to compile a DCE application, use the following:
   ```
   cc -o amqsput0 <amqsput0>.c -mt -lmqm -lmqmscs_d -lmqmzse -ldce -lthread -lsocket -lnsl -ldl
   ```

   If you use the unsupported compiler /usr/ucb/cc, your application may compile and link successfully. However when you run it, it will fail when it attempts to connect to the queue manager.
Preparing C programs

If you want to use the programs on a machine which has only the WebSphere MQ client for Solaris installed, recompile the programs to link them with the client library instead:

c -o <amqsput0> <amqsput0>.c -lmqic -lqmcs -lsocket

To build a WebSphere MQ client application that uses DCE, enter:

c -o <amqsput0> <amqsput0>.c -mt -lmqic -lqmcs_d -lqmzse -ldce -lm -lpthread -lsocket -lc -lnsl -ldl

Linking libraries

You must link with the WebSphere MQ libraries that are appropriate for your application type:

Program/exit type | Library files
--- | ---
Server for C | libmqm.so, libqmcs.so, and libqmzse.so
Client for C | libmqic.so, libqmcs.so, and libqmzse.so
Server for C with DCE | libmqm.so, libqmcs_d.so, and libqmzse.so
Client for C with DCE | libmqic.so, libqmcs_d.so, and libqmzse.so

Notes:

1. If you are writing an installable service (see [WebSphere MQ System Administration Guide](#) for further information), link to the libmqmzmf.so library.
2. If you are producing an XA switch load file for external coordination by an XA-compliant transaction manager such as IBM CICS, Transarc Encina, or Novell Tuxedo, link to the libmqmxa.a library.
3. To run the sample Encina program, link against the following libraries in addition to the libraries listed above.
   - libmqmxa.a

   Also, link against libqmcs_d.so instead of libqmcs.so, in addition to the Encina and DCE libraries:
   - libEncServer.so
   - libEncina.so
   - libdce.so

Preparing COBOL programs

Before preparing your COBOL programs, you should check with your system administrator that the COBOL compiler is set up to link with the correct C libraries. By default, the COBOL compiler Version 3.2 links to 3.0 SPARCompiler C libraries. For example, to update the compiler to link with SPARCompiler Version 4.0, ensure that your system administrator has completed the following:

1. Change directory to $COBDIR/coblib:

   cd $COBDIR/coblib

   **Note:** By default, COBDIR is /opt/lib/cobol.
2. Make a backup copy of liblist:
   
   cp liblist liblist.saved

3. Edit the liblist file using a standard UNIX editor like vi:
   
   vi liblist

4. Change all references from SC3.0 to SC4.0.

The COBOL compiler is now set up for you to compile COBOL programs.

Precompiled COBOL programs are supplied in the /opt/mqm/samp/bin directory. Use the Micro Focus compiler from the directory /opt/bin to build a sample from source code.

To compile, for example, the sample program amq0put0:

1. Ensure that the environment is set:
   
   export COBDIR=/opt/lib/cobol
   export PATH=/opt/bin:$PATH
   export LD_LIBRARY_PATH=$COBDIR/coblib:$LD_LIBRARY_PATH

Note: The above assumes that COBOL is installed in the default directories.

2. Define the location of the copybooks which declare the MQI structures:
   
   export COBCPY="/opt/mqm/inc"

3. Link your program with one of the following libraries when building the application:
   
   libmqmcb.so
     Server for COBOL
   
   libmqicb.so
     Client for COBOL

4. Compile the program:
   
   cob -vxP amq0put0.cbl -lmqmcb -lmqm -lmqmcs -lmqmzse

---

Preparing CICS programs

XA switch modules are provided to enable you to link CICS with WebSphere MQ:

**Table 27. Essential Code for CICS applications (Solaris)**

<table>
<thead>
<tr>
<th>Description</th>
<th>C (source)</th>
<th>C (exec) - add one of the following to your XAD.Stanza</th>
</tr>
</thead>
<tbody>
<tr>
<td>XA initialization routine</td>
<td>amqzscix.c</td>
<td>amqzsc - TXSeries for Solaris</td>
</tr>
</tbody>
</table>

Always link your transactions with the thread safe WebSphere MQ library libmqm.so.

You can find more information about supporting CICS transactions in **WebSphere MQ System Administration Guide**.

**CICS on Open Systems support**

WebSphere MQ on UNIX systems supports CICS on Open Systems via the XA interface.

You must ensure that CICS COBOL applications are linked to the threaded version of the library. CICS on Open Systems WebSphere MQ transactions must link with libmqm_r, except on Solaris, where you must link with lmqmcs_d.
Preparing CICS programs

Preparing CICS COBOL programs using Micro Focus COBOL
To use Micro Focus COBOL, follow these steps:

1. Add the WebSphere MQ COBOL run-time library module to the run-time library using the following command:
   
   \texttt{cicsmkcobol /opt/mqm/lib/libmqmcbrt.o -lmqmcs_d}

   This creates the Micro Focus COBOL language method file and enables the CICS run-time COBOL library to call WebSphere MQ on UNIX systems.

   \textbf{Note:} \texttt{cicsmkcobol} must be run only when one of the following is installed:
   
   - New version or release of Micro Focus COBOL
   - New version or release of TXSeries for Solaris
   - New version or release of any supported database product (for COBOL transactions only)
   - TXSeries for Solaris

2. Export the following environment variables:

   \texttt{COBCPY=/opt/mqm/inc export COBCPY}
   
   \texttt{LDFLAGS="-L/usr/mqm/lib -lmqmcs_d" export LDFLAGS}

3. Translate, compile, and link the program by typing:

   \texttt{cicstcl -l COBOL -e <yourprog>.ccp}

Preparing CICS C programs
You build CICS C programs using the standard CICS facilities:

1. Export \textit{one} of the following environment variables:

   - \texttt{LDFLAGS = “-L/opt/mqm/lib -L/opt/cics/lib -lmqmcs_d -lmqm -lmqmzse}
     
     -socket -lins1 -ldl”

2. Translate, compile, and link the program by typing:

   \texttt{cicstcl -l C amqscic0.ccs}

CICS C sample transaction: Sample C source for a CICS WebSphere MQ transaction is provided by AMQSCIC0.CCS. The transaction reads messages from the transmission queue \texttt{SYSTEM.SAMPLE.CICS.WORKQUEUE} on the default queue manager and places them onto the local queue whose name is contained in the transmission header of the message. Any failures are sent to the queue \texttt{SYSTEM.SAMPLE.CICS.DLQ}. The sample MQSC script AMQSCIC0.TST may be used to create these queues and sample input queues.
Chapter 31. Building your application on VSE/ESA

This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building MQSeries for VSE/ESA applications to run under MQSeries for VSE/ESA. C, COBOL, and PL/I programming languages are supported.

Linking library

The object decks required by MQSeries for VSE/ESA applications are held in the install sublibrary PRD2.MQSERIES (this is its default name). Reference the sublibrary in a LIBDEF statement in the compile JCL:

```
// LIBDEF SEARCH=(PRD2.MQSERIES,PRD2.SCEECICS,PRD2.SCEECEBASE)
```

The WebSphere MQ object code is autolinked into the application.

Using the batch interface

If you invoke the WebSphere MQ API from a VSE/ESA batch application, you must link-edit a special object module, which intercepts and handles the WebSphere MQ calls, with the usercode by specifying:

```
INCLUDE MQBIBTCH
```

as part of the link-edit JCL.

Preparing C programs

You must meet the requirements of the COBOL language interface when you write C programs. There are no sample programs provided but an include file, equivalent to the COBOL copybooks, is supplied. It is called CMQC.H, and it declares everything required.

Preparing COBOL programs

Sample programs and copybooks are provided in COBOL for VSE/ESA.

Preparing PL/I programs

You must meet the requirements of the COBOL language interface when you write PL/I programs. There are no sample programs provided but two include files, equivalent to the COBOL copybooks, are supplied:

- **CMQEEP.P**
  - Declares the MQI calls and structures

- **CMQP.P**
  - Declares the MQI constants
Preparing PL/I programs
Chapter 32. Building your application on Windows systems

The Windows systems publications describe how to build executable applications from the programs you write. This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building WebSphere MQ for Windows applications to run under Windows systems. ActiveX, C, C++, COBOL, PL/I, and Visual Basic programming languages are supported. For information about preparing your ActiveX programs, see WebSphere MQ for Windows, V5.3 Using the Component Object Model Interface. For information about preparing your C++ programs, see WebSphere MQ Using C++.

The tasks you must perform to create an executable application using WebSphere MQ for Windows vary with the programming language your source code is written in. In addition to coding the MQI calls in your source code, you must add the appropriate language statements to include the WebSphere MQ for Windows include files for the language you are using. You should make yourself familiar with the contents of these files. See Appendix F, “WebSphere MQ data definition files”, on page 591 for a full description.

Preparing C programs

Work in your normal environment; WebSphere MQ for Windows requires nothing special.

- You need to link your programs with the appropriate libraries provided by WebSphere MQ:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQM.LIB</td>
<td>server for 32-bit C</td>
</tr>
<tr>
<td>MQIC32.LIB</td>
<td>client for 32-bit C</td>
</tr>
</tbody>
</table>

The following command gives an example of compiling the sample program amqsget0 (using the Microsoft Visual C++ compiler):

```
c1 amqsget0.c /link mqm.lib
```

Notes:

1. If you are writing an installable service (see WebSphere MQ System Administration Guide for further information), you need to link to the MQMZFLIB library.
2. If you are producing an XA switch load file for external coordination by an XA-compliant transaction manager such as IBM TXSeries, Transarc Encina, or Novell Tuxedo, use the MQRMIXASwitch structure and link to the MQMXA.LIB library.
3. If you are producing an XA switch load file using the MQRMIXASwitchDynamic structure, link to the Encina MQMENC.LIB library.
4. To build the Encina sample, link against the following libraries:
   - MQM.LIB
   - MQMENC.LIB
   - libEncServer.lib
   - libEncina.lib
Preparing C programs

- libdce.lib

5. If you are writing a CICS exit, link to the MQMCICS.LIB library.
6. If an application is to make changes to environment variables, such as MQSERVER, you must link it to the same C run-time libraries as those used by WebSphere MQ. Use the ‘-MD’ compile switch to accomplish this.

- **For DOS only:** Your application must also be linked with two of the following libraries, one for each protocol, indicating whether you do or do not require it. If you require TCP/IP you must also link to SOCKETL from the DOS TCP/IP product.

<table>
<thead>
<tr>
<th>Library file</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQICN.LIB</td>
<td>NetBIOS required</td>
</tr>
<tr>
<td>MQICDN.LIB</td>
<td>NetBIOS not required</td>
</tr>
<tr>
<td>MQICT.LIB</td>
<td>TCP/IP required</td>
</tr>
<tr>
<td>MQICDT.LIB</td>
<td>TCP/IP not required</td>
</tr>
</tbody>
</table>

- You must ensure that you have specified adequate run-time heap and stack sizes. A heap size of 8 KB and stack size of 16 KB are the recommended minimum size.
- The DLLs must be in the path (PATH) you have specified.
- If you use lowercase characters whenever possible, you can move from WebSphere MQ for Windows to WebSphere MQ on UNIX systems, where use of lowercase is necessary.

Preparing CICS and Transaction Server programs

Sample C source for a CICS WebSphere MQ transaction is provided by AMQSCIC0.CCS. You build it using the standard CICS facilities:

For CICS for Windows NT V2:
1. Add the following lines to the CICSENV.CMD file:
   
   ```
   UserWork = 'c:\mqm\dll'
   UserIncl = 'c:\mqm\tools\c\include;c:\mqm\tools\c\samples'
   ```
   
   If necessary replace c:\mqm with the path on which you installed the sample code.
2. Edit the CICSCCL.CMD file (found in <drive>:\CNT200\UTIL) and add the library mqm.lib to the set of libraries.
3. To the LIB environment variable add:
   
   ```
   <drive>:\MQM\TOOLS\LIB
   ```
4. To the INCLUDE environment variable add:
   
   ```
   <drive>:\MQM\TOOLS\C\INCLUDE
   <drive>:\CNT200\INCLUDE
   ```
5. Compile using the command:
   
   ```
   CICSTCCL AMQSCIC0
   ```
   
   This is described in the *CICS for Windows NT V2.0 Application Programming Guide.*

For TXSeries for Windows NT, V4:
1. Set the environment variable (enter the following on one line):
   
   ```
   set CICS_IBMC_FLAGS=-IC:"C:\Program Files\IBM\WebSphere MQ\Tools\C\Include; %CICS_IBMC_FLAGS%
   ```
Preparing C programs

Chapter 32. Building your application on Windows systems

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Preparing COBOL programs

To prepare COBOL programs on Windows systems, link your program to one of the following libraries provided by WebSphere MQ:

<table>
<thead>
<tr>
<th>Library file</th>
<th>Program/exit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQMCBB</td>
<td>server for 32-bit IBM COBOL</td>
</tr>
<tr>
<td>MQMCBB32</td>
<td>server for 32-bit Micro Focus COBOL</td>
</tr>
<tr>
<td>MQICCBB</td>
<td>client for 32-bit IBM COBOL</td>
</tr>
<tr>
<td>MQICCB32</td>
<td>client for 32-bit Micro Focus COBOL</td>
</tr>
<tr>
<td>MQMCBB16</td>
<td>server for 16-bit Micro Focus COBOL</td>
</tr>
<tr>
<td>MQICCB16</td>
<td>client for 16-bit Micro Focus COBOL</td>
</tr>
</tbody>
</table>

When you are running a program in the MQI client environment, ensure the DOSCALLS library appears before any COBOL or WebSphere MQ library.

Micro Focus

You must relink any existing WebSphere MQ Micro Focus COBOL programs using either mqmcb32.lib or mqiccb32.lib rather than the mqmcbb and mqiccb libraries.

To compile, for example, the sample program amq0put0, using IBM VisualAge COBOL:

1. Set the SYSLIB environment variable to include the path to the WebSphere MQ VisualAge COBOL copybooks (enter the following on one line):

   ```
   set SYSLIB=<drive>:\Program Files\IBM\WebSphere MQ\Tools\Cobol\Copybook\VAcobol;%SYSLIB%
   ```

2. Compile and link the program (enter the following examples on one line):

   ```
   cob2 amq0put0.cbl -qlib "<drive>:\Program Files\IBM\WebSphere MQ\Tools\Lib\mqmcbb.lib"
   ```

   (for use on the WebSphere MQ server)

   ```
   cob2 amq0put0.cbl -qlib "<drive>:\Program Files\IBM\WebSphere MQ\Tools\Lib\mqiccb.lib"
   ```

   (for use on the WebSphere MQ client)

   **Note:** Although the compiler option CALLINT(SYSTEM) must be used, this is the default for cob2.

To compile, for example, the sample program amq0put0, using Micro Focus COBOL:
Preparing COBOL programs

1. Set the COBCPY environment variable to point to the WebSphere MQ COBOL copybooks (enter the following on one line):
   ```bash
   set COBCPY=<drive>:\Program Files\IBM\WebSphere MQ\Tools\Cobol\Copybook
   ```
2. Compile the program to give you an object file:
   ```bash
   cobol amq0put0 LITLINK
   ```
3. Link the object file to the run-time system.
   Set the LIB environment variable to point to the compiler COBOL libraries.
   Link the object file for use on the WebSphere MQ server:
   ```bash
   cbllink amq0put0.obj mqmcb32.lib
   ```
   or
   ```bash
   Link the object file for use on the WebSphere MQ client:
   cbllink amq0put0.obj mqiccb32.lib
   ```

Preparing CICS and Transaction Server programs

To compile and link a TXSeries for Windows NT, V4 program using IBM VisualAge COBOL:

1. Set the environment variable (enter the following on one line):
   ```bash
   set CICS_IBMCOB_FLAGS=c:\Program Files\IBM\WebSphere MQ\Tools\Cobol\Copybook\VAcobol;%CICS_IBMCOB_FLAGS%
   ```
2. Set the USERLIB environment variable:
   ```bash
   set USERLIB=MQMCBB.LIB
   ```
3. Translate, compile, and link your program:
   ```bash
   cicstcl -l IBMCOB myprog.ccp
   ```
   This is described in the *Transaction Server for Windows NT, V4 Application Programming Guide*.

To compile and link a CICS for Windows NT V2 program using Micro Focus COBOL:

- Edit the CICSLINK.CMD file and add the library mqmcbb.lib to the set of libraries. (This file is called by the CICSTCL.CMD utility.)
- Set the COBCPY environment variable:
  ```bash
  set
  cobcpy=<drive>:\mqm\tools\cobol\copybook;<drive>:\cnt200\copybook
  ```
- To the LIB environment variable add:
  ```bash
  <drive>:\mqm\tools\lib
  <drive>:\cobol32\lib
  ```
- Edit the CICSCOMP.CMD file, change LITLINK(2) to LITLINK to enable link-time, not run-time resolution of the MQI calls.
- Compile using the command:
  ```bash
  CICSTCL MQMXADC
  ```
  Where MQMXADC.CCP (not actually provided as a sample program) is the name of the program. This creates a MQMXADC.DLL.

This is described in the *CICS for Windows NT V2.0 Application Programming Guide*. 
Preparing PL/I programs

Sample PL/I programs are supplied with WebSphere MQ. PL/I include files are also provided so that the C entry points in the WebSphere MQ libraries can be invoked directly.

To prepare a PL/I program:
1. Link your program with one of the libraries listed in “Preparing C programs” on page 375.
2. Ensure that \mqm\tools\pli\include is in your INCLUDE environment variable.
3. Compile your program:
   ```
   pli amqpput0.pli
   llink amqpput0.obj mqm.lib
   ```

Preparing Visual Basic programs

To prepare Visual Basic programs on Windows:
1. Create a new project.
2. Add the supplied module file, CMQB.BAS, to the project.
3. Add other supplied module files if you need them:
   ```
   CMQBB.BAS     MQAI support
   CMQCFB.BAS     PCF support
   CMQXB.BAS     Channel exits support
   CMQPSB.BAS     Publish/subscribe
   ```

See “Coding in Visual Basic” on page 80 for information about use of the MQCONNXAny call from within Visual Basic.

Call the procedure MQ_SETDEFAULTS before making any MQI calls in the project code. This procedure sets up default structures that the MQI calls require.

Specify whether you are creating an WebSphere MQ server or client, before you compile or run the project, by setting the conditional compilation variable MqType. Set MqType in a Visual Basic project to 1 for a server or 2 for a client as follows:
1. Select the Project menu.
2. Select Name Properties (where Name is the name of the current project).
3. Select the Make tab in the dialog box.
4. In the Conditional Compilation Arguments field, enter this for a server:
   ```
   MqType=1
   ```
   or this for a client:
   ```
   MqType=2
   ```

SSPI security exit

WebSphere MQ for Windows supplies a security exit for both the WebSphere MQ client and the WebSphere MQ server. This is a channel-exit program that provides authentication for WebSphere MQ channels by using the Security Services Programming Interface (SSPI). The SSPI provides the integrated security facilities of Windows NT and Windows 2000.
The security packages are loaded from either security.dll or secur32.dll. These DLLs are supplied with your operating system.

One-way authentication is provided on both Windows NT and Windows 2000, using NTLM authentication services. Two way authentication is provided on Windows 2000, using Kerberos authentication services.

The security exit program is supplied in source and object format. You can use the object code as it is, or you can use the source code as a starting point to create your own user-exit programs.

See also “Using the SSPI security exit on Windows systems” on page 469.

Introduction to security exits

A security exit forms a secure connection between two security exit programs, where one program is for the sending message channel agent (MCA), and one is for the receiving MCA. The program that initiates the secure connection, that is, the first program to get control after the MCA session is established, is known as the context initiator. The partner program is known as the context acceptor.

The following table shows some of the channel types that are context initiators and their associated context acceptors.

<table>
<thead>
<tr>
<th>Context Initiator</th>
<th>Context Acceptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQCHT_CLNTCONN</td>
<td>MQCHT_SVRCONN</td>
</tr>
<tr>
<td>MQCHT_RECEIVER</td>
<td>MQCHT_SENDER</td>
</tr>
<tr>
<td>MQCHT_CLUSRCVR</td>
<td>MQCHT_CLUSSDR</td>
</tr>
</tbody>
</table>

The security exit program has two entry points:

- **SCY_NTLM**
  
  This uses NTLM authentication services, which provide one-way authentication. NTLM allows servers to verify the identities of their clients. It does not allow clients to verify a server’s identity, or one server to verify the identity of another. NTLM authentication was designed for a network environment in which servers are assumed to be genuine. NTLM is supported in Windows NT and Windows 2000.

- **SCY_KERBEROS**
  
  This uses Kerberos mutual authentication services. The Kerberos protocol does not assume that servers in a network environment are genuine. Parties at both ends of a network connection can verify the identity of the other party. That is, servers can verify the identity of clients and other servers, and clients can verify the identity of a server. Kerberos is supported only in Windows 2000.

What the security exit does

This section describes what the SSPI channel-exit programs do.

The supplied channel-exit programs provide either one-way or two-way (mutual) authentication of a partner system when a session is being established. For a particular channel, each exit program has an associated principal (similar to a user ID, see “WebSphere MQ access control and Windows principals” on page 381). A connection between two exit programs is an association between the two principals.
After the underlying session is established, a secure connection between two security exit programs (one for the sending MCA and one for the receiving MCA), is established. The sequence of operations is as follows:

1. Each program is associated with a particular principal, for example as a result of an explicit login operation.

2. The context initiator requests a secure connection with the partner from the security package (for Kerberos, the named partner) and receives a token (called token1). The token is sent, using the underlying session that is already established, to the partner program.

3. The partner program (the context acceptor) passes token1 to the security package, which verifies that the context initiator is authentic. For NTLM, the connection is now established.

4. For the Kerberos supplied security exit (that is, for mutual authentication), the security package also generates a second token (called token2), which the context acceptor returns to the context initiator by using the underlying session.

5. The context initiator uses token2 to verify that the context acceptor is authentic.

6. At this stage, if both applications are satisfied with the authenticity of the partner’s token, the secure (authenticated) connection is established.

**WebSphere MQ access control and Windows principals**

The access control that WebSphere MQ provides is based on the user and group. The authentication that Windows provides is based on principals, such as user and servicePrincipalName (SPN). In the case of servicePrincipalName, there may be many of these associated with a single user.

The SSPI security exit uses the relevant Windows principals for authentication. If Windows authentication is successful, the exit passes the userid that is associated with the Windows principal to MQSeries for access control.

The Windows principals that are relevant for authentication vary, depending on the type of authentication used.

- For NTLM authentication, the Windows principal for Context Initiator is the userid associated with the process that is running. Because this authentication is one-way, the principal associated with the Context Acceptor is irrelevant.

- For Kerberos authentication, on CLNTCONN channels, the Windows principal is the userid associated with the process that is running. Otherwise, the Windows principal is the servicePrincipalName that is formed by adding the following prefix to the QueueManagerName.

`ibmMQSeries`
What the security exit does
Chapter 33. Building your application on z/OS

The CICS, IMS, and z/OS publications describe how to build applications that run in these environments. This chapter describes the additional tasks, and the changes to the standard tasks, you must perform when building WebSphere MQ for z/OS applications for these environments. COBOL, C, C++, Assembler, and PL/I programming languages are supported. (For information on building C++ applications see [WebSphere MQ Using C++].)

The tasks you must perform to create an executable WebSphere MQ for z/OS application depend on both the programming language the program is written in, and the environment in which the application will run.

In addition to coding the MQI calls in your program, you must add the appropriate language statements to include the WebSphere MQ for z/OS data definition file for the language you are using. You should make yourself familiar with the contents of these files. See [Appendix F, “WebSphere MQ data definition files”, on page 591] for a full description.

Note
The name thlqual is the high-level qualifier of the installation library on z/OS.

This chapter introduces building z/OS applications, under these headings:

• “Preparing your program to run”
• “Dynamically calling the WebSphere MQ stub” on page 387
• “Debugging your programs” on page 391

Preparing your program to run

After you have written the program for your WebSphere MQ application, to create an executable application you have to compile or assemble it, then link-edit the resulting object code with the stub program that WebSphere MQ for z/OS supplies for each environment it supports. How you prepare your program depends on both the environment (batch, CICS, or IMS(BMP or MPP)) in which the application will run, and the structure of the data sets on your z/OS installation. The details are described in the following sections.

“Dynamically calling the WebSphere MQ stub” on page 387 describes an alternative method of making MQI calls in your programs so that you do not need to link-edit a WebSphere MQ stub. This method is not available for all languages and environments.

Do not link-edit a higher level of stub program than that of the version of WebSphere MQ for z/OS on which your program is running. For example, a program running on MQSeries for OS/390, V5.2 must not be link-edited with a stub program supplied with WebSphere MQ for z/OS, V5.3.
Building z/OS batch applications

To build an application for WebSphere MQ for z/OS that runs under z/OS batch, create job control language (JCL) that performs these tasks:

1. Compile (or assemble) the program to produce object code. The JCL for your compilation must include SYSLIB statements that make the product data definition files available to the compiler. The data definitions are supplied in the following WebSphere MQ for z/OS libraries:
   - For COBOL, `thlqual.SCSQCOBC`
   - For assembler language, `thlqual.SCSQMACS`
   - For C, `thlqual.SCSQC370`
   - For PL/I, `thlqual.SCSQPLIC`

2. For a C application, prelink the object code created in step [1].

3. Link-edit the object code created in step [1] (or step [2] for a C application) to produce a load module. When you link-edit the code, you must include one of the WebSphere MQ for z/OS batch stub programs (CSQBSTUB or one of the RRS stub programs: CSQBRRSI or CSQBRSTB).
   - `CSQBSTUB` single-phase commit provided by WebSphere MQ for z/OS
   - `CSQBRRSI` two-phase commit provided by RRS via the MQI
   - `CSQBRSTB` two-phase commit provided by RRS directly

   **Note:** If you use CSQBRSTB then you must also link-edit your application with ATRSCSS from SYS1.CSSLIB. Figure 19 and Figure 20 on page 385 show fragments of JCL to do this. The stubs are language-independent and are supplied in library `thlqual.SCSQLOAD`.

4. Store the load module in an application load library.

```
... /*
  /* WEBSPHERE MQ FOR Z/OS LIBRARY CONTAINING BATCH STUB */
  /*
  //CSQSTUB DSN+++HLQ.MQM100++.SCSQLOAD,DISP=SHR
  /*
  ...
  //SYSIN DD *
  INCLUDE CSQSTUB(CSQBSTUB)
  ...
  */
```

*Figure 19. Fragments of JCL to link-edit the object module in the batch environment, using single-phase commit*
Building batch applications

To run a batch or RRS program, you must include the libraries `thlqual.SCSQAUTH` and `thlqual.SCSQLOAD` in the STEPLIB or JOBLIB data set concatenation.

To run a TSO program, you must include the libraries `thlqual.SCSQAUTH` and `thlqual.SCSQLOAD` in the STEPLIB used by the TSO session.

To run an OpenEdition® batch program from the OpenEdition shell, add the libraries `thlqual.SCSQAUTH` and `thlqual.SCSQLOAD` to the STEPLIB specification in your `$HOME/.profile` like this:

```
STEPLIB=thlqual.SCSQAUTH:thlqual.SCSQLOAD
export STEPLIB
```

Building CICS applications

To build an application for WebSphere MQ for z/OS that runs under CICS, you must:

- Translate the CICS commands in your program into the language in which the rest of your program is written
- Compile or assemble the output from the translator to produce object code
- Link-edit the object code to create a load module

CICS provides a procedure to execute these steps in sequence for each of the programming languages it supports.

- For CICS Transaction Server for z/OS, the CICS Transaction Server for z/OS System Definition Guide describes how to use these procedures and the CICS/ESA® Application Programming Guide gives more information on the translation process.

You must include:

- In the SYSLIB statement of the compilation (or assembly) stage, statements that make the product data definition files available to the compiler. The data definitions are supplied in the following WebSphere MQ for z/OS libraries:
  - For COBOL, `thlqual.SCSQC0BC`
  - For assembler language, `thlqual.SCSQMACS`
  - For C, `thlqual.SCSQC370`
  - For PL/I, `thlqual.SCSQPLIC`

- In your link-edit JCL, the WebSphere MQ for z/OS CICS stub program (`CSQCSTUB`). Figure 21 on page 386 shows fragments of JCL code to do this. The stub is language-independent and is supplied in library `thlqual.SCSQLOAD`.

*Figure 20. Fragments of JCL to link-edit the object module in the batch environment, using two-phase commit*

To run a batch or RRS program, you must include the libraries `thlqual.SCSQAUTH` and `thlqual.SCSQLOAD` in the STEPLIB or JOBLIB data set concatenation.

To run a TSO program, you must include the libraries `thlqual.SCSQAUTH` and `thlqual.SCSQLOAD` in the STEPLIB used by the TSO session.

To run an OpenEdition® batch program from the OpenEdition shell, add the libraries `thlqual.SCSQAUTH` and `thlqual.SCSQLOAD` to the STEPLIB specification in your `$HOME/.profile` like this:

```
STEPLIB=thlqual.SCSQAUTH:thlqual.SCSQLOAD
export STEPLIB
```

Building CICS applications

To build an application for WebSphere MQ for z/OS that runs under CICS, you must:

- Translate the CICS commands in your program into the language in which the rest of your program is written
- Compile or assemble the output from the translator to produce object code
- Link-edit the object code to create a load module

CICS provides a procedure to execute these steps in sequence for each of the programming languages it supports.

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  - For assembler language, `thlqual.SCSQMACS`
  - For C, `thlqual.SCSQC370`
  - For PL/I, `thlqual.SCSQPLIC`

- In your link-edit JCL, the WebSphere MQ for z/OS CICS stub program (`CSQCSTUB`). Figure 21 on page 386 shows fragments of JCL code to do this. The stub is language-independent and is supplied in library `thlqual.SCSQLOAD`. 

Chapter 33. Building your application on z/OS
Building CICS applications

When you have completed these steps, store the load module in an application load library and define the program to CICS in the usual way.

...
Before you run an IMS program, your system administrator must define it to IMS as a WebSphere MQ program and transaction: you can then run it in the usual way.

**Dynamically calling the WebSphere MQ stub**

Instead of link-editing the WebSphere MQ stub program with your object code, you can dynamically call the stub from within your program. You can do this in the batch, IMS, and CICS environments. This facility is not supported by programs using PL/I in the CICS environment and it is not supported in the RRS environment.

However, this method:
- Increases the complexity of your programs
- Increases the storage required by your programs at execution time
- Reduces the performance of your programs
- Means that you cannot use the same programs in other environments

If you call the stub dynamically, the appropriate stub program and its aliases must be available at execution time. To ensure this, include the WebSphere MQ for z/OS data set SCSQLOAD:

For batch and IMS
- In the STEPLIB concatenation of the JCL

For CICS
- In the CICS DFHRPL concatenation

For IMS, you must ensure that the library containing the dynamic stub (built as described in the information about installing the IMS adapter in the WebSphere MQ for z/OS System Setup Guide) is ahead of the data set SCSQLOAD in the STEPLIB concatenation of the region JCL.

Use the names shown in Table 29 when you call the stub dynamically. In PL/I, only declare the call names used in your program.

**Table 29. Call names for dynamic linking**

<table>
<thead>
<tr>
<th>MQI call</th>
<th>Dynamic call name</th>
<th>Batch (non-RRS)</th>
<th>CICS</th>
<th>IMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQBACK</td>
<td>CSQBBACK</td>
<td>not supported</td>
<td>not supported</td>
<td>not supported</td>
</tr>
<tr>
<td>MQCMIT</td>
<td>CSQBCOMM</td>
<td>not supported</td>
<td>not supported</td>
<td>not supported</td>
</tr>
<tr>
<td>MQCLOSE</td>
<td>CSQBCLOS</td>
<td>CSQCLOS</td>
<td>MQCLOSE</td>
<td></td>
</tr>
<tr>
<td>MQCONN</td>
<td>CSQBCONN</td>
<td>CSQCONN</td>
<td>MQCONN</td>
<td></td>
</tr>
</tbody>
</table>
## Calling the WebSphere MQ stub

*Table 29. Call names for dynamic linking (continued)*

<table>
<thead>
<tr>
<th>MQI call</th>
<th>Dynamic call name</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQCONNX</td>
<td>CSQBCONNX</td>
</tr>
<tr>
<td>MQDISC</td>
<td>CSQBDISC</td>
</tr>
<tr>
<td>MQGET</td>
<td>CSQBGET</td>
</tr>
<tr>
<td>MQINQ</td>
<td>CSQBINQ</td>
</tr>
<tr>
<td>MQOPEN</td>
<td>CSQBOPEN</td>
</tr>
<tr>
<td>MQPUT</td>
<td>CSQBPUT</td>
</tr>
<tr>
<td>MQPUT1</td>
<td>CSQBPUT1</td>
</tr>
<tr>
<td>MQSET</td>
<td>CSQBSET</td>
</tr>
</tbody>
</table>

For examples of how to use this technique, see the following figures:

- **Batch and COBOL**  
  - Figure 23
- **CICS and COBOL**  
  - Figure 24 on page 389
- **IMS and COBOL**  
  - Figure 25 on page 389
- **Batch and assembler**  
  - Figure 26 on page 389
- **CICS and assembler**  
  - Figure 27 on page 390
- **IMS and assembler**  
  - Figure 28 on page 390
- **Batch and C**  
  - Figure 29 on page 390
- **CICS and C**  
  - Figure 30 on page 390
- **IMS and C**  
  - Figure 31 on page 391
- **Batch and PL/I**  
  - Figure 32 on page 391
- **IMS and PL/I**  
  - Figure 33 on page 391

```asm
WORKING-STORAGE SECTION.

05 WS-MQOPEN PIC X(8) VALUE 'CSQBOPEN'.

PROCEDURE DIVISION.

CALL WS-MQOPEN WS-HCONN
    MQOD
    WS-OPTIONS
    WS-HOBJ
    WS-COMPCODE
    WS-REASON.
```

*Figure 23. Dynamic linking using COBOL in the batch environment*
Figure 24. Dynamic linking using COBOL in the CICS environment

WORKING-STORAGE SECTION.

05 WS-MQOPEN PIC X(8) VALUE 'CSQCOPEN'.

PROCEDURE DIVISION.

CALL WS-MQOPEN WS-HCONN MQOD
   WS-OPTIONS
   WS-HOBJ
   WS-COMPCODE
   WS-REASON.

* ----------------------------------------------------------- *
* If the compile option 'DYNAM' is specified                 *
* then you may code the MQ calls as follows                 *
* ----------------------------------------------------------- *

CALL 'MQOPEN' WS-HCONN MQOD
   WS-OPTIONS
   WS-HOBJ
   WS-COMPCODE
   WS-REASON.

Figure 25. Dynamic linking using COBOL in the IMS environment

LOAD EP=CSQBOPEN

CALL (15),(HCONN,MQOD,OPTIONS,HOBJ,COMPCODE,REASON),VL

DELETE EP=CSQBOPEN

Figure 26. Dynamic linking using assembler language in the batch environment
Calling the WebSphere MQ stub

EXEC CICS LOAD PROGRAM('CSQCOPEN') ENTRY(R15)
CALL (15), (HCONN, MQOD, OPTIONS, HOBJ, COMPCODE, REASON), VL
EXEC CICS RELEASE PROGRAM('CSQCOPEN')

Figure 27. Dynamic linking using assembler language in the CICS environment

LOAD EP=MQOPEN
CALL (15), (HCONN, MQOD, OPTIONS, HOBJ, COMPCODE, REASON), VL
DELETE EP=MQOPEN

Figure 28. Dynamic linking using assembler language in the IMS environment

typedef void CALL_ME();
#pragma linkage(CALL_ME, OS)

main()
{
CALL_ME * csqbopen;
csqbopen = (CALL_ME *) fetch("CSQBOPEN");
(*csqbopen)(Hconn, &ObjDesc, Options, &Hobj, &CompCode, &Reason);

Figure 29. Dynamic linking using C language in the batch environment

typedef void CALL_ME();
#pragma linkage(CALL_ME, OS)

main()
{
CALL_ME * csqcopen;

EXEC CICS LOAD PROGRAM("CSQCOPEN") ENTRY(csqcopen);
(*csqcopen)(Hconn, &ObjDesc, Options, &Hobj, &CompCode, &Reason);

Figure 30. Dynamic linking using C language in the CICS environment
Debugging your programs

The main aids to debugging WebSphere MQ for z/OS application programs are the reason codes returned by each API call. See the WebSphere MQ Application Programming Reference for a list of these and for more information, including suggestions for corrective action.

This chapter also suggests other debugging tools that you may want to use in particular environments.
Debugging programs

### Debugging CICS programs

You can use the CICS Execution Diagnostic Facility (CEDF) to test your CICS programs interactively without having to modify the program or program-preparation procedure. For more information about EDF, see the CICS Transaction Server for z/OS CICS Application Programming Guide.

### CICS trace

You will probably also find it helpful to use the CICS Trace Control transaction (CETR) to control CICS trace activity. For more information about CETR, see the CICS Transaction Server for z/OS CICS-Supplied Transactions manual.

To determine whether CICS trace is active, display connection status using the CKQC panel. This panel also shows the trace number.

To interpret CICS trace entries, see Table 30.

The CICS trace entry for these values is AP0xxx (where xxx is the trace number specified when the CICS adapter was enabled). All trace entries except CSQCTEST are issued by CSQCTRUE. CSQCTEST is issued by CSQCRST and CSQCDSP.

#### Table 30. CICS adapter trace entries

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Trace sequence</th>
<th>Trace data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQCABNT</td>
<td>Abnormal termination</td>
<td>Before issuing END_THREAD ABNORMAL to WebSphere MQ. This is due to the end of the task and therefore an implicit backout could be performed by the application. A ROLLBACK request is included in the END_THREAD call in this case.</td>
<td>Unit of work information. You can use this information when finding out about the status of work. (For example, it can be verified against the output produced by the DISPLAY THREAD command, or the WebSphere MQ for z/OS log print utility.)</td>
</tr>
<tr>
<td>CSQCBACK</td>
<td>Syncpoint backout</td>
<td>Before issuing BACKOUT to WebSphere MQ for z/OS. This is due to an explicit backout request from the application.</td>
<td>Unit of work information.</td>
</tr>
<tr>
<td>CSQCCCRC</td>
<td>Completion code and reason code</td>
<td>After unsuccessful return from API call.</td>
<td>Completion code and reason code.</td>
</tr>
<tr>
<td>CSQCCOMM</td>
<td>Syncpoint commit</td>
<td>Before issuing COMMIT to WebSphere MQ for z/OS. This can be due to a single-phase commit request or the second phase of a two-phase commit request. The request is due to a explicit syncpoint request from the application.</td>
<td>Unit of work information.</td>
</tr>
<tr>
<td>CSQCDBACK</td>
<td>Execute resolve</td>
<td>Before issuing EXECUTE_RESOLVE to WebSphere MQ for z/OS.</td>
<td>The unit of work information of the unit of work issuing the EXECUTE_RESOLVE. This is the last indoubt unit of work in the resynchronization process.</td>
</tr>
<tr>
<td>CSQCGETW</td>
<td>GET wait</td>
<td>Before issuing CICS wait.</td>
<td>Address of the ECB to be waited on.</td>
</tr>
<tr>
<td>CSQCMGMD</td>
<td>GET message data</td>
<td>After successful return from MQGET.</td>
<td>Up to 40 bytes of the message data.</td>
</tr>
<tr>
<td>CSQCMGMD</td>
<td>GET message handle</td>
<td>Before issuing MQGET to WebSphere MQ for z/OS.</td>
<td>Object handle.</td>
</tr>
<tr>
<td>CSQCMGMD</td>
<td>Get message ID</td>
<td>After successful return from MQGET.</td>
<td>Message ID and correlation ID of the message.</td>
</tr>
<tr>
<td>CSQCINDL</td>
<td>Indoubt list</td>
<td>After successful return from the second INQUIRE_INDOUBT.</td>
<td>The indoubt units of work list.</td>
</tr>
<tr>
<td>CSQCINDO</td>
<td>IBM use only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 30. CICS adapter trace entries (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Trace sequence</th>
<th>Trace data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQCINDS</td>
<td>Indoubt list size</td>
<td>After successful return from the first INQUIRE_INDOUBT and the indoubt list is not empty.</td>
<td>Length of the list. Divided by 64 gives the number of indoubt units of work.</td>
</tr>
<tr>
<td>CSQCNQH</td>
<td>INQ handle</td>
<td>Before issuing MQINQ to WebSphere MQ for z/OS.</td>
<td>Object handle.</td>
</tr>
<tr>
<td>CSQCLOSH</td>
<td>CLOSE handle</td>
<td>Before issuing MQCLOSE to WebSphere MQ for z/OS.</td>
<td>Object handle.</td>
</tr>
<tr>
<td>CSQCLOST</td>
<td>Disposition lost</td>
<td>During the resynchronization process, CICS informs the adapter that it has been cold started so no disposition information regarding the unit of work being resynchronized is available.</td>
<td>Unit of work ID known to CICS for the unit of work being resynchronized.</td>
</tr>
<tr>
<td>CSQCNIND</td>
<td>Disposition not indoubt</td>
<td>During the resynchronization process, CICS informs the adapter that the unit of work being resynchronized should not have been indoubt (that is, perhaps it is still running).</td>
<td>Unit of work ID known to CICS for the unit of work being resynchronized.</td>
</tr>
<tr>
<td>CSQCNORT</td>
<td>Normal termination</td>
<td>Before issuing END_THREAD NORMAL to WebSphere MQ for z/OS. This is due to the end of the task and therefore an implicit syncpoint commit may be performed by the application. A COMMIT request is included in the END_THREAD call in this case.</td>
<td>Unit of work information.</td>
</tr>
<tr>
<td>CSQCOPNH</td>
<td>OPEN handle</td>
<td>After successful return from MQOPEN.</td>
<td>Object handle.</td>
</tr>
<tr>
<td>CSQCOPNO</td>
<td>OPEN object</td>
<td>Before issuing MQOPEN to WebSphere MQ for z/OS.</td>
<td>Object name.</td>
</tr>
<tr>
<td>CSQCPMgd</td>
<td>PUT message data</td>
<td>Before issuing MQPUT to WebSphere MQ for z/OS.</td>
<td>Up to 40 bytes of the message data.</td>
</tr>
<tr>
<td>CSQCPMgh</td>
<td>PUT message handle</td>
<td>Before issuing MQPUT to WebSphere MQ for z/OS.</td>
<td>Object handle.</td>
</tr>
<tr>
<td>CSQCPMgi</td>
<td>PUT message ID</td>
<td>After successful MQPUT from WebSphere MQ for z/OS.</td>
<td>Message ID and Correlation ID of the message.</td>
</tr>
<tr>
<td>CSQCOPP</td>
<td>Syncpoint prepare</td>
<td>Before issuing PREPARE to WebSphere MQ for z/OS in the first phase of two-phase commit processing. This call can also be issued from the distributed queuing component as an API call.</td>
<td>Unit of work information.</td>
</tr>
<tr>
<td>CSQC1MD</td>
<td>PUTONE message data</td>
<td>Before issuing MQPUT1 to WebSphere MQ for z/OS.</td>
<td>Up to 40 bytes of data of the message.</td>
</tr>
<tr>
<td>CSQC1MI</td>
<td>PUTONE message ID</td>
<td>After successful return from MQPUT1.</td>
<td>Message ID and correlation ID of the message.</td>
</tr>
<tr>
<td>CSQC1ON</td>
<td>PUTONE object name</td>
<td>Before issuing MQPUT1 to WebSphere MQ for z/OS.</td>
<td>Object name.</td>
</tr>
<tr>
<td>CSQCRBAK</td>
<td>Resolved backout</td>
<td>Before issuing RESOLVE_ROLLBACK to WebSphere MQ for z/OS.</td>
<td>Unit of work information.</td>
</tr>
<tr>
<td>CSQRCMT</td>
<td>Resolved commit</td>
<td>Before issuing RESOLVE_COMMIT to WebSphere MQ for z/OS.</td>
<td>Unit of work information.</td>
</tr>
</tbody>
</table>
## Debugging programs

Table 30. CICS adapter trace entries (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Trace sequence</th>
<th>Trace data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQCRMIR</td>
<td>RMI response</td>
<td>Before returning to the CICS RMI (resource manager interface) from a specific invocation.</td>
<td>Architected RMI response value. Its meaning depends on the type of the invocation. These values are documented in the CICS Transaction Server for z/OS Customization Guide. To determine the type of invocation, look at previous trace entries produced by the CICS RMI component.</td>
</tr>
<tr>
<td>CSQCRSYN</td>
<td>Resynchronization</td>
<td>Before the resynchronization process starts for the task.</td>
<td>Unit of work ID known to CICS for the unit of work being resynchronized.</td>
</tr>
<tr>
<td>CSQCSETH</td>
<td>SET handle</td>
<td>Before issuing MQSET to WebSphere MQ for z/OS.</td>
<td>Object handle.</td>
</tr>
<tr>
<td>CSQCTASE</td>
<td>IBM use only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSQCTEST</td>
<td>Trace test</td>
<td>Used in EXEC CICS ENTER TRACE call to verify the trace number supplied by the user or the trace status of the connection.</td>
<td>No data.</td>
</tr>
<tr>
<td>CSQCDCFF</td>
<td>IBM use only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Debugging TSO programs

The following interactive debugging tools are available for TSO programs:

- TEST tool
- VS COBOL II interactive debugging tool
- INSPECT interactive debugging tool for C and PL/I programs
Chapter 34. Using lightweight directory access protocol services with WebSphere MQ for Windows

This chapter explains what a directory service is and the part played by a directory access protocol (DAP). It also explains how WebSphere MQ applications can use a lightweight directory access protocol (LDAP) directory using a sample program as a guide.

Note: The sample program is designed for someone who is already familiar with LDAP.

What is a directory service?

A directory is a repository of information about objects, which is organized in such a way that it is easy to find the information on a specific object. A common example is a telephone directory, where information (address and telephone number) is stored about people and companies. Another example is an address book for an e-mail system, where e-mail addresses, and optionally other information such as telephone numbers, are stored for people.

On computer systems, directories can store information about computer resources, such as printers or shared disks. For example you could use a directory to find out where the nearest color printer is located. In a WebSphere MQ application a directory can be used to provide the association between an application service (such as accounts-receivable processing) and the queue to be used for messages requiring that service (possibly identified through the queue name and its host queue manager name).

Directories are implemented as client-server systems, where the directory server holds all the information and answers requests from clients. The clients could be user-interface programs, which provide the information directly to the user, or application programs which need to locate resources to complete their work. A Directory Service comprises the directory server, administrative programs, and the client libraries and programs which are needed to configure, update, and read the directory.

What is LDAP?

Many directory services exist, such as Novell Directory Services, DCE Cell Directory Service, Banyan StreetTalk, Windows Directory Services, X.500, and the address book services associated with e-mail products. X.500 was proposed as a standard for global directory services by the International Standards Organization (ISO). It requires an OSI protocol stack for its communications, and largely because of this, its use has been restricted to large organizations and academic institutions. An X.500 directory server communicates with its clients using the Directory Access Protocol (DAP).

LDAP (Lightweight Directory Access Protocol) was created as a simplified version of DAP. It is easier to implement, omits some of the lesser-used features of DAP, and runs over TCP/IP. As a result of these changes it is rapidly being adopted as the directory access protocol for most purposes, replacing the multitude of proprietary protocols previously used. LDAP clients can still access an X.500 server
What is LDAP?

through a gateway (X.500 still requires the OSI protocol stack), or increasingly X.500 implementations typically include native support for LDAP as well as DAP access.

LDAP directories can be distributed and can use replication to enable efficient access to their contents.

For a more complete description of LDAP, please see IBM Redbook *Understanding LDAP*.

Using LDAP with WebSphere MQ

In WebSphere MQ configurations, the information that defines message and transmission queues is stored locally. This means that in a WebSphere MQ network the various definitions are distributed, with no central directory of this information being available for browsing. Remote messaging between WebSphere MQ applications is commonly achieved through the use of local definitions of remote queues. The application first issues an MQOPEN call using the name specified in the local definition of the remote queue. To put the message on the remote queue, the application then issues MQPUT, specifying the handle returned from the MQOPEN call. The remote queue definition supplies the name of the destination queue, the destination queue manager, and optionally, a transmission queue. In this technique the application has to know at run-time the name specified in the local queue definition.

A variation on the above avoids the use of local definitions of remote queues. The application can specify the full destination queue name, which includes the remote queue manager name as part of the MQOPEN. The application therefore has to know these two names at run-time. Again the local queue manager must be correctly configured with the local queue definition, and with a suitably named (or default) transmission queue and an associated channel that delivers to the target.

In the case where both the source and target queue managers are defined as being members of the same cluster, then the transmission queue and channel aspects of the above two scenarios can be ignored. If the target transmission queue is a cluster queue then a local definition of a remote queue is also not required. However, similarly to the previous cases described, the application must still know the name of the destination queue.

A directory service can be used to remove this application dependency on queue names (or the combination of queue and queue manager names). The mapping between application criteria and WebSphere MQ object names can be held in a directory and be updated dynamically, and independently of applications. At run-time the WebSphere MQ application wishing to send a message first queries the directory using application-based criteria, for example where: service_name = “accounts receivable”, retrieves the relevant WebSphere MQ object names, and then uses these returned values in the MQOPEN call.

Another example of the use of a directory is for a company that has many small depots or offices, WebSphere MQ clients may be used to send messages to WebSphere MQ servers located in the larger offices. The clients need to know the name of the host machine, MQI channel, and queue name for each server they send messages to. Occasionally it may be necessary to move a WebSphere MQ server to another machine; every client that communicates with the server would need to know about the change. An LDAP directory service could be used to store the names of the host machines (and the channel and queue names) and the client
programs could retrieve the information from the directory whenever they want to send a message to a server. In this case only the directory needs to be updated if a host name (or channel or queue name) changed.

Multiple destinations for an application message could be stored in a directory, with the one chosen being dependent on availability or load-sharing considerations.

WebSphere MQ can also use an LDAP directory to store authentication information for use with Secure Sockets Layer (SSL). WebSphere MQ classes for Java can also store information in an LDAP directory.

LDAP sample program

The sample program is designed for someone who is familiar with LDAP and probably already uses it. It is intended to show how WebSphere MQ applications can use an LDAP directory.

Building the sample program

This program has been built and tested only on Windows using TCP/IP. As well as the general considerations mentioned in “Preparing C programs” on page 375, the following points must be observed:

- This program is designed to run as a client program, so it should be linked with the MQIC32.LIB library.
- As well as the WebSphere MQ header files and libraries, this program must be built using LDAP client header files and libraries. These are available from several locations, including the IBM eNetwork Web site at:
  http://www.software.ibm.com/enetwork

  For example, using the IBM eNetwork client, the program should be linked with the LIBLDAPSTATIC.LIB and LIBBERSTATICSSL.LIB libraries.

Configuring the directory

Before the sample program can be run, an LDAP Directory Server must be configured with sample data. The file MQuser.ldif contains some sample data in LDIF (LDAP Data Interchange Format). You can edit this file to suit your needs. It contains data for a fictitious company called MQuser that has a Transport Department comprising three offices. Each of these offices has a machine that runs a WebSphere MQ server.

As a minimum you must edit the three lines that contain the host names of the machines running the WebSphere MQ servers - these are lines 18, 27, and 36:

```
host: LondonHost
...
host: SydneyHost
...
host: WashingtonHost
```

You must change “LondonHost”, “SydneyHost”, and “WashingtonHost” to the names of three of your machines which run WebSphere MQ servers. You may also change the channel and queue names if you wish (the sample uses names of the system defaults). You may also wish to increase or decrease the number of offices in the sample data.
Refer to the eNetwork LDAP Directory Administrator’s Guide for information about installing the directory. In the chapter “Installing and Configuring Server”, work through the sections “Installing Server” and “Basic Server Configuration”. If necessary, read through the chapter “Administrator Interface” to familiarize yourself with how the interface works.

In the chapter “Configuring - How Do I”, follow the instructions for starting up the administrator, then work through the section “Configure Database” and create a default database. Skip the section “Configure replica” and using the section “Work with Suffixes”, add a suffix “o=MQuser”.

Before adding any entries to the database, you must extend the directory schema by adding some attribute definitions and an objectClass definition. This is described in the eNetwork LDAP Directory Administrator’s Guide in the chapter “Reference Information” under the section “Directory Schema”. Two sample files are included to help you with this. The file “mq.at.conf” includes the attribute definitions which you must add to the file “/etc/slapd.at.conf”. Do this by including the sample file by editing slapd.at.conf and adding a line:

```
include <pathname>/mq.at.conf
```

Alternatively you can edit the file slapd.at.conf and add the contents of the sample file directly to it, that is, add the lines:

```
# MQ attribute definitions
attribute mqChannel ces mqChannel 1000 normal
attribute mqQueueManager ces mqQueueManager 1000 normal
attribute mqQueue ces mqQueue 1000 normal
attribute mqPort cis mqPort 64 normal
```

Similarly for the objectClass definition, you can either include the sample file by editing “etc/slapd.oc.conf” and add the line:

```
include <pathname>/mq.oc.conf
```

or you can add the contents of the sample file directly to slapd.oc.conf, that is, add the lines:

```
# MQ object classdefinition
objectclass mqApplication
  requires
    objectClass, cn, host, mqChannel, mqQueue
  allows
    mqQueueManager, mqPort, description, l, ou, seeAlso
```

You can now start the directory server (Administration, Server, Startup) and add the sample entries to it. To add the sample entries, go to the Administration, Add Entries page of the administrator, type in the full pathname of the sample file “MQuser.ldif” and click the Submit button.

The directory server is now running and loaded with data suitable for running the sample program.
Configuring the Netscape directory server

Using the Netscape Server Administration page, click on “Create New Netscape Directory Server”. You should now be presented with a form containing configuration information. Change the Directory Suffix to “o=MQuser” and add a password for the Unrestricted User. You may also, if you wish, change any other information to suit your installation. Click on the OK button, and the directory should be created successfully. Click on “Return to Server Administration” and start the directory server. Click on the directory name to start the Directory Server Administration server for the new directory.

Before adding any entries to the database, you must extend the directory schema by adding some attribute definitions and an objectclass definition. Click on the “Schema” tab of the Directory Server page. You are now presented with a form that allows you to add new attributes. Add the following attributes (the Attribute OID can be left blank for all of them):

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>mqChannel</td>
<td>Case Exact String</td>
</tr>
<tr>
<td>mqQueueManager</td>
<td>Case Exact String</td>
</tr>
<tr>
<td>mqQueue</td>
<td>Case Exact String</td>
</tr>
<tr>
<td>mqPort</td>
<td>Integer</td>
</tr>
</tbody>
</table>

Add a new objectClass by clicking “Create ObjectClass” in the side panel. Enter “mqApplication” as the ObjectClass Name, select “applicationProcess” as the parent ObjectClass and leave the ObjectClass OID blank. Now add some attributes to the objectClass. Select “host”, “mqChannel”, and “mqQueue” as Required Attributes, and select “mqQueueManager” and “mqPort” as Allowed attributes. Press the “Create New ObjectClass” button to create the objectClass.

To add the sample data, click on the “Database Management” tab and select “Add Entries” from the side panel. You must enter the pathname of the sample data file `<pathname>\MQuser.ldif`, enter the password, and click on the OK button.

The sample program runs as an unauthorized user, and by default the Netscape Directory does not allow unauthorized users to search the directory. You must change this by clicking the “Access Control” tab. Enter the password for the Unrestricted User and click the OK button to load in the access control entries for the directory. These should currently be empty. Press the “New ACI” button to create a new access control entry. In the entry box which appears, click on the word “Deny” (which is underlined) and in the resultant dialog box, change it to “Allow”. Add a name, for example, “MQuser-access”, and click on “choose a suffix” to select “o=MQuser”. Enter “o=MQuser” as the target, enter the password for the Unrestricted User, and click on the “Submit” button.

The directory server is now running and loaded with data suitable for running the sample program.

Running the sample program

You should now have an LDAP Directory Server running and populated with the sample data. The data specifies three host machines all of which should be running WebSphere MQ servers. You should ensure that the default queue manager is running on each machine (unless you changed the sample data to specify a different queue manager).
Running the sample

You should also start the WebSphere MQ listener program on each machine; the sample uses TCP/IP with the default WebSphere MQ port number, so you can start the listener with the command:

```
runmqslr -t tcp
```

To test the sample, you might also wish to run a program to read the messages arriving at each WebSphere MQ server, for example you could use the “amqstrg” sample program:

```
amqstrg SYSTEM.DEFAULT.LOCAL.QUEUE
```

The sample program uses three environment variables, one required and two optional. The required variable is LDAP_BASEDN, which specifies the base Distinguished Name for the directory search. To work with the sample data, you should set this to “ou=Transport, o=MQuser”, for example at a command prompt on Windows systems type:

```
set LDAP_BASEDN=ou=Transport, o=MQuser
```

The optional variables are LDAP_HOST and LDAP_VERSION. The LDAP_HOST variable specifies the name of the host where the LDAP server is running, it defaults to the local host if it is not specified. The LDAP_VERSION variable specifies the version of the LDAP protocol to be used, and can be either 2 or 3. Most LDAP servers now support version 3 of the protocol; they all support the older version 2. This sample works equally well with either version of the protocol, and if it is not specified it defaults to version 2.

You can now run the sample by typing the program name followed by the name of the WebSphere MQ application you wish to send messages to, in the case of the sample data the application names are “London”, “Sydney”, and “Washington”. For example, to send messages to the London application:

```
amqsldpc London
```

If the program fails to connect to the WebSphere MQ server, an appropriate error message will appear. If it connects successfully you can start typing messages, each line you type (terminated by <return> or <enter>) is sent as a separate message, an empty line ends the program.

Program design

The program has two distinct parts: the first part uses the environment variables and command line value to query an LDAP directory server; the second part establishes the WebSphere MQ connection using the information returned from the directory and sends the messages.

The LDAP calls used in the first part of the program differ slightly depending on whether LDAP version 2 or 3 is being used, and they are described in detail by the documentation which comes with the LDAP client libraries. This section gives a brief description.

The first part of the program checks that it has been called correctly and reads the environment variables. It then establishes a connection with the LDAP directory server at the specified host:

```
if (ldapVersion == LDAP_VERSION3)
{
    if ((ld = ldap_init(ldapHost, LDAP_PORT)) == NULL)
        ...
}
```
When a connection has been established, the program sets some options on the server with the “ldap_set_option” call, and then authenticates itself to the server by binding to it:

```c
if (ldapVersion == LDAP_VERSION3)
{
  if (ldap_simple_bind_s(ld, bindDN, password) != LDAP_SUCCESS)
      ...
}
else
{
  if (ldap_bind_s(ld, bindDN, password, LDAP_AUTH_SIMPLE) != LDAP_SUCCESS)
      ...
}
```

In the sample program “bindDN” and “password” are set to NULL, which means that the program authenticates itself as an anonymous user, that is, it does not have any special access rights and can access only information which is publicly available. In practice most organizations would restrict access to the information they store in directories so that only authorized users can access it.

The first parameter to the bind call “ld” is a handle which is used to identify this particular LDAP session throughout the rest of the program. After authenticating, the program searches the directory for entries which match the application name:

```c
rc = ldap_search_s(ld, /* LDAP Handle */
          baseDN, /* base distinguished name */
          LDAP_SCOPE_ONELEVEL, /* one-level search */
          filterPattern, /* filter search pattern */
          attrs, /* attributes required */
           FALSE, /* NOT attributes only */
          &ldapResult); /* search result */
```

This is a simple synchronous call to the server which returns the results directly. There are other types of search which are more appropriate for complex queries or when a large number of results is expected. The first parameter to the search is the handle “ld” which identifies the session. The second parameter is the base distinguished name, which specifies where in the directory the search is to begin, and the third parameter is the scope of the search, that is, which entries relative to the starting point are searched. These two parameters together define which entries in the directory are searched. The next parameter, “filterPattern” specifies what we are searching for. The “attrs” parameter lists the attributes which we want to get back from the object when we have found it. The next attribute says whether we want just the attributes or their values as well, setting this to FALSE means that we want the attribute values. The final parameter is used to return the result.

The result could contain many directory entries, each with the specified attributes and their values. We have to extract the values we want from the result. In this sample program we only expect one entry to be found, so we only look at the first entry in the result:

```c
ldapEntry = ldap_first_entry(ld, ldapResult);
```
This call returns a handle which represents the first entry, and we set up a for loop to extract all the attributes from the entry:

```c
for (attribute = ldap_first_attribute(ld, ldapEntry, &ber);
    attribute != NULL;
    attribute = ldap_next_attribute(ld, ldapEntry, ber ))
{
```

For each of these attributes, we extract the values associated with it. Again we only expect one value per attribute, so we only use the first value; we determine which attribute we have and store the value in the appropriate program variable:

```c
values = ldap_get_values(ld, ldapEntry, attribute);
if (values != NULL && values[0] != NULL)
```

```c
if (strcmp(attribute, MQ_HOST_ATTR) == 0)
```

```c
mqHost = strdup(values[0]);
...
```

Finally we tidy up by freeing memory (ldap_value_free, ldap_memfree, ldap_msgfree) and close the session by “unbinding” from the server:

```c
ldap_unbind(ld);
```

We check that we have found all the WebSphere MQ values we need from the directory, and if so we call sendMessages() to connect to the WebSphere MQ server and send the WebSphere MQ messages.

The second part of the sample program is the sendMessages() routine which contains all of the WebSphere MQ calls. This is modelled on the amqsput0 sample program, the differences being that the parameters to the program have been extended and MQCONNXX is used instead of the MQCONN call.
## Part 4. Sample WebSphere MQ programs

### Chapter 35. Sample programs (all platforms except z/OS)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Features demonstrated in the sample programs</td>
<td>405</td>
</tr>
<tr>
<td>Samples for Compaq OpenVMS Alpha and UNIX systems</td>
<td>406</td>
</tr>
<tr>
<td>Samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows</td>
<td>408</td>
</tr>
<tr>
<td>PL/I samples for WebSphere MQ for AIX, MQSeries for OS/2 Warp, and WebSphere MQ for Windows</td>
<td>409</td>
</tr>
<tr>
<td>Visual Basic samples for WebSphere MQ for Windows</td>
<td>410</td>
</tr>
<tr>
<td>Samples for WebSphere MQ for iSeries</td>
<td>410</td>
</tr>
<tr>
<td>Samples for MQSeries for Compaq NonStop Kernel</td>
<td>412</td>
</tr>
<tr>
<td>Samples for MQSeries for VSE/ESA</td>
<td>412</td>
</tr>
<tr>
<td>Preparing and running the sample programs</td>
<td>413</td>
</tr>
<tr>
<td>OS/400</td>
<td>413</td>
</tr>
<tr>
<td>UNIX systems</td>
<td>413</td>
</tr>
<tr>
<td>Compaq OpenVMS Alpha</td>
<td>414</td>
</tr>
<tr>
<td>OS/2 and Windows systems</td>
<td>414</td>
</tr>
<tr>
<td>Compaq NonStop Kernel</td>
<td>415</td>
</tr>
<tr>
<td>Building C sample programs</td>
<td>415</td>
</tr>
<tr>
<td>Building C++ sample programs</td>
<td>417</td>
</tr>
<tr>
<td>Building COBOL sample programs</td>
<td>418</td>
</tr>
<tr>
<td>Building TAL sample programs</td>
<td>420</td>
</tr>
<tr>
<td>Building sample programs on OSS (native mode only)</td>
<td>420</td>
</tr>
<tr>
<td>Running the sample programs</td>
<td>420</td>
</tr>
<tr>
<td>On all platforms except OS/400</td>
<td>421</td>
</tr>
<tr>
<td>On OS/400</td>
<td>421</td>
</tr>
<tr>
<td>Length of queue name</td>
<td>421</td>
</tr>
<tr>
<td>Inquire, Set, and Echo examples</td>
<td>422</td>
</tr>
<tr>
<td>The Put sample programs</td>
<td>422</td>
</tr>
<tr>
<td>Running the amqsput and amqsputc samples</td>
<td>422</td>
</tr>
<tr>
<td>Running the amqspu sample</td>
<td>422</td>
</tr>
<tr>
<td>Running the AMQSPUT4 C sample</td>
<td>422</td>
</tr>
<tr>
<td>Running the AMQSPUT4 COBOL sample</td>
<td>423</td>
</tr>
<tr>
<td>Design of the Put sample program</td>
<td>423</td>
</tr>
<tr>
<td>The Distribution List sample program</td>
<td>423</td>
</tr>
<tr>
<td>Running the Distribution List sample, amqspl10</td>
<td>423</td>
</tr>
<tr>
<td>Design of the Distribution List sample</td>
<td>424</td>
</tr>
<tr>
<td>The Browse sample programs</td>
<td>424</td>
</tr>
<tr>
<td>OS/2, UNIX systems, Compaq OpenVMS Alpha, and Windows systems</td>
<td>424</td>
</tr>
<tr>
<td>OS/400</td>
<td>425</td>
</tr>
<tr>
<td>Design of the Browse sample program</td>
<td>425</td>
</tr>
<tr>
<td>The Browser sample program</td>
<td>426</td>
</tr>
<tr>
<td>The Get sample programs</td>
<td>426</td>
</tr>
<tr>
<td>Running the amqsget and amqsgetc samples</td>
<td>426</td>
</tr>
<tr>
<td>Running the amqsget sample</td>
<td>427</td>
</tr>
<tr>
<td>Running the AMQSGET4 and the AMQSGET4 samples</td>
<td>427</td>
</tr>
<tr>
<td>Design of the Get sample program</td>
<td>427</td>
</tr>
<tr>
<td>The Reference Message sample programs</td>
<td>428</td>
</tr>
<tr>
<td>Notes for OS/400 users</td>
<td>428</td>
</tr>
<tr>
<td>Running the Reference Message samples</td>
<td>429</td>
</tr>
<tr>
<td>Design of the Put Reference Message sample (amqsprma.c, AMQSPRM4).</td>
<td>433</td>
</tr>
<tr>
<td>Design of the Reference Message Exit sample (amqsrma.c, AMQSRXM4).</td>
<td>434</td>
</tr>
<tr>
<td>Compiling the Reference Message Exit sample</td>
<td>435</td>
</tr>
<tr>
<td>Design of the Get Reference Message sample (amqsgrm4a, AMQGRM4).</td>
<td>436</td>
</tr>
<tr>
<td>The Request sample programs</td>
<td>436</td>
</tr>
<tr>
<td>Running the amqreq0c, amqreq, and amqreqc samples</td>
<td>436</td>
</tr>
<tr>
<td>Running the amqreq0cbl sample</td>
<td>437</td>
</tr>
<tr>
<td>Running the AMQREQ4 sample</td>
<td>437</td>
</tr>
<tr>
<td>Running the AMQREQ4 sample</td>
<td>437</td>
</tr>
<tr>
<td>Running the Request sample using triggering</td>
<td>437</td>
</tr>
<tr>
<td>OS/2, UNIX systems, and Windows systems</td>
<td>437</td>
</tr>
<tr>
<td>OS/400</td>
<td>439</td>
</tr>
<tr>
<td>Design of the Request sample program</td>
<td>440</td>
</tr>
<tr>
<td>The Inquire sample programs</td>
<td>441</td>
</tr>
<tr>
<td>Design of the Inquire sample program</td>
<td>442</td>
</tr>
<tr>
<td>The Set sample programs</td>
<td>443</td>
</tr>
<tr>
<td>Design of the Set sample program</td>
<td>443</td>
</tr>
<tr>
<td>The Echo sample programs</td>
<td>444</td>
</tr>
<tr>
<td>Design of the Echo sample programs</td>
<td>445</td>
</tr>
<tr>
<td>The Data-Conversion sample program</td>
<td>445</td>
</tr>
<tr>
<td>Design of the data-conversion sample</td>
<td>445</td>
</tr>
<tr>
<td>The Triggering sample programs</td>
<td>446</td>
</tr>
<tr>
<td>Running the amqstrg0c, amqstrg, and amqstrgc samples</td>
<td>446</td>
</tr>
<tr>
<td>Running the AMQSTRG4 sample</td>
<td>446</td>
</tr>
<tr>
<td>Design of the triggering sample</td>
<td>446</td>
</tr>
<tr>
<td>Running the AMQSERV4 sample</td>
<td>447</td>
</tr>
<tr>
<td>Design of the trigger server</td>
<td>447</td>
</tr>
<tr>
<td>Ending the triggering sample programs</td>
<td>447</td>
</tr>
<tr>
<td>Running the samples using remote queues</td>
<td>448</td>
</tr>
<tr>
<td>Database coordination samples</td>
<td>448</td>
</tr>
<tr>
<td>Creating the databases and tables</td>
<td>450</td>
</tr>
<tr>
<td>Precompiling, compiling, and linking the samples</td>
<td>451</td>
</tr>
<tr>
<td>Precompiling in C.</td>
<td>451</td>
</tr>
<tr>
<td>Precompiling in COBOL.</td>
<td>451</td>
</tr>
<tr>
<td>Compiling and linking</td>
<td>451</td>
</tr>
<tr>
<td>Running the samples</td>
<td>453</td>
</tr>
<tr>
<td>C samples</td>
<td>453</td>
</tr>
<tr>
<td>COBOL samples</td>
<td>454</td>
</tr>
<tr>
<td>The CICS transaction sample</td>
<td>455</td>
</tr>
<tr>
<td>TUXEDO samples</td>
<td>455</td>
</tr>
<tr>
<td>Building the server environment</td>
<td>455</td>
</tr>
<tr>
<td>To build the server environment for WebSphere MQ for AIX:</td>
<td>455</td>
</tr>
<tr>
<td>To build the server environment for MQSeries for AT&amp;T GIS UNIX and WebSphere MQ for Solaris:</td>
<td>456</td>
</tr>
</tbody>
</table>
To build the server environment for WebSphere MQ for HP-UX: 457
To build the server environment for MQSeries for SINIX and DC/OSx 458
To build the server environment for WebSphere MQ for Windows: 460
To build the server environment for MQSeries for Compaq Tru64 UNIX 463
Server sample program for TUXEDO 464
Put sample program for TUXEDO 465
Get sample for TUXEDO 465
Encina sample program 466
Building the AMQSEXAE0.C sample 466
Compiling and linking on Windows systems 466
Compiling and linking on Solaris 467
Dead-letter queue handler sample 467
The Connect sample program 467
Running the amqscnx sample 468
The API exit sample program 468
Configuring for the sample exit 469
Using the SSPI security exit on Windows systems 469
Object code 469
Source code 470

Chapter 36. Sample programs for WebSphere MQ for z/OS 471
Features demonstrated in the sample applications 471
Put samples 471
Get samples 472
Browse sample 472
Print Message sample 472
Queue Attributes sample 473
Mail Manager sample 473
Credit Check sample 474
The Message Handler sample 474
Distributed queuing exit samples 475
Data-conversion exit samples 475
Preparing and running sample applications for the batch environment 475
Names of the sample batch applications 476
Preparing sample applications for the TSO environment 477
Names of the sample TSO applications 477
Preparing the sample applications for the CICS environment 478
QLOP abend 479
Names of the sample CICS applications 479
Preparing the sample application for the IMS environment 481
Names of the sample IMS application 482
The Put samples 482
Design of the Put sample 482
The Put samples for the batch environment 483
Usage notes 483
The Put samples for the CICS environment 484
Usage notes 484
The Get samples 485
Design of the Get sample 485
The Get samples for the batch environment 485
Usage notes 486
The Get samples for the CICS environment 486
Usage notes 487
The Browse sample 487
Design of the Browse sample 488
Language-dependent design considerations 489
The Print Message sample 489
Design of the sample 491
The Queue Attributes sample 493
Design of the sample 493
The Mail Manager sample 494
Preparing the sample 494
Preparing the sample for the TSO environment 495
Running the sample 495
Design of the sample 497
Menu program 498
Get-mail and display-message programs 499
Send-mail program 500
Nickname program 501
The Credit Check sample 501
Preparing and running the Credit Check sample 502
Entering information in the inquiry panels 503
Design of the sample 503
User-interface program (CSQ4CVB1) 505
Credit application manager (CSQ4CVB2) 505
Checking-account program (CSQ4CVB3) 508
Distribution program (CSQ4CVB4) 508
Agency-query program (CSQ4CVB5/CSQ4CCB5) 509
Design considerations 510
Separate inquiry and reply queues in the CAM 510
How the sample handles errors 510
How the sample handles unexpected messages 510
How the sample uses syncpoints 511
How the sample uses message context information 511
Use of message and correlation identifiers in the CAM 512
The Credit Check sample with multiple queue managers 512
The IMS extension to the Credit Check sample 512
Design of the IMS checking-account program (CSQ4ICB3) 513
The Message Handler sample 514
Preparing and running the sample 514
Using the sample 514
Design of the sample 516
Object validation program 517
Message list program 517
Message content program 517

404 WebSphere MQ Application Programming Guide
Chapter 35. Sample programs (all platforms except z/OS)

This chapter describes the sample programs delivered with WebSphere MQ, written in C, COBOL, PL/I, and TAL. The samples demonstrate typical uses of the Message Queue Interface (MQI).

The samples are not intended to demonstrate general programming techniques, so some error checking that you may want to include in a production program has been omitted. However, these samples are suitable for use as a base for your own message queuing programs.

The source code for all the samples is provided with the product; this source includes comments that explain the message queuing techniques demonstrated in the programs.

DCE sample exit: For information on compiling and linking the DCE sample exit (amqsdsc0.c) see WebSphere MQ Intercommunication.

C++ sample programs: See WebSphere MQ Using C++ for a description of the sample programs available in C++.

RPG sample programs: See WebSphere MQ for iSeries V5.3 Application Programming Reference (ILE RPG) for a description of the sample programs available in RPG.

The names of the samples start with the prefix amq, except for TAL programs that start zmq. The fourth character indicates the programming language, and the compiler where necessary.

s C language
0 COBOL language on both IBM and Micro Focus compilers
i COBOL language on IBM compilers only
m COBOL language on Micro Focus compilers only
v COBOL language on DEC COBOL V2.3 and subsequent releases
p PL/1 language

This chapter introduces the sample programs, under these headings:

- “Features demonstrated in the sample programs” on page 406
- “Preparing and running the sample programs” on page 413
- “The Put sample programs” on page 422
- “The Distribution List sample program” on page 423
- “The Browse sample programs” on page 424
- “The Browser sample program” on page 426
- “The Get sample programs” on page 426
- “The Reference Message sample programs” on page 428
- “The Request sample programs” on page 436
- “The Inquire sample programs” on page 441
- “The Set sample programs” on page 443
- “The Echo sample programs” on page 444
- “The Data-Conversion sample program” on page 445
- “The Triggering sample programs” on page 446
- “Running the samples using remote queues” on page 448
- “Database coordination samples” on page 448
WebSphere MQ sample programs

- “The CICS transaction sample” on page 455
- “TUXEDO samples” on page 455
- “Encina sample program” on page 466
- “Dead-letter queue handler sample” on page 467
- “The Connect sample program” on page 467
- “The API exit sample program” on page 468
- “Using the SSPI security exit on Windows systems” on page 469

Features demonstrated in the sample programs

The following tables show the techniques demonstrated by the WebSphere MQ sample programs on all systems except z/OS (see Chapter 36, “Sample programs for WebSphere MQ for z/OS”, on page 471). All the samples open and close queues using the MQOPEN and MQCLOSE calls, so these techniques are not listed separately in the tables. See the heading that includes the platform you are interested in:

- “Samples for Compaq OpenVMS Alpha and UNIX systems”
- “Samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows” on page 408
- “PL/I samples for WebSphere MQ for AIX, MQSeries for OS/2 Warp, and WebSphere MQ for Windows” on page 409
- “Visual Basic samples for WebSphere MQ for Windows” on page 410
- “Samples for WebSphere MQ for iSeries” on page 410
- “Samples for MQSeries for Compaq NonStop Kernel” on page 412
- “Samples for MQSeries for VSE/ESA” on page 412

Samples for Compaq OpenVMS Alpha and UNIX systems

Table 31 shows the techniques demonstrated by the sample programs for WebSphere MQ on UNIX systems and WebSphere MQ for Digital OpenVMS.

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>C (executable)</th>
<th>Client (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting messages using the MQPUT call</td>
<td>amqsput0</td>
<td>amq0put0</td>
<td>amqsput</td>
<td>amqsputc</td>
</tr>
<tr>
<td>Putting a single message using the MQPUT1 call</td>
<td>amqsinqa</td>
<td>amqsecha</td>
<td>amqsinq</td>
<td>amqsechc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Putting messages to a distribution list</td>
<td>amqsptl0</td>
<td>no sample</td>
<td>amqsptl</td>
<td>amqsptlc</td>
</tr>
<tr>
<td>Replying to a request message</td>
<td>amqsinq0</td>
<td>amq0inqa</td>
<td>amqsinq</td>
<td>no sample</td>
</tr>
<tr>
<td>Getting messages (no wait)</td>
<td>amqsgr0</td>
<td>amq0gr0</td>
<td>amqsgr</td>
<td>no sample</td>
</tr>
<tr>
<td>Getting messages (wait with a time limit)</td>
<td>amqsget0</td>
<td>amq0get0</td>
<td>amqsget</td>
<td>amqsgetc</td>
</tr>
<tr>
<td>Getting messages (unlimited wait)</td>
<td>amqstrg0</td>
<td>no sample</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Getting messages (with data conversion)</td>
<td>amqsecha</td>
<td>no sample</td>
<td>amqsech</td>
<td>no sample</td>
</tr>
<tr>
<td>Putting Reference Messages to a queue</td>
<td>amqsprma</td>
<td>no sample</td>
<td>amqsprm</td>
<td>amqsprmc</td>
</tr>
<tr>
<td>Getting Reference Messages from a queue</td>
<td>amqsgrma</td>
<td>no sample</td>
<td>amqsgrm</td>
<td>amqsgrmc</td>
</tr>
</tbody>
</table>
Table 31. WebSphere MQ on UNIX and Compaq OpenVMS Alpha sample programs demonstrating use of the MQI (continued)

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>C (executable)</th>
<th>Client (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Message channel exit</td>
<td>amqsqrma</td>
<td>no sample</td>
<td>amqsxrm</td>
<td>no sample</td>
</tr>
<tr>
<td>Browsing first 20 characters of a message</td>
<td>amqsgbr0</td>
<td>amq0gbr0</td>
<td>amqsgbr</td>
<td>amqsgbrc</td>
</tr>
<tr>
<td>Browsing complete messages</td>
<td>amqsbcg0</td>
<td>no sample</td>
<td>amqsbcg</td>
<td>amqsbcgc</td>
</tr>
<tr>
<td>Using a shared input queue</td>
<td>amqsinq0</td>
<td>amqminqx</td>
<td>amqiinqx</td>
<td>amqsinq</td>
</tr>
<tr>
<td></td>
<td></td>
<td>amqvinqx</td>
<td>amqvinqx</td>
<td>amqsinqc</td>
</tr>
<tr>
<td>Using an exclusive input queue</td>
<td>amqstrg0</td>
<td>amq0req0</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Using the MQINQ call</td>
<td>amqsinqa</td>
<td>amqminqx</td>
<td>amqiinqx</td>
<td>amqsinq</td>
</tr>
<tr>
<td></td>
<td></td>
<td>amqvinqx</td>
<td>amqvinqx</td>
<td>no sample</td>
</tr>
<tr>
<td>Using the MQSET call</td>
<td>amqsseta</td>
<td>amqmsetx</td>
<td>amqssetx</td>
<td>amqssetc</td>
</tr>
<tr>
<td>Using a reply-to queue</td>
<td>amqsreq0</td>
<td>amq0req0</td>
<td>amqsreq</td>
<td>amqsreqc</td>
</tr>
<tr>
<td>Requesting message exceptions</td>
<td>amqsreq0</td>
<td>amq0req0</td>
<td>amqsreq</td>
<td>no sample</td>
</tr>
<tr>
<td>Accepting a truncated message</td>
<td>amqsgbr0</td>
<td>amq0gbr0</td>
<td>amqsgbr</td>
<td>no sample</td>
</tr>
<tr>
<td>Using a resolved queue name</td>
<td>amqsgbr0</td>
<td>amq0gbr0</td>
<td>amqsgbr</td>
<td>no sample</td>
</tr>
<tr>
<td>Triggering a process</td>
<td>amqstrg0</td>
<td>no sample</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Using data conversion</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>WebSphere MQ (coordinating XA-compliant database managers) accessing a single database using SQL</td>
<td>amqxsas0.sqc</td>
<td>amq0xas0.sqb</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>WebSphere MQ (coordinating XA-compliant database managers) accessing two databases using SQL</td>
<td>amqsxag0.c</td>
<td>amq0xag0.cbl</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td></td>
<td>amqsxab0.sqc</td>
<td>amq0xab0.sqb</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td></td>
<td>amqsxf0.sqc</td>
<td>amq0xaf0.sqb</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>CICS transaction</td>
<td>amqscic0.ccs</td>
<td>no sample</td>
<td>amqscic0</td>
<td>no sample</td>
</tr>
<tr>
<td>Encina transaction</td>
<td>amqsxae0</td>
<td>no sample</td>
<td>amqsxae0</td>
<td>no sample</td>
</tr>
<tr>
<td>TUXEDO transaction to put messages</td>
<td>amqsxtpx</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>TUXEDO transaction to get messages</td>
<td>amqsxgx</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Server for TUXEDO</td>
<td>amqsxsx</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Dead-letter queue handler</td>
<td>no sample</td>
<td>no sample</td>
<td>amqsd1q</td>
<td>no sample</td>
</tr>
<tr>
<td>From an MQI client, putting a message</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
<td>amqsputc</td>
</tr>
<tr>
<td>From an MQI client, getting a message</td>
<td>no sample</td>
<td>no sample</td>
<td>no sample</td>
<td>amqsgetc</td>
</tr>
<tr>
<td>Connecting to the queue manager using MQCONNX</td>
<td>amqscnx</td>
<td>no sample</td>
<td>no sample</td>
<td>amqscnxc</td>
</tr>
<tr>
<td>Using API exits</td>
<td>amq.saxe0.c</td>
<td>no sample</td>
<td>amq.saxe</td>
<td>no sample</td>
</tr>
<tr>
<td>Cluster workload balancing exit</td>
<td>amqswlm0.c</td>
<td>no sample</td>
<td>amqswlm</td>
<td>no sample</td>
</tr>
</tbody>
</table>
Features demonstrated

Table 31. WebSphere MQ on UNIX and Compaq OpenVMS Alpha sample programs demonstrating use of the MQI (continued)

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>C (executable)</th>
<th>Client (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting messages using the MQPUT call</td>
<td>amqsput0</td>
<td>amq0put0</td>
<td>amqsput</td>
<td>amqsputc</td>
</tr>
<tr>
<td>Putting a single message using the MQPUT1 call</td>
<td>amqsinqqa</td>
<td>amqmech2</td>
<td>amqmech2</td>
<td>amqmechc</td>
</tr>
<tr>
<td>Putting messages to a distribution list</td>
<td>amqsptl0</td>
<td>no sample</td>
<td>amqsptl</td>
<td>amqsptlc</td>
</tr>
<tr>
<td>Replying to a request message</td>
<td>amqsinq0</td>
<td>amqmech2</td>
<td>amqmechc</td>
<td>amqsinqc</td>
</tr>
<tr>
<td>Getting messages (no wait)</td>
<td>amqsgrab0</td>
<td>amq0grab0</td>
<td>amqsgrab</td>
<td>amqsgrabc</td>
</tr>
<tr>
<td>Getting messages (wait with a time limit)</td>
<td>amqsget0</td>
<td>amq0get0</td>
<td>amqsget</td>
<td>amqsgetc</td>
</tr>
<tr>
<td>Getting messages (unlimited wait)</td>
<td>amqstrg0</td>
<td>no sample</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Getting messages (with data conversion)</td>
<td>amqsecha</td>
<td>no sample</td>
<td>amqsecha</td>
<td>amqsechc</td>
</tr>
<tr>
<td>Putting Reference Messages to a queue</td>
<td>amqsprma</td>
<td>no sample</td>
<td>amqsprma</td>
<td>amqsprmc</td>
</tr>
<tr>
<td>Getting Reference Messages from a queue</td>
<td>amqsgrm0</td>
<td>no sample</td>
<td>amqsgrm</td>
<td>amqsgrmc</td>
</tr>
<tr>
<td>Reference Message channel exit</td>
<td>amqsgmrma</td>
<td>no sample</td>
<td>amqsgmrma</td>
<td>amqsgmrma</td>
</tr>
<tr>
<td>Browsing first 20 characters of a message</td>
<td>amqsgrab0</td>
<td>amq0grab0</td>
<td>amqsgrab</td>
<td>amqsgrabc</td>
</tr>
</tbody>
</table>

Notes:
1. The executable version of the WebSphere MQ client samples share the same source as the samples that run in a server environment.
2. COBOL is not supported by MQSeries for AT&T GIS UNIX. Compile programs beginning ‘amqm’ with the Micro Focus COBOL compiler, those beginning ‘amqi’ with the IBM COBOL compiler, and those beginning ‘amq0’ with either.
3. The executable versions of the WebSphere MQ client samples are not available on WebSphere MQ for HP-UX or MQSeries for Compaq OpenVMS Alpha.
4. Not available on MQSeries for Compaq Tru64 UNIX.
5. Supported on WebSphere MQ for AIX, WebSphere MQ for HP-UX, and WebSphere MQ for Solaris only.
6. On WebSphere MQ for AIX, WebSphere MQ for HP-UX, MQSeries for DIGITAL UNIX (Compaq Tru64 UNIX), and WebSphere MQ for Solaris this program is called amqsvfc0c. On MQSeries for AT&T GIS UNIX, MQSeries for Compaq OpenVMS Alpha, and MQSeries for SINIX and DC/OSx this program is called amqsvfcx.c.
7. CICS is supported by WebSphere MQ for AIX and WebSphere MQ for HP-UX only.
8. TUXEDO is not supported by WebSphere MQ for iSeries or MQSeries for Compaq OpenVMS Alpha.
9. The source for the dead-letter queue handler is made up of several files and provided in a separate directory.
10. The API exit function is only available on WebSphere MQ platforms from V5.3.

Samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows

Table 32 shows the techniques demonstrated by the sample programs for MQSeries for OS/2 Warp and WebSphere MQ for Windows.

Table 32. MQSeries for OS/2 Warp and WebSphere MQ for Windows sample programs demonstrating use of the MQI

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>C (executable)</th>
<th>Client (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting messages using the MQPUT call</td>
<td>amqsput0</td>
<td>amq0put0</td>
<td>amqsput</td>
<td>amqsputc</td>
</tr>
<tr>
<td>Putting a single message using the MQPUT1 call</td>
<td>amqsinqqa</td>
<td>amqmech2</td>
<td>amqmech2</td>
<td>amqmechc</td>
</tr>
<tr>
<td>Putting messages to a distribution list</td>
<td>amqsptl0</td>
<td>no sample</td>
<td>amqsptl</td>
<td>amqsptlc</td>
</tr>
<tr>
<td>Replying to a request message</td>
<td>amqsinq0</td>
<td>amqmech2</td>
<td>amqmechc</td>
<td>amqsinqc</td>
</tr>
<tr>
<td>Getting messages (no wait)</td>
<td>amqsgrab0</td>
<td>amq0grab0</td>
<td>amqsgrab</td>
<td>amqsgrabc</td>
</tr>
<tr>
<td>Getting messages (wait with a time limit)</td>
<td>amqsget0</td>
<td>amq0get0</td>
<td>amqsget</td>
<td>amqsgetc</td>
</tr>
<tr>
<td>Getting messages (unlimited wait)</td>
<td>amqstrg0</td>
<td>no sample</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Getting messages (with data conversion)</td>
<td>amqsecha</td>
<td>no sample</td>
<td>amqsecha</td>
<td>amqsechc</td>
</tr>
<tr>
<td>Putting Reference Messages to a queue</td>
<td>amqsprma</td>
<td>no sample</td>
<td>amqsprma</td>
<td>amqsprmc</td>
</tr>
<tr>
<td>Getting Reference Messages from a queue</td>
<td>amqsgrm0</td>
<td>no sample</td>
<td>amqsgrm</td>
<td>amqsgrmc</td>
</tr>
<tr>
<td>Reference Message channel exit</td>
<td>amqsgmrma</td>
<td>no sample</td>
<td>amqsgmrma</td>
<td>amqsgmrma</td>
</tr>
<tr>
<td>Browsing first 20 characters of a message</td>
<td>amqsgrab0</td>
<td>amq0grab0</td>
<td>amqsgrab</td>
<td>amqsgrabc</td>
</tr>
</tbody>
</table>
Table 32. MQSeries for OS/2 Warp and WebSphere MQ for Windows sample programs demonstrating use of the MQI (continued)

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>C (executable)</th>
<th>Client (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Browsing complete messages</td>
<td>amqsbcg0</td>
<td>no sample</td>
<td>amqsbcg</td>
<td>amqsbcgc</td>
</tr>
<tr>
<td>Using a shared input queue</td>
<td>amqsinq0</td>
<td>amqminq2</td>
<td>amqsinq</td>
<td>amqsinqc</td>
</tr>
<tr>
<td>Using an exclusive input queue</td>
<td>amqstrg0</td>
<td>amq0req0</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Using the MQINQ call</td>
<td>amqsinqa</td>
<td>amqminq2</td>
<td>amqsinq</td>
<td>amqsinqc</td>
</tr>
<tr>
<td>Using the MQSET call</td>
<td>amqsseta</td>
<td>amqset2</td>
<td>amqsset</td>
<td>amqssetc</td>
</tr>
<tr>
<td>Using a reply-to queue</td>
<td>amqsreq0</td>
<td>amq0req0</td>
<td>amqsreq</td>
<td>amqsreqc</td>
</tr>
<tr>
<td>Requesting message exceptions</td>
<td>amqsreq0</td>
<td>amq0req0</td>
<td>amqsreq</td>
<td>amqsreqc</td>
</tr>
<tr>
<td>Accepting a truncated message</td>
<td>amqsgrbr0</td>
<td>amq0grbr0</td>
<td>amqsgrbr</td>
<td>amqsgrbrc</td>
</tr>
<tr>
<td>Using a resolved queue name</td>
<td>amqsgrbr0</td>
<td>amq0grbr0</td>
<td>amqsgrbr</td>
<td>amqsgrbrc</td>
</tr>
<tr>
<td>Triggering a process</td>
<td>amqstrg0</td>
<td>no sample</td>
<td>amqstrg</td>
<td>amqstrgc</td>
</tr>
<tr>
<td>Using data conversion</td>
<td>amqsfc0</td>
<td>no sample</td>
<td>amqsfc0</td>
<td>no sample</td>
</tr>
<tr>
<td>CICS transaction</td>
<td>amqscict0.ccs</td>
<td>no sample</td>
<td>amqscict0</td>
<td>(1) no sample</td>
</tr>
<tr>
<td>TUXEDO transaction to put messages</td>
<td>amqstpx</td>
<td>no sample</td>
<td>amqstpx</td>
<td>no sample</td>
</tr>
<tr>
<td>(Windows systems only)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUXEDO transaction to get messages</td>
<td>amqstgx</td>
<td>no sample</td>
<td>amqstgx</td>
<td>no sample</td>
</tr>
<tr>
<td>(Windows systems only)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Server for TUXEDO (Windows systems only)</td>
<td>amqstxsx</td>
<td>no sample</td>
<td>amqstxsx</td>
<td>no sample</td>
</tr>
<tr>
<td>Encina transaction</td>
<td>amqsexs</td>
<td>no sample</td>
<td>amqsexs</td>
<td>no sample</td>
</tr>
<tr>
<td>Dead-letter queue handler</td>
<td></td>
<td>no sample</td>
<td>amqsdlq</td>
<td>no sample</td>
</tr>
<tr>
<td>From a WebSphere MQ client, putting a message</td>
<td>no sample</td>
<td>no sample</td>
<td>amqsputc</td>
<td></td>
</tr>
<tr>
<td>From a WebSphere MQ client, getting a message</td>
<td>no sample</td>
<td>no sample</td>
<td>amqsgetc</td>
<td></td>
</tr>
<tr>
<td>Connecting to the queue manager using MQCONNX</td>
<td>amqscnx</td>
<td>no sample</td>
<td>amqscnx</td>
<td></td>
</tr>
<tr>
<td>Using API exits</td>
<td>amqsaxe0</td>
<td>no sample</td>
<td>amqsaxe</td>
<td>no sample</td>
</tr>
<tr>
<td>Cluster workload balancing</td>
<td>amqsxwm0</td>
<td>no sample</td>
<td>amqsxwm</td>
<td>no sample</td>
</tr>
<tr>
<td>SSPI security routines</td>
<td></td>
<td>no sample</td>
<td>amqspinning.dll</td>
<td>amqspinning.dll</td>
</tr>
</tbody>
</table>

Notes:
1. The executable version on OS/2 is for CICS Transaction Server for OS/2, Version 4; the version on Windows systems is for TXSeries for Windows NT, Version 4.
2. The source for the dead-letter queue handler is made up of several files and provided in a separate directory.
3. Only available for WebSphere MQ from V5.3.
4. Only available for WebSphere MQ for Windows.

PL/I samples for WebSphere MQ for AIX, MQSeries for OS/2 Warp, and WebSphere MQ for Windows

Table 33 on page 410 shows the techniques demonstrated by the WebSphere MQ for AIX, MQSeries for OS/2 Warp, and WebSphere MQ for Windows sample programs.
Features demonstrated

Table 33. WebSphere MQ for AIX, MQSeries for OS/2 Warp and WebSphere MQ for Windows sample programs demonstrating use of the MQI

<table>
<thead>
<tr>
<th>Technique</th>
<th>PL/I (source)</th>
<th>PL/I (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting messages using the MQPUT call</td>
<td>amqpput0</td>
<td>no sample</td>
</tr>
<tr>
<td>Getting messages (wait with a time limit)</td>
<td>amqpget0</td>
<td>no sample</td>
</tr>
</tbody>
</table>

Visual Basic samples for WebSphere MQ for Windows

Table 34 shows the techniques demonstrated by the WebSphere MQ for Windows sample programs.

A project may contain several files. When you open a project within Visual Basic the other files will be loaded automatically. No executable programs are provided.

All the sample projects, except mqtrivc.vbp, are set up to work with the WebSphere MQ server. To find out how to change the sample projects to work with the WebSphere MQ clients see "Preparing Visual Basic programs" on page 379.

Table 34. WebSphere MQ for Windows sample programs demonstrating use of the MQI

<table>
<thead>
<tr>
<th>Technique</th>
<th>Project file name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting messages using the MQPUT call</td>
<td>amqsputb.vbp</td>
</tr>
<tr>
<td>Getting messages using the MQGET call</td>
<td>amqsgetb.vbp</td>
</tr>
<tr>
<td>Browsing a queue using the MQGET call</td>
<td>amqsbcgb.vbp</td>
</tr>
<tr>
<td>Simple MQGET and MQPUT sample (client)</td>
<td>mqtrivc.vbp</td>
</tr>
<tr>
<td>Simple MQGET and MQPUT sample (server)</td>
<td>mqtrivs.vbp</td>
</tr>
<tr>
<td>Putting and getting strings and user-defined structures using MQPUT and MQGET</td>
<td>strings.vbp</td>
</tr>
<tr>
<td>Using PCF structures to start and stop a channel</td>
<td>pcfsamp.vbp</td>
</tr>
<tr>
<td>Creating a queue using the MQAI</td>
<td>amqsaicq.vbp</td>
</tr>
<tr>
<td>Listing a queue manager’s queues using the MQAI</td>
<td>amqsailq.vbp</td>
</tr>
<tr>
<td>Monitoring events using the MQAI</td>
<td>amqsaiem.vbp</td>
</tr>
</tbody>
</table>

Samples for WebSphere MQ for iSeries

Table 35 shows the techniques demonstrated by the WebSphere MQ for iSeries sample programs. Some techniques occur in more than one sample program, but only one program is listed in the table.

Table 35. WebSphere MQ for iSeries sample programs demonstrating use of the MQI

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>RPG (source)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting messages using the MQPUT call</td>
<td>AMQSPUT0</td>
<td>AMQ0PUT4</td>
<td>AMQ3PUT4</td>
</tr>
<tr>
<td>Putting messages from a data file using the MQPUT call</td>
<td>AMQSPUT4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Putting a single message using the MQPUT1 call</td>
<td>AMQ0INQ4, AMQ3INQ4, AMQ3ECH4</td>
<td>AMQ0INQ4, AMQ0ECH4</td>
<td>AMQ3INQ4, AMQ3ECH4</td>
</tr>
<tr>
<td>Putting messages to a distribution list</td>
<td>AMQSPTL4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Replying to a request message</td>
<td>AMQ0INQ4</td>
<td>AMQ0INQ4</td>
<td>AMQ3INQ4</td>
</tr>
<tr>
<td>Getting messages (no wait)</td>
<td>AMQSGBR4</td>
<td>AMQ0GBR4</td>
<td>AMQ3GBR4</td>
</tr>
</tbody>
</table>
### Table 35. WebSphere MQ for iSeries sample programs demonstrating use of the MQI (continued)

<table>
<thead>
<tr>
<th>Technique</th>
<th>C (source)</th>
<th>COBOL (source)</th>
<th>RPG (source)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting messages (wait with a time limit)</td>
<td>AMQSGET4</td>
<td>AMQ0GET4</td>
<td>AMQ3GET4</td>
</tr>
<tr>
<td>Getting messages (unlimited wait)</td>
<td>AMQSTRG4</td>
<td>no sample</td>
<td>AMQ3TRG4</td>
</tr>
<tr>
<td>Getting messages (with data conversion)</td>
<td>AMQSECH4</td>
<td>AMQ0ECH4</td>
<td>AMQ3ECH4</td>
</tr>
<tr>
<td>Putting Reference Messages to a queue</td>
<td>AMQSPRM4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Getting Reference Messages from a queue</td>
<td>AMQSGRM4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Reference Message channel exit</td>
<td>AMQSQRM4,</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td></td>
<td>AMQ5XRMM4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message exit</td>
<td>AMQSCMX4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Browsing first 49 characters of a message</td>
<td>AMQ5GBR4</td>
<td>AMQ0GBR4</td>
<td>AMQ3GBR4</td>
</tr>
<tr>
<td>Browsing complete messages</td>
<td>AMQSBCG4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Using a shared input queue</td>
<td>AMQSINQ4</td>
<td>AMQ0INQ4</td>
<td>AMQ3INQ4</td>
</tr>
<tr>
<td>Using an exclusive input queue</td>
<td>AMQSREQ4</td>
<td>AMQ0REQ4</td>
<td>AMQ3REQ4</td>
</tr>
<tr>
<td>Using the MQINQ call</td>
<td>AMQSINQ4</td>
<td>AMQ0INQ4</td>
<td>AMQ3INQ4</td>
</tr>
<tr>
<td>Using the MQSET call</td>
<td>AMQ5SET4</td>
<td>AMQ0SET4</td>
<td>AMQ3SET4</td>
</tr>
<tr>
<td>Using a reply-to queue</td>
<td>AMQ5REQ4</td>
<td>AMQ0REQ4</td>
<td>AMQ3REQ4</td>
</tr>
<tr>
<td>Requesting message exceptions</td>
<td>AMQSREQ4</td>
<td>AMQ0REQ4</td>
<td>AMQ3REQ4</td>
</tr>
<tr>
<td>Accepting a truncated message</td>
<td>AMQ5GBR4</td>
<td>AMQ0GBR4</td>
<td>AMQ3GBR4</td>
</tr>
<tr>
<td>Using a resolved queue name</td>
<td>AMQ5GBR4</td>
<td>AMQ0GBR4</td>
<td>AMQ3GBR4</td>
</tr>
<tr>
<td>Triggering a process</td>
<td>AMQ5TRG4</td>
<td>no sample</td>
<td>AMQ3TRG4</td>
</tr>
<tr>
<td>Trigger server</td>
<td>AMQSERV4</td>
<td>no sample</td>
<td>AMQ3SRV4</td>
</tr>
<tr>
<td>Using a trigger server (including CICS transactions)</td>
<td>AMQSERV4</td>
<td>no sample</td>
<td>AMQ3SRV4</td>
</tr>
<tr>
<td>Using data conversion</td>
<td>AMQ5VFC4</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Using API exits</td>
<td>AMQSAXE0</td>
<td>no sample</td>
<td>no sample</td>
</tr>
<tr>
<td>Cluster workload balancing</td>
<td>AMQ5WLM0</td>
<td>no sample</td>
<td>no sample</td>
</tr>
</tbody>
</table>

**Notes:**

1. Source for the C samples is in the file QMQMSAMP/QCSRC. Include files exist as members in the file QMQM/H.
2. Source for the COBOL samples are in the files QMQMSAMP/QCBLSRC for the OPM compiler, and QMQMSAMP/QCBLESRC for the ILE compiler. The members are named AMQ0xxx4, where xxx indicates the sample function.
3. Source for the RPG samples is in QMQMSAMP/QRPGLESRC. Members are named AMQ3xxx4, where xxx indicates the sample function. Copy members exist in QMQM/QRPGLESRC. Each member name has the suffix “G”.

In addition to these, the WebSphere MQ for iSeries sample option includes a sample data file, which can be used as input to the sample programs, AMQSDATA and sample CL programs that demonstrate administration tasks. The CL samples are described in [WebSphere MQ for iSeries V5.3 System Administration Guide](#). You could use the sample CL program amqsamp4 to create queues to use with the sample programs described in this chapter.
## Samples for MQSeries for Compaq NonStop Kernel

The following C and COBOL sample programs are supplied with MQSeries for Compaq NonStop Kernel:

<table>
<thead>
<tr>
<th>Description</th>
<th>C source</th>
<th>C executable</th>
<th>COBOL85 source</th>
<th>COBOL85 executable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read and output message descriptor and context for each message on a queue</td>
<td>amqsbcg0</td>
<td>amqsbcg</td>
<td>No sample</td>
<td>No sample</td>
</tr>
<tr>
<td>Echo a message from a message queue to the reply-to queue</td>
<td>amqsecha</td>
<td>amqsech</td>
<td>amq0ech0</td>
<td>amq0ech</td>
</tr>
<tr>
<td>Write messages from a queue to stdout, leave messages on the queue (Browse)</td>
<td>amqsgbr0</td>
<td>amqsgbr</td>
<td>amq0gbr0</td>
<td>amq0gbr</td>
</tr>
<tr>
<td>Remove messages from the named queue and write to stdout</td>
<td>amqsget0</td>
<td>amqsget</td>
<td>amq0get0</td>
<td>amq0get</td>
</tr>
<tr>
<td>Read the triggered queue, respond with queue information</td>
<td>amqsinqa</td>
<td>amqsinq</td>
<td>No sample</td>
<td>No sample</td>
</tr>
<tr>
<td>Use a shared input queue</td>
<td>No sample</td>
<td>No sample</td>
<td>amq0inq0</td>
<td>amq0inq</td>
</tr>
<tr>
<td>Copy stdin to a message and put the message on a specified queue</td>
<td>amqsput0</td>
<td>amqsput</td>
<td>amq0put0</td>
<td>amq0put</td>
</tr>
<tr>
<td>Put a request message on a specified queue and display the replies</td>
<td>amqsreq0</td>
<td>amqsreq</td>
<td>amq0req0</td>
<td>amq0req</td>
</tr>
<tr>
<td>(Trigger function) inhibit puts on a named queue and respond with a statement of the result</td>
<td>amqsseta</td>
<td>amqsset</td>
<td>amq0set0</td>
<td>amq0set</td>
</tr>
<tr>
<td>Trigger monitor</td>
<td>amqstrg0</td>
<td>amqstrg</td>
<td>No sample</td>
<td>No sample</td>
</tr>
<tr>
<td>Sample skeleton for data conversion exit</td>
<td>amqsvfcn</td>
<td>No sample</td>
<td>No sample</td>
<td>No sample</td>
</tr>
<tr>
<td>Sample skeleton for channel exit</td>
<td>amqsvchn</td>
<td>No sample</td>
<td>No sample</td>
<td>No sample</td>
</tr>
<tr>
<td>Sample skeleton for cluster workload exit</td>
<td>amqswhm0</td>
<td>No sample</td>
<td>No sample</td>
<td>No sample</td>
</tr>
<tr>
<td>Sample skeleton for MQLOADEXIT</td>
<td>amqslxp0</td>
<td>No sample</td>
<td>No sample</td>
<td>No sample</td>
</tr>
</tbody>
</table>

The following TAL sample programs are supplied with MQSeries for Compaq NonStop Kernel:

<table>
<thead>
<tr>
<th>Description</th>
<th>TAL (source)</th>
<th>TAL (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read ( n ) messages from a queue</td>
<td>zmqreadt</td>
<td>zmqread</td>
</tr>
<tr>
<td>Write ( n ) messages of ( n ) length to a queue</td>
<td>zmqwritt</td>
<td>zmqwrit</td>
</tr>
</tbody>
</table>

## Samples for MQSeries for VSE/ESA

Table 38 on page 413 shows the techniques demonstrated by the MQSeries for VSE/ESA COBOL sample programs.
Features demonstrated

Table 38. MQSeries for VSE/ESA COBOL sample programs demonstrating use of the MQI

<table>
<thead>
<tr>
<th>Description</th>
<th>COBOL (source)</th>
<th>COBOL (executable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction that demonstrates MQI calls</td>
<td>TTPTST2.Z</td>
<td>TTPTST2</td>
</tr>
<tr>
<td>Test facility that starts the sample transaction TTPTST2</td>
<td>TTPTST3.Z</td>
<td>TTPTST3</td>
</tr>
<tr>
<td>Triggered test program that echoes a message from a queue to a reply-to queue</td>
<td>MQPECHO.Z</td>
<td>MQPECHO</td>
</tr>
</tbody>
</table>

Notes:
1. Demonstrates MQGET, MQINQ, MQPUT, MQPUT1, both MQPUT and MQGET, MQGET and delete, MQPUT and reply.
2. Each TTPTST2 that is started is a task.

Preparing and running the sample programs

The following sections help you find the samples that you need to run on the different platforms.

**OS/400**

The source for WebSphere MQ for iSeries sample programs are provided in library QMQMSAMP as members of QC SRC, QC LSRC, QCBL SRC, QCBL LESRC, QRPG SRC, and QR PGLESRC. To run the samples use either the C executable versions, supplied in the library QMQM, or compile them as you would any other WebSphere MQ application. For more information see “Running the sample programs” on page 420.

**UNIX systems**

Table 39. Where to find the samples for WebSphere MQ on UNIX systems

<table>
<thead>
<tr>
<th>Content</th>
<th>Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>source files</td>
<td>/mqmtop/samp</td>
</tr>
<tr>
<td>C source file for Windows 3.1 sample</td>
<td>/mqmtop/win_client/samp</td>
</tr>
<tr>
<td>dead-letter queue handler source files</td>
<td>/mqmtop/samp/dlq</td>
</tr>
<tr>
<td>executable files</td>
<td>/mqmtop/bin</td>
</tr>
<tr>
<td>Other WebSphere MQ client executable files</td>
<td>/mqmtop/dos_client/samp/bin</td>
</tr>
<tr>
<td></td>
<td>/mqmtop/os2_client/samp/bin</td>
</tr>
<tr>
<td></td>
<td>/mqmtop/win_client/samp/bin</td>
</tr>
</tbody>
</table>

Note: For WebSphere MQ for AIX mqmtop is /usr/mqm, for WebSphere MQ for other UNIX systems mqmtop is /opt/mqm.

The WebSphere MQ on UNIX systems sample files will be in the directories listed in Table 39 if the defaults were used at installation time. To run the samples, either use the executable versions supplied or compile the source versions as you would any other applications, using an ANSI compiler. For information on how to do this, see “Running the sample programs” on page 420.
Preparing and running samples

Compaq OpenVMS Alpha

Table 40. Where to find the samples for MQSeries for Compaq OpenVMS Alpha

<table>
<thead>
<tr>
<th>Content</th>
<th>Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>source files</td>
<td>MQS_EXAMPLES</td>
</tr>
<tr>
<td>C source file for Windows 3.1 sample</td>
<td>[.WIN_CLIENT.SAMP] under MQS_EXAMPLES</td>
</tr>
<tr>
<td>dead-letter queue handler source files</td>
<td>[.DLQ] under MQS_EXAMPLES</td>
</tr>
<tr>
<td>executable files</td>
<td>[.BIN] under MQS_EXAMPLES</td>
</tr>
<tr>
<td>Other WebSphere MQ client executable files</td>
<td>[.DOS_CLIENT.SAMP.BIN] under MQS_EXAMPLES [OS2_CLIENT.SAMP.BIN] under MQS_EXAMPLES [WIN_CLIENT.SAMP.BIN] under MQS_EXAMPLES</td>
</tr>
</tbody>
</table>

The MQSeries for Compaq OpenVMS Alpha sample files are in the directories listed in Table 40 if the defaults were used at installation time. To run the samples, either use the executable versions supplied or compile the source versions as you would any other applications, using an ANSI compiler. For information on how to do this, see “Running the sample programs” on page 420.

OS/2 and Windows systems

Table 41. Where to find the samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows

<table>
<thead>
<tr>
<th>Content</th>
<th>Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>C source code</td>
<td><a href="">drive:directory</a>\MQM\TOOLS\C\SAMPLES</td>
</tr>
<tr>
<td>Source code for dead-letter handler sample</td>
<td><a href="">drive:directory</a>\MQM\TOOLS\C\SAMPLES\DLQ</td>
</tr>
<tr>
<td>C source code for Windows 3.1 sample</td>
<td><a href="">drive:directory</a>\MQM\WIN</td>
</tr>
<tr>
<td>COBOL source code</td>
<td><a href="">drive:directory</a>\MQM\TOOLS\COBOL\SAMPLES</td>
</tr>
<tr>
<td>C executable files</td>
<td><a href="">drive:directory</a>\MQM\TOOLS\C\SAMPLES\BIN</td>
</tr>
<tr>
<td>Other WebSphere MQ client executable files</td>
<td><a href="">drive:directory</a>\MQM\DOS <a href="">drive:directory</a>\MQM\AIX <a href="">drive:directory</a>\MQM\WIN</td>
</tr>
<tr>
<td>Sample MQSC files</td>
<td><a href="">drive:directory</a>\MQM\TOOLS\MQSC\SAMPLES</td>
</tr>
<tr>
<td>PL/I source code</td>
<td><a href="">drive:directory</a>\MQM\TOOLS\PLI\SAMPLES</td>
</tr>
<tr>
<td>Visual Basic Version 6 source code</td>
<td><a href="">drive:directory</a>\Program Files\IBM\WebSphere MQ\Tools\VB\SampVB6</td>
</tr>
</tbody>
</table>
Preparing and running samples

Table 41. Where to find the samples for MQSeries for OS/2 Warp and WebSphere MQ for Windows (continued)

<table>
<thead>
<tr>
<th>Content</th>
<th>Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes:</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>The Visual Basic samples are not available for OS/2.</td>
</tr>
<tr>
<td>2.</td>
<td>Paths beginning “<a href="">drive:directory</a>\Program Files\” apply to Windows systems; paths beginning “<a href="">drive:directory</a>\MQM\” apply to OS/2.</td>
</tr>
</tbody>
</table>

The MQSeries for OS/2 Warp and WebSphere MQ for Windows sample files will be in the directories listed in Table 41 on page 414 if the defaults were used at installation time, the <drive:directory> will default to <c:>. To run the samples, either use the executable versions supplied or compile the source versions as you would any other MQSeries for OS/2 Warp or WebSphere MQ for Windows applications. For information on how to do this, see “Running the sample programs” on page 420.

Compaq NonStop Kernel

This section tells you how to build the MQSeries for Compaq NonStop Kernel sample programs:

Building C sample programs

Non-native (using non-native static library MQMLIB): The subvolume ZMQSSMPL contains the following TACL macro files for building non-native sample C applications:

**CSAMP**

Usage: CSAMP source-code-file-name

This is a basic macro for compiling a C source file using the include files contained in subvolume ZMQSLIB. For example, to compile the sample AMQSBCG0, use CSAMP AMQSBCG0. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example, AMQSBCGO.

**BSAMP**

Usage: BSAMP exe-file-name

This is a basic macro used to bind an object file with the user library MQMLIB in ZMQSLIB. For example, to bind the compiled sample AMQSBCG0, use BSAMP AMQSBCG. The macro produces an executable file called exe-file-nameE; for example, AMQSBCGE.

**COMPALL**

Usage: COMPALL

This TACL macro compiles each of the sample source code files using the CSAMP macro.

**BINDALL**

Usage: BINDALL

This TACL macro binds each of the sample object files into executables using the BSAMP macro.

**BUILD**

Usage: BUILD
This TACL macro compiles and binds all of the C sample files using the macros COMPALL and BINDALL.

Native (using native static library MQMLIBN): For a native install, use the following TACL macro files to build sample MQI applications:

NMCALL
Usage: NMCALL
Macro to compile all samples native using NMCSAMP.

NMCSAMP
Usage: NMCSAMP source-code-file-name
This is a basic macro for compiling a C source file using the include files contained in subvolume ZMQSLIB. For example, to compile the sample AMQSBCG0, use NMCSAMP AMQSBCG0. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example, AMQSBCGO.

NMLDSAMP
Usage: NMLDSAMP exe-file-name
This basic macro links an object file with the static native MQI library MQMLIBN in ZMQSLIB.

NMLDALL
Usage: NMLDALL
This TACL macro binds each of the sample object files into executables using the NMLDSAMP macro.

NMBUILDC
Usage: NMBUILDC
This TACL macro compiles and binds all the sample object files using the NMLDSAMP macro.

Native (using SRL MQSRLLIB):

NMLDSSMP
Usage: NMLDSSMP exe-file-name
This basic macro links an object file with the native MQ SRL MQSRLLIB in ZMQSLIB.

NMLDSALL
Usage: NMLDSALL
This TACL macro binds each of the sample object files into executables using the NMLDSSMP macro.

NMBULDSC
Usage: NMBULDSC
This TACL macro compiles and binds all the Native C sample files using the macros NMCALL and NMLDSALL.

NMLDPSRL
Usage: NMLDPSRL exe-file-name
This basic macro links an object file with the MQSeries private SRL in ZMQSLIB.

NMCPSRL
Usage: NMCPSRL source-code-file-name
Macro to compile user code for inclusion in the MQSeries PSRL.

**NMLDUSRL**

Usage: NMLDUSRL object-input-file, where object-input-file is a file containing a list of objects to be linked.

This is a basic macro for linking user code into a relinkable library.

**Note:** Non-native applications can connect to native queue managers, and vice versa. All combinations of native and non-native operation are valid and supported.

**Building C++ sample programs**

**Note:** When linking C++ applications with the Native Static Library (MQMLIBN), you must link in the C++ runtime library (ZCPLSRL). This is illustrated in the sample link script (NMLDSAMP).

Native (using native static library MQMLIBN):

**NMCPPALL**

Usage: NMCPPALL

Macro to compile all samples native using NMCCPP.

**NMCCPP**

Usage: NMCCPP source-code-file-name

This is a basic macro for compiling a C++ source file using the include files contained in subvolume ZMQSLIB. For example, to compile the sample IMQSGETP, use NMCCPP IMQSGETP. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example, IMQSGETO.

**NMLDCPP**

Usage: NMLDCPP exe-file-name

This basic macro links an object file with the static native MQI library MQMLIBN in ZMQSLIB.

**NMLDCPPA**

Usage: NMLDCPPA

This TACL macro binds each of the sample object files into executables using the NMLDSAMP macro.

**NMBLDCPP**

Usage: NMBUILDC

This TACL macro compiles and binds all the native C++ sample files using the macros NMCPPALL and NMLDCPPA.

Native (using SRL MQSRLLIB):

**NMLDCPPS**

Usage: NMLDCPPS MQSeries-Private-SRL-Volume

This basic macro links an object file with the native MQ SRL MQSRLLIB in ZMQSLIB.

**NMLDCPSA**

Usage: NMLDCPSA
Building C++ samples

This TACL macro binds each of the sample object files into executables using the NMLDCPPS macro.

NMBLDSCP
Usage: NMBLDSCP MQSeries Private SRL volume
This TACL macro compiles and binds all the native C sample files using the macros NMCPPALL and NMLDCPSA.

Building COBOL sample programs

Non-native (using non-native static library MQMLIB): The subvolume ZMQSSMPL contains the following files to be used for building sample COBOL applications.

COBSAMP
Usage: COBSAMP source-code-file-name
This is a basic macro for compiling a COBOL source file using the definition files contained in subvolume ZMQSLIB. For example, to compile the program AMQ0GBR0, use COBSAMP AMQ0GBR0. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example AMQ0GBRO.

BCOBSAMP
Usage: BCOBSAMP exe-file-name
This is a basic macro used to bind an object with the user libraries in ZMQSLIB. For example to bind the compiled sample AMQ0GBRO, use BCOBSAMP AMQ0GBR. The macro produces an executable called exe-file-name AMQ0GBR.

CCBSMPLS
Usage: CCBSMPLS
This TACL macro compiles each of the COBOL sample source code files.

BCBSMPLS
Usage: BIND /IN BCBSMPLS/
This bind input file binds each of the COBOL sample object files into executables.

BUILDCOB
Usage: BUILDCOB
This TACL macro compiles and binds all the COBOL sample files using the macros CCBSMPLS and BCBSMPLS.

Native (using native static library MQMLIBN):

NMCOBBSMP
Usage: NMCOBBSMP source-code-file-name
This is a macro for compiling native mode COBOL 'NMCOBOL' using the MQSeries native library MQMLIBN in ZMQSLIB. For example, to compile the program AMQ0GBR0, use NMCOBBSMP AMQ0GBR0. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example AMQ0GBRO.

NMLDCOB
Usage: NMLDCOB exe-file-name
Building COBOL samples

This macro binds an object with the MQSeries native library MQMLIBN in ZMQSLIB. For example to bind the compiled sample AMQ0GBRO, use NMLDCOB AMQ0GBR. The macro produces an executable called \textit{exe-file-name} AMQ0GBR.

**NMCOBALL**

Usage: NMCOBALL

This TACL macro compiles each of the COBOL sample source code files using NMCOBSSMP.

**NMLDACOB**

Usage: NMLDACOB

This bind input file binds each of the NMLDCOB sample object files into executables.

**NMBLDCOB**

Usage: NMBLDCOB

This TACL macro compiles and binds all the COBOL sample files using the macros NMCOBALL and NMLDACOB.

Native (using SRL MQSRLLIB):

**NMCBSSMP**

Usage: NMCBSSMP \textit{source-code-file-name}

This is a macro for compiling native mode COBOL ‘NMCOBOL’ using the MQSeries SRL MQSRLLIB in ZMQSLIB. For example, to compile the program AMQ0GBR0, use NMCBSSMP AMQ0GBR0. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example AMQ0GBRO.

**NMLDSCOB**

Usage: NMLDSCOB \textit{exe-file-name}

This macro binds an object with the MQSeries SRL MQSRLLIB in ZMQSLIB. For example to bind the compiled sample AMQ0GBRO, use NMLDSCOB AMQ0GBR. The macro produces an executable called \textit{exe-file-name} AMQ0GBR.

**NMCBSALL**

Usage: NMCBSALL

This TACL macro compiles each of the COBOL sample source code files using NMCBSSMP.

**NMLDSCOB**

Usage: NMLDSCOB

This bind input file binds each of the NMLDSCOB sample object files into executables.

**NMBLDSCL**

Usage: NMBLDSCL

This TACL macro compiles and binds all the COBOL sample files using the macros NMCBSALL and NMLDSCOB.
Building TAL samples

Building TAL sample programs

Non-native (using non-native static library MQMLIB): The subvolume ZMQSSMPL contains the following files to be used for building sample TAL programs.

- **TALSAMP**
  Usage: TALSAMP source-code-file-name
  This is a basic macro for compiling a TAL source file using the definition files contained in subvolume Appendix I. MQSeries for Compaq NSK sample programs 335.ZMQSLIB. For example, to compile the program ZMQWRITT, use TALSAMP ZMQWRITT. If the compilation is successful, the macro produces an object file with the last character of the file name replaced by the letter O; for example ZMQWRITO.

- **BTALSAMP**
  Usage: BTALSAMP exe-file-name
  This is a basic macro used to bind an object with the user libraries in ZMQSLIB. For example to bind the compiled sample ZMQWRITO, use BTALSAMP ZMQWRIT.

- **CTLSMPLS**
  Usage: CTLSMPLS
  This TACL macro compiles each of the TAL sample source code files.

- **BTLSMPLS**
  Usage: BIND /IN BTLSMPLS/
  This bind input file binds each of the TAL sample object files into executables.

- **BUILDTAL**
  Usage: BUILDTAL
  This TACL macro compiles and binds all the TAL sample files using the macros CTLSMPLS and BTLSMPLS.

Building sample programs on OSS (native mode only)
The directory /opt/mqm/samp contains the sample programs for MQSeries and the make file MQMAKE.SMP. This MakeFile contains all the targets needed to build all the C, C++, and NMCOBOL samples.

The directory /opt/mqm/inc contains all the copylibs and header files needed to build programs on OSS.

The readme.txt file contains information on building the OSS sample programs using the SRL MQSRLLIB or static library MQMLIBN.

Note: The MQSeries SRL file and the native MQI library MQMLIBN exist only on the Guardian file system. You need to edit your build scripts and make files to point to them if needed, for example, /G/system/zmqslib/mqsrllib.

Running the sample programs

Before you can run any of the sample programs, a queue manager must be created and the default definitions set up. This is explained in WebSphere MQ System Administration Guide for WebSphere MQ for AIX, WebSphere MQ for Linux,
WebSphere MQ for HP-UX, MQSeries for OS/2 Warp, WebSphere MQ for Solaris, and WebSphere MQ for Windows; for other platforms, see the appropriate System Management Guide.

**On all platforms except OS/400**

The samples need a set of queues to work with. Either use your own queues or run the sample MQSC file amqscos0.tst to create a set.

To do this on UNIX systems and Compaq OpenVMS Alpha, enter:
```
runmqsc QManagerName <amqscos0.tst >/tmp/sampobj.out
```
Check the sampobj.out file to ensure that there are no errors.

To do this on OS/2 and Windows systems enter:
```
runmqsc QManagerName <amqscos0.tst > sampobj.out
```
Check the sampobj.out file to ensure that there are no errors. This file is in your current directory.

To do this on Compaq NonStop Kernel enter:
```
runmqsc -i $SYSTEM.ZMQSSMPL.AMQSCOMA
```
Check the sampobj.out file to ensure that there are no errors. This file will be found in your current directory.

The sample applications can now be run. Enter the name of the sample application followed by any parameters, for example:
```
amqsput myqueue qmanagername
```
where myqueue is the name of the queue on which the messages are going to be put, and qmanagername is the queue manager that owns myqueue.

See the description of the individual samples for information on the parameters that each of them expects.

**On OS/400**

You can use your own queues when you run the samples, or you can run the sample program AMQSAMP4 to create some sample queues. The source for this program is shipped in file QCLSRC in library QMQMSAMP. It can be compiled using the CRTCLPGM command.

To call one of the sample programs using data from member PUT in file AMQSDATA of library QMQMSAMP, use a command like:
```
CALL PGM(QMQM/AMQSPUT4) PARM('QMQMSAMP/AMQSDATA(PUT)')
```

The sample data only applies to the C/400® sample programs.

**Note:** For a compiled module to use the IFS file system, specify the option SYSIFCOPT(*IFSIO) on CRTCMOD, then the file name, passed as a parameter, must be specified in the following format:

```
home/me/myfile
```

**Length of queue name**

For the COBOL sample programs, when you pass queue names as parameters, you must provide 48 characters, padding with blank characters if necessary. Anything other than 48 characters causes the program to fail with reason code 2085.
Inquire, Set, and Echo examples
For the Inquire, Set, and Echo examples, the sample definitions cause the C versions of these samples to be triggered. If you want the COBOL versions you must change the process definitions:

SYSTEM.SAMPLE.INQPROCESS
SYSTEM.SAMPLE.SETPROCESS
SYSTEM.SAMPLE.ECHOPROCESS

On OS/2, Windows systems and UNIX do this by editing the amqscos0.tst file and changing the C executable file names to the COBOL executable file names before using the runmqsc command above.

On OS/400, you can use the CHGMQMPRC command (described in WebSphere MQ for iSeries V5.3 System Administration Guide), or edit and run AMQSAMP4 with the alternative definition.

The Put sample programs

The Put sample programs put messages on a queue using the MQPUT call. See "Features demonstrated in the sample programs" on page 406 for the names of these programs.

Running the amqsput and amqsputc samples

These programs each take 2 parameters:
1. The name of the target queue (required)
2. The name of the queue manager (optional)

If a queue manager is not specified, amqsput connects to the default queue manager and amqsputc connects to the queue manager identified by an environment variable or the client channel definition file. To run these programs, enter one of the following:

amqsput myqueue qmanagername
amqsputc myqueue qmanagername

where myqueue is the name of the queue on which the messages are going to be put, and qmanagername is the queue manager that owns myqueue.

Running the amq0put sample

The COBOL version does not have any parameters. It connects to the default queue manager and when you run it you are prompted:

Please enter the name of the target queue

It takes input from StdIn and adds each line of input to the target queue. A blank line indicates there is no more data.

Running the AMQSPUT4 C sample

The C program creates messages by reading data from a member of a source file. You must specify the name of the file as a parameter when you start the program. The structure of the file must be:

queue name
text of message 1
text of message 2
A sample of input for the put samples is supplied in library QMQMSAMP file AMQSDATA member PUT.

**Note:** Remember that queue names are case sensitive. All the queues created by the sample file create program AMQSAMP4 have names created in uppercase characters.

The C program puts messages on the queue named in the first line of the file—you could use the supplied queue SYSTEM.SAMPLE.LOCAL. The program puts the text of each of the following lines of the file into separate datagram messages, and stops when it reads a blank line at the end of the file.

Using the example data file the command is:

```
CALL PGM(QMQM/AMQSPUT4) PARM('QMQMSAMP/AMQSDATA(PUT)')
```

**Running the AMQOPUT4 COBOL sample**

The COBOL program creates messages by accepting data from the keyboard. To start the program, call the program and give the name of your target queue as a program parameter. The program accepts input from the keyboard into a buffer and creates a datagram message for each line of text. The program stops when you enter a blank line at the keyboard.

**Design of the Put sample program**

The program uses the MQOPEN call with the MQOO_OUTPUT option to open the target queue for putting messages. If it cannot open the queue, the program outputs an error message containing the reason code returned by the MQOPEN call. To keep the program simple, on this and on subsequent MQI calls, the program uses default values for many of the options.

For each line of input, the program reads the text into a buffer and uses the MQPUT call to create a datagram message containing the text of that line. The program continues until either it reaches the end of the input or the MQPUT call fails. If the program reaches the end of the input, it closes the queue using the MQCLOSE call.

**The Distribution List sample program**

The Distribution List sample amqsptl0 gives an example of putting a message on several message queues. It is based on the MQPUT sample, amqsput0.

**Running the Distribution List sample, amqsptl0**

The Distribution List sample runs in a similar way to the Put samples. It takes the following parameters:

- The names of the queues
- The names of the queue managers

These values are entered as pairs. For example:

```
amqsptl0 queue1 qmanagername1 queue2 qmanagername2
```
The queues are opened using MQOPEN and messages are put to the queues using MQPUT. Reason codes are returned if any of the queue or queue manager names are not recognized.

Remember to define channels between queue managers so that messages can flow between them. The sample program does not do that for you!

**Design of the Distribution List sample**

Put Message Records (MQPMRs) specify message attributes on a per destination basis. The sample chooses to provide values for *MsgId* and *CorrelId*, and these override the values specified in the MQMD structure.

The `PutMsgRecFields` field in the MQPMO structure indicates which fields are present in the MQPMRs:

```c
MQLONG PutMsgRecFields=MQPMRF_MSG_ID + MQPMRF_CORREL_ID;
```

Next, the sample allocates the response records and object records. The object records (MQORs) require at least one pair of names and an even number of names, that is, *ObjectName* and *ObjectQMgrName*.

The next stage involves connecting to the queue managers using MQCONN. The sample attempts to connect to the queue manager associated with the first queue in the MQOR; if this fails, it goes through the object records in turn. You are informed if it is not possible to connect to any queue manager and the program exits.

The target queues are opened using MQOPEN and the message is put to these queues using MQPUT. Any problems and failures are reported in the response records (MQRRs).

Finally, the target queues are closed using MQCLOSE and the program disconnects from the queue manager using MQDISC. The same response records are used for each call stating the *CompCode* and *Reason*.

**The Browse sample programs**

The Browse sample programs browse messages on a queue using the MQGET call. See "Features demonstrated in the sample programs" on page 406 for the names of these programs.

**OS/2, UNIX systems, Compaq OpenVMS Alpha, and Windows systems**

The C version of the program takes 2 parameters

1. The name of the source queue (necessary)
2. The name of the queue manager (optional)

If a queue manager is not specified, it will connect to the default one. For example, enter one of the following:

```sh
amqsgbr myqueue qmanagername
amqsgbrc myqueue qmanagername
amq0gbr0 myqueue
```

where *myqueue* is the name of the queue that the messages will be viewed from, and *qmanagername* is the queue manager that owns *myqueue*. 

424  WebSphere MQ Application Programming Guide
Browse samples

If you omit the qmanagername, when running the C sample, it will assume that the default queue manager owns the queue.

The COBOL version does not have any parameters. It connects to the default queue manager and when you run it you are prompted:

Please enter the name of the target queue

Only the first 50 characters of each message are displayed, followed by --- truncated when this is the case.

OS/400

Each program retrieves copies of all the messages on the queue you specify when you call the program; the messages remain on the queue. You could use the supplied queue SYSTEM.SAMPLE.LOCAL; run the Put sample program first to put some messages on the queue. You could use the queue SYSTEM.SAMPLE.ALIAS, which is an alias name for the same local queue. The program continues until it reaches the end of the queue or an MQI call fails.

The C samples allow for specification of queue manager name, generally as the second parameter, in a similar fashion to the Windows systems samples. For example:

CALL PGM(QMQM/AMQSTRG4) PARM('SYSTEM.SAMPLE.TRIGGER' 'QM01')

If a queue manager is not specified, it will connect to the default one. This is also relevant to the RPG samples. However, with the RPG samples you must supply a queue manager name rather than allowing it to default.

Design of the Browse sample program

The program opens the target queue using the MQOPEN call with the MQOO_BROWSE option. If it cannot open the queue, the program outputs an error message containing the reason code returned by the MQOPEN call.

For each message on the queue, the program uses the MQGET call to copy the message from the queue, then displays the data contained in the message. The MQGET call uses these options:

MQGMO_BROWSE_NEXT
After the MQOPEN call, the browse cursor is positioned logically before the first message in the queue, so this option causes the first message to be returned when the call is first made.

MQGMO_NO_WAIT
The program does not wait if there are no messages on the queue.

MQGMO_ACCEPT_TRUNCATED_MSG
The MQGET call specifies a buffer of fixed size. If a message is longer than this buffer, the program displays the truncated message, together with a warning that the message has been truncated.

The program demonstrates how you must clear the MsgId and CorrelId fields of the MQMD structure after each MQGET call, because the call sets these fields to the values contained in the message it retrieves. Clearing these fields means that successive MQGET calls retrieve messages in the order in which the messages are held in the queue.
The program continues to the end of the queue; at this point the MQGET call returns the MQRC_NO_MSG_AVAILABLE reason code and the program displays a warning message. If the MQGET call fails, the program displays an error message that contains the reason code.

The program then closes the queue using the MQCLOSE call.

---

**The Browser sample program**

The Browser sample program is written as a utility not just to demonstrate a technique. It reads and writes out both the message descriptor and the message content fields of all the messages on a queue. See “Features demonstrated in the sample programs” on page 406 for the names of these programs.

This program takes 2 parameters:
1. The name of the source queue
2. The name of the queue manager

Both input parameters for this program are mandatory. For example, enter one of the following:

```
amqsbcg myqueue qmanagername
amqsbcgc myqueue qmanagername
```

where `myqueue` is the name of the queue on which the messages are going to be browsed, and `qmanagername` is the queue manager that owns `myqueue`.

It reads each message from the queue and writes the following to stdout:

- Formatted message descriptor fields
- Message data (dumped in hex and, where possible, character format)

The program is restricted to printing the first 32767 characters of the message, and will fail with the reason ‘truncated msg’ if a longer message is read.

See the [WebSphere MQ System Administration Guide](#) or the [System Management Guide](#) for your platform, for examples of the output from this utility.

---

**The Get sample programs**

The Get sample programs get messages from a queue using the MQGET call. See “Features demonstrated in the sample programs” on page 406 for the names of these programs.

**Running the amqsget and amqsgetc samples**

These programs each take two parameters:
1. The name of the source queue (required)
2. The name of the queue manager (optional)

If a queue manager is not specified, amqsget connects to the default queue manager, and amqsgetc connects to the queue manager identified by an environment variable or the client channel definition file.

To run these programs, enter one of the following:

```
amqsget myqueue qmanagername
amqsgetc myqueue qmanagername
```
where myqueue is the name of the queue from which the program will get messages, and qmanagername is the queue manager that owns myqueue.

If you omit the qmanagername, the programs assume the default, or, in the case of the MQI client, the queue manager identified by an environment variable or the client channel definition file.

Running the amq0get sample
The COBOL version does not have any parameters. It connects to the default queue manager and when you run it you are prompted:

Please enter the name of the source queue

Each program removes messages from the queue you specify when you call the program. You could use the supplied queue SYSTEM.SAMPLE.LOCAL; run the Put sample program first to put some messages on the queue. You could use the queue SYSTEM.SAMPLE.ALIAS, which is an alias name for the same local queue. The program continues until the queue is empty or an MQI call fails.

Running the AMQSGET4 and the AMQ0GET4 samples
The Get sample programs get messages from a queue using the MQGET call. The programs are named:

C language AMQSGET4
COBOL language AMQ0GET4

Each program removes messages from the queue you specify when you call the program. You could use the supplied queue SYSTEM.SAMPLE.LOCAL; run the Put sample program first to put some messages on the queue. You could use the queue SYSTEM.SAMPLE.ALIAS, which is an alias name for the same local queue. The program continues until the queue is empty or an MQI call fails.

An example of a command to call the C program is:

CALL PGM(QM/QMAMQSGET4) PARM('SYSTEM.SAMPLE.LOCAL')

Design of the Get sample program
The program opens the target queue using the MQOPEN call with the MQOO_INPUT_AS_Q_DEF option. If it cannot open the queue, the program displays an error message containing the reason code returned by the MQOPEN call.

For each message on the queue, the program uses the MQGET call to remove the message from the queue, then displays the data contained in the message. The MQGET call uses the MQGMO_WAIT option, specifying a WaitInterval of 15 seconds, so that the program waits for this period if there is no message on the queue. If no message arrives before this interval expires, the call fails and returns the MQRC_NO_MSG_AVAILABLE reason code.

The program demonstrates how you must clear the MsgId and CorrelId fields of the MQMD structure after each MQGET call because the call sets these fields to the values contained in the message it retrieves. Clearing these fields means that successive MQGET calls retrieve messages in the order in which the messages are held in the queue.
The MQGET call specifies a buffer of fixed size. If a message is longer than this buffer, the call fails and the program stops.

The program continues until either the MQGET call returns the MQRC_NO_MSG_AVAILABLE reason code or the MQGET call fails. If the call fails, the program displays an error message that contains the reason code.

The program then closes the queue using the MQCLOSE call.

The Reference Message sample programs

The Reference Message samples allow a large object to be transferred from one node to another (usually on different systems) without the need for the object to be stored on WebSphere MQ queues at either the source or the destination nodes.

A set of sample programs is provided to demonstrate how Reference Messages can be 1) put to a queue, 2) received by message exits, and 3) taken from a queue. The sample programs use Reference Messages to move files. If you want to move other objects such as databases, or if you want to perform security checks, you must define your own exit, based on our sample, amqsxrm. The following sections describe the Reference Message sample programs.

There are four versions of the Reference Message exit sample program. The one to use depends on the platform on which the channel is running. If the sender channel is running on:

MQSeries or WebSphere MQ Version 5 products (excluding WebSphere MQ for iSeries and WebSphere MQ for z/OS)

Use amqsxrma at the sending end. Use amqsxrma at the receiving end if the receiver is running under MQSeries or WebSphere MQ Version 5 products (excluding WebSphere MQ for iSeries and WebSphere MQ for z/OS) or amqsxrm4 if the receiver is running under WebSphere MQ for iSeries.

Notes for OS/400 users

To receive a Reference Message using the sample message exit, specify a file in the root file system of IFS or any subdirectory so that a stream file can be created. The sample message exit on OS/400 creates the file, converts the data to EBCDIC, and sets the code page to your system code page. You then have the option of copying this file to the QSYS.LIB file system using the CPYFRMSTMF command. For example:

```
CPYFRMSTMF FROMSTMF('JANEP/TEST.TXT')
  TOMBFR('qsys.lib.janep.lib/test.fie/test.mbr') MBROPT(*REPLACE)
  CVTDTA(*NONE)
```

Note that the CPYFRMSTMF command does not create the file. You must create it before running this command.

If you send a file from QSYS.LIB no changes are required to the samples. For any other file system ensure that the CCSID specified in the CodedCharSetId field in the MQRMH structure matches the bulk data you are sending.

When using the integrated file system, create program modules with the SYSIFCOPT(*IFSIO) option set. If you want to move database or fixed-length record files, define your own exit based on the supplied sample AMQXSXRM4.
The recommended method of transferring a database file is to convert it to IFS structure, using the CPYTOSTMF command, and then send the Reference Message attaching the IFS file. If you choose to transfer a database file by referring to it from within IFS, but do not convert it to IFS structure, you must specify the member name. Data integrity is not guaranteed if you choose this method.

**Running the Reference Message samples**

The Reference Message samples run as follows:

1. Set up the environment to start the listeners, channels, and trigger monitors, and define your channels and queues.

   For the purposes of describing how to set up the Reference Message example this refers to the sending machine as MACHINE1 with a queue manager called QMGR1 and the receiving machine as MACHINE2 with a queue manager called QMGR2.

   **Note:** The following definitions allow a Reference Message to be built to send a file with an object type of FLATFILE from queue manager QMGR1 to QMGR2 and to recreate the file as defined in the call to AMQSPRM (or...
AMQSPRMA on OS/400). The Reference Message (including the file data) is sent using channel CHL1 and transmission queue XMITQ and placed on queue DQ. Exception and COA reports are sent back to QMGR1 using the channel REPORT and transmission queue QMGR1.

The application that receives the Reference Message (AMQSGRM or AMQSPRMA on OS/400) is triggered using the initiation queue INITQ and process PROC. You need to ensure the CONNAME fields are set correctly and the MSGEXIT field reflects your directory structure, depending on machine type and where the WebSphere MQ product is installed.

The MQSC definitions have used an AIX style for defining the exits, so if you are using MQSC on OS/400 you will need to modify these accordingly. It is important to note that the message data FLATFILE is case sensitive and the sample will not work unless it is in uppercase.

On machine MACHINE1, queue manager QMGR1

MQSC syntax

```
define chl(chl1) chltype(sdr) trptype(tcp) conname('machine2') xmitq(xmitq)
msgdata(FLATFILE) msgexit('/usr/lpp/mqm/samp/bin/amqsxrm(MsgExit)')
```

```
define ql(xmitq) usage(xmitq)
```

```
define chl(report) chltype(rcvr) trptype(tcp) replace
```

```
def qr(qr) rname(dq) rqmname(qmgr2) xmitq(xmitq) replace
```

OS/400 command syntax

`Note:` If you do not specify a queue manager name the system uses the default queue manager.

```
CRTMQMCHL CHLNAME(CHL1) CHLTYPE(*SDR) MQMNAME(QMGR1) +
REPLACE(*YES) TRPTYPE(*TCP) +
CONNAME('MACHINE2(60501)') TMQNAME(XMITQ) +
MSGEXIT(QMQM/AMQSXRM4) MSGUSRDATA(FLATFILE)
```

```
CRTMQMQ QNAME(XMITQ) QTYPE(*LCL) MQMNAME(QMGR1) +
REPLACE(*YES) USAGE(*TMQ)
```

```
CRTMQMCHL CHLNAME(REPORT) CHLTYPE(*RCVR) +
MQMNAME(QMGR1) REPLACE(*YES) TRPTYPE(*TCP)
```

```
CRTMQMQ QNAME(QR) QTYPE(*RMT) MQMNAME(QMGR1) +
REPLACE(*YES) RMTQNAME(DQ) +
RMTMQMNAME(QMGR2) TMQNAME(XMITQ)
```

On machine MACHINE2, queue manager QMGR2

MQSC syntax

```
define chl(chl1) chltype(rcvr) trptype(tcp)
msgexit('/usr/lpp/mqm/samp/bin/amqsxrm(MsgExit)')
msgdata(Flatfile)
```

```
def chl(report) chltype(sdr) trptype(tcp) conname('MACHINE1')
xmitq(qmgr1)
```

```
def qr(initq)
```

```
def qr(qmgr1) usage(xmitq)
```
define pro(proc) applicid('/usr/lpp/mqm/samp/bin/amqsgrm')
define qi(dq) initq(initq) process(proc) trigger trigtype(first)

OS/400 command syntax

Note: If you do not specify a queue manager name the system uses the default queue manager.

CRTMQMCHL CHLNAME(CHL1) CHLTYPE(*RCVR) MQMNAME(QMGR2) +
REPLACE(*YES) TRPTYPE(*TCP) +
MSGEXIT(QMQM/AMQSXRMA) MSGUSRDATA(FLATFILE)

CRTMQMCHL CHLNAME(REPORT) CHLTYPE(*SDR) MQMNAME(QMGR2) +
REPLACE(*YES) TRPTYPE(*TCP) +
CONNAME('MACHINE1(60500)') TMQNAME(QMGR1)

CRTMQMQ QNAME(INITQ) QTYPE(*LCL) MQMNAME(QMGR2) +
REPLACE(*YES) USAGE(*NORMAL)

CRTMQMQ QNAME(QMGR1) QTYPE(*LCL) MQMNAME(QMGR2) +
REPLACE(*YES) USAGE(*TMQ)

CRTMQMPRC PRCNAME(PROC) MQMNAME(QMGR2) REPLACE(*YES) +
APPID('QMQM/AMQSXRMA')

CRTMQMQ QNAME(DQ) QTYPE(*LCL) MQMNAME(QMGR2) +
REPLACE(*YES) PRCNAME(PROC) TRGENBL(*YES) +
INITQNAME(INITQ)

2. Once the above WebSphere MQ objects have been created:
   a. Where applicable to the platform, start the listener for the sending and receiving queue managers
   b. Start the channels CHL1 and REPORT
   c. On the receiving queue manager start the trigger monitor for the initiation queue INITQ

3. Invoke the put Reference Message sample program AMQSPRM (AMQSPRMA) on OS/400) from the command line using the following parameters:

   -m Name of the local queue manager, this defaults to the default queue manager
   -i Name and location of source file
   -o Name and location of destination file
   -q Name of queue
   -g Name of queue manager where the queue, defined in the -q parameter exists This defaults to the queue manager specified in the -m parameter
   -t Object type
   -w Wait interval, that is, the waiting time for exception and COA reports from the receiving queue manager

For example, to use the sample with the objects defined above you would use the following parameters:

   amqsprm -q QR -m QMGR1 -i d:\x\file.in -o d:\y\file.out -t FLATFILE -w120

Increasing the waiting time will allow time for a large file to be sent across a network before the program putting the messages times out.

OS/400 users:

   a. Use the following command:
CALL PGM(QMQM/AMQSPRM4) PARM('-mQMGR1' +
'-i/refmsgs/rmsg1' +
'-o/refmsgs/rmsgx' '-qQR' +
'-gQMGR1' '-tFLATFILE' '-w15')

This assumes that the original file rmsg1 is in IFS directory /refmsgs and you want the destination file to be rmsgx in IFS directory /refmsgs on the target system.

b. Create your own directory using the CRTDIR command rather than using the root directory.

c. When you call the program that puts data, remember that the output file name will need to reflect the IFS naming convention; for instance /TEST/FIENAME will create a file called FILENAME in the directory TEST.

Note: You can use either a forward slash (/) or a dash (-) when specifying parameters.

For example:

```
amqsprm /i\d:\files\infile.dat /o\e:\files\outfile.dat /q QR
/m QMGR1 /w 30 /t FLATFILE
```

Note: For UNIX platforms, you must use two backslashes (\\) instead of one to denote the destination file directory. Therefore, the above command looks like this:

```
amqsprm -i /files/infile.dat -o /e:\files\outfile.dat -q QR
-m QMGR1 -w 30 -t FLATFILE
```

Running the put Reference Message program does the following:

- The Reference Message will be put to queue QR on queue manager QMGR1.
- The source file and path is d:\files\infile.dat and exists on the system where the example command is issued.
- If the queue QR is a remote queue, the Reference Message is sent to another queue manager, on a different system, where a file is created with the name and path e:\files\outfile.dat. The contents of this file are the same as the source file.
- amqsprm waits for 30 seconds for a COA report from the destination queue manager.
- The object type is flatfile, so the channel used to move messages from the queue QR must specify this in the MsgData field.

4. When you define your channels, select the message exit at both the sending and receiving ends to be amqsxrm. This is defined on MQSeries for OS/2 Warp, and WebSphere MQ for Windows as follows:

```
msgexit('<pathname>\amqsxrm.d11(MsgExit)')
```

This is defined on WebSphere MQ for AIX, WebSphere MQ for HP-UX, MQSeries for DIGITAL UNIX (Compaq Tru64 UNIX), and WebSphere MQ for Solaris as follows:

```
msgexit('<pathname>/amqsxrm(MsgExit)')
```

If a pathname is specified, the complete name must be specified (including the extension .d11 on OS/2). If a pathname is not specified, it is assumed that the
program is in the path specified in the qm.ini file (or, on WebSphere MQ for Windows, the path specified in the registry). This is explained fully in WebSphere MQ Intercommunication.

5. The channel exit reads the Reference Message header and finds the file that it refers to.

6. It can then choose to segment the file before sending it down the channel along with the header. On WebSphere MQ for AIX, WebSphere MQ for HP-UX, MQSeries for DIGITAL UNIX (Compaq Tru64 UNIX), and WebSphere MQ for Solaris, you must change the group owner of the target directory to ‘mqm’ so that the sample message exit can create the file in that directory. Also, change the permissions of the target directory to allow mqm group members to write to it. The file data is not stored on the WebSphere MQ queues.

7. When the last segment of the file is processed by the receiving message exit, the Reference Message is put to the destination queue specified by amqsprm. If this queue is triggered (that is, the definition specifies **Trigger**, **InitQ**, and **Process** queue attributes), the program specified by the PROC parameter of the destination queue is triggered. The program to be triggered must be defined in the **ApplId** field of the **Process** attribute.

8. When the Reference Message reaches the destination queue (DQ), a COA report is sent back to the putting application (amqsprm).

9. The Get Reference Message sample, amqsgrm, gets messages from the queue specified in the input trigger message and checks the existence of the file.

### Design of the Put Reference Message sample (amqsprma.c, AMQSPRM4)

This sample creates a Reference Message that refers to a file and puts it on a specified queue:

1. The sample connects to a local queue manager using MQCONN.
2. It then opens (MQOPEN) a model queue which is used to receive report messages.
3. The sample builds a Reference Message containing the values required to move the file, for example, the source and destination file names and the object type. As an example, the sample shipped with WebSphere MQ builds a Reference Message to send the file d:\x\file.in from QMGR1 to QMGR2 and to recreate the file as d:\y\file.out using the following parameters:

   amqsprm -q QR -m QMGR1 -i d:\x\file.in -o d:\y\file.out -t FLATFILE

   Where QR is a remote queue definition that refers to a target queue on QMGR2.

   **Note:** For UNIX platforms, you must use two backslashes (\\) instead of one to denote the destination file directory. Therefore, the above command looks like this:

   amqsprm -q QR -m QMGR1 -i /x/file.in -o d:\\y\file.out -t FLATFILE

4. The Reference Message is put (without any file data) to the queue specified by the /q parameter. If this is a remote queue, the message is put to the corresponding transmission queue.

5. The sample waits, for the duration of time specified in the /w parameter (which defaults to 15 seconds), for COA reports, which, along with exception reports, are sent back to the dynamic queue created on the local queue manager (QMGR1).
Design of the Reference Message Exit sample (amqsxrma.c, AMQSXRM4)

This sample recognizes Reference Messages with an object type that matches the object type in the message exit user data field of the channel definition. For these messages, the following happens:

- At the sender or server channel, the specified length of data is copied from the specified offset of the specified file into the space remaining in the agent buffer after the Reference Message. If the end of the file is not reached, the Reference Message is put back on the transmission queue after updating the DataLogicalOffset field.

- At the requester or receiver channel, if the DataLogicalOffset field is zero and the specified file does not exist, it is created. The data following the Reference Message is added to the end of the specified file. If the Reference Message is not the last one for the specified file, it is discarded. Otherwise, it is returned to the channel exit, without the appended data, to be put on the target queue.

For sender and server channels, if the DataLogicalLength field in the input Reference Message is zero, the remaining part of the file, from DataLogicalOffset to the end of the file, is to be sent along the channel. If it is not zero, only the length specified is sent.

If an error occurs (for example, if the sample is unable to open a file), MQCXP.ExitResponse is set to MQXCC_SUPPRESS_FUNCTION so that the message being processed is put to the dead-letter queue instead of continuing to the destination queue. A feedback code is returned in MQCXP.Feedback and returned to the application that put the message in the Feedback field of the message descriptor of a report message. This is because the putting application requested exception reports by setting MQRO_EXCEPTION in the Report field of the MQMD.

If the encoding or CodedCharacterSetId (CCSID) of the Reference Message is different from that of the queue manager, the Reference Message is converted to the local encoding and CCSID. In our sample, amqsprm, the format of the object is MQFMT_STRING, so amqsxrm converts the object data to the local CCSID at the receiving end before the data is written to the file.

The format of the file being transferred should not be specified as MQFMT_STRING if the file contains multibyte characters (for example, DBCS or Unicode). This is because a multibyte character could be split when the file is segmented at the sending end. To transfer and convert such a file, the format should be specified as something other than MQFMT_STRING so that the Reference Message exit does not convert it and the file should be converted at the receiving end when the transfer is complete.
Compiling the Reference Message Exit sample
To compile amqsxrma, use the following commands:

Note: Throughout this section the “\" character is used to split long commands
over more than one line. Do not enter this character, enter each command as
a single line.

On AIX:
$ xl_r -c -I/usr/mqm/inc amqsxrma.c
$ ld -o amqsxrm amqsxrma.o -H512 -T512 -e MQStart \ 
  -bM:SRE -bE:amqsxrm.exp -lc_r -ls_r -1mqm_r -1pthreads

On Compaq Tru64 UNIX Version 4.0:
In a nonthreaded environment:
$ cc -std1 -c -I /opt/mqm/inc amqsxrma.c
$ cc -std1 -shared -0 amqsxrma amqsxrma.o -L /opt/mqm/lib -1mqm -e MQStart -lc

In a threaded environment:
$ cc -std1 -c -I /opt/mqm/inc amqsxrma.c
$ cc -std1 -shared -pthread -0 amqsxrma_r amqsxrma.o -L /opt/mqm/lib \ 
  -l1mqm_r -e MQStart -lc

On Compaq Tru64 UNIX Version 5.0:
$ cc -std1 -c -I /opt/mqm/inc amqsxrma.c
$ cc -std1 -shared -pthread -0 amqsxrma amqsxrma.o -L /opt/mqm/lib \ 
  -l1mqm -e MQStart -lc

On HP-UX:
$ cc -c -Aa +z -I/opt/mqm/inc amqsxrma.c
$ ld -b -o amqsxrm amqsxrma.o -z +b : -1mqm -lc

On Linux:
$ gcc -c -I/opt/mqm/inc amqsxrma.c
$ gcc -o amqsxrm amqsxrma.o -shared \ 
  -L/opt/mqm/lib -1mqm

On OS/400: To create the module use the following command:
CRTCMOD MODULE(MYLIB/AMQSXRMA) SRCFILE(QMQMSAMP/QCSRC) 
TERASPACE(*YES *TSIFC)

Notes:
1. To create your module so that it uses the IFS file system add the option 
   SYSFICOPT(*IFS10)
2. To create the program for use with nonthreaded channels use the following 
   command: CRTPGM PGM(MYLIB/AMQSXRMA) BNDSRVPGM(QMQM/LIBMQM)
3. To create the program for use with threaded channels use the following 
   command: CRTPGM PGM(MYLIB/AMQSXRMA) BNDSRVPGM(QMQM/LIBMQM_R)
Reference Message samples

On Solaris:

$ cc -c -KPIC -l/opt/mqm/inc amqsxrma.c
$ ld -G -o amqsxrm amqsxrma.o -dy -lmqm -lc -lns1 -ldl

On Windows systems:

c1 amqsxrma.c -o amqsxrm.dll -LD -DEFAULTLIB mqm.lib mqmvx.lib amqsxrm.def

Design of the Get Reference Message sample (amqsgurma.c, AMQSGRM4)

The program logic is as follows:

1. The sample is triggered and extracts the queue and queue manager names from the input trigger message.
2. It then connects to the specified queue manager using MQCONN and opens the specified queue using MQOPEN.
3. The sample issues MQGET with a wait interval of 15 seconds within a loop to get messages from the queue.
4. If a message is a Reference Message, the sample checks the existence of the file that has been transferred.
5. It then closes the queue and disconnects from the queue manager.

The Request sample programs

The Request sample programs demonstrate client/server processing. The samples are the clients that put request messages on a target server queue that is processed by a server program. They wait for the server program to put a reply message on a reply-to queue.

The Request samples put a series of request messages on target server queue using the MQPUT call. These messages specify the local queue, SYSTEM.SAMPLE.REPLY as the reply-to queue, which can be a local or remote queue. The programs wait for reply messages, then display them. Replies are sent only if the target server queue is being processed by a server application, or if an application is triggered for that purpose (the Inquire, Set, and Echo sample programs are designed to be triggered). The C sample waits 1 minute (the COBOL sample waits 5 minutes), for the first reply to arrive (to allow time for a server application to be triggered), and 15 seconds for subsequent replies, but both samples can end without getting any replies. See "Features demonstrated in the sample programs" on page 406 for the names of the Request sample programs.

Running the amqsreq0.c, amqsreq, and amqsreqc samples

The C version of the program takes 2 parameters:

1. The name of the target server queue (necessary)
2. The name of the queue manager (optional)

If a queue manager is not specified, it will connect to the default one. For example, enter one of the following:

amqsreq myqueue qmanagername
amqsreqc myqueue qmanagername
amq0req0 myqueue

where myqueue is the name of the target server queue, and qmanagername is the queue manager that owns myqueue.
If you omit the qmanagername, when running the C sample, it will assume that the default queue manager owns the queue.

**Running the amq0req0.cbl sample**

The COBOL version does not have any parameters. It connects to the default queue manager and when you run it you are prompted:

```
Please enter the name of the target server queue
```

The program takes its input from StdIn and adds each line to the target server queue, taking each line of text as the content of a request message. The program ends when a null line is read.

**Running the AMQSREQ4 sample**

The C program creates messages by taking data from stdin (the keyboard) with a blank time terminating input. The program takes up to three parameters: the name of the target queue (required), the queue manager name (optional), and the reply-to queue name (optional). If no queue manager name is specified, the default queue manager is used. If no reply-to queue is specified, the SYSTEM.SAMPLE.REPLY queue is used.

Here is an example of how to call the C sample program, specifying the reply-to queue, but letting the queue manager default:

```
CALL PGM(QMQM/AMQSREQ4) PARM('SYSTEM.SAMPLE.LOCAL' '' 'SYSTEM.SAMPLE.REPLY')
```

**Note:** Remember that queue names are case sensitive. All the queues created by the sample file create program AMQSAMP4 have names created in uppercase characters.

**Running the AMQ0REQ4 sample**

The COBOL program creates messages by accepting data from the keyboard. To start the program, call the program and specify the name of your target queue as a parameter. The program accepts input from the keyboard into a buffer and creates a request message for each line of text. The program stops when you enter a blank line at the keyboard.

**Running the Request sample using triggering**

If the sample is used with triggering and one of the Inquire, Set, or Echo sample programs, the line of input must be the queue name of the queue that you want the triggered program to access.

**OS/2, UNIX systems, and Windows systems**

To run the samples using triggering:

1. Start the trigger monitor program RUNMQTRM in one session (the initiation queue SYSTEM.SAMPLE.TRIGGER is available for you to use).
2. Start the amqsreq program in another session.
3. Make sure you have defined a target server queue.

The sample queues available to you to use as the target server queue for the request sample to put messages are:

- SYSTEM.SAMPLE.INQ - for the Inquire sample program
- SYSTEM.SAMPLE.SET - for the Set sample program
- SYSTEM.SAMPLE.ECHO - for the Echo sample program
Request samples

These queues have a trigger type of FIRST, so if there are already messages on the queues before you run the Request sample, server applications are not triggered by the messages you send.

4. Make sure you have defined a queue for the Inquire, Set or Echo sample program to use.

This means that the trigger monitor is ready when the request sample sends a message.

Note: The sample process definitions created using RUNMQSC and the amqscos0.tst file cause the C samples to be triggered. Change the process definitions in amqscos0.tst and use RUNMQSC with this updated file if the COBOL versions are required.

Figure 35 demonstrates how the Request and Inquire samples can be used together.

In Figure 35 the Request sample puts messages on to the target server queue, SYSTEM.SAMPLE.INQ, and the Inquire sample queries the queue, MYQUEUE. Alternatively, you can use one of the sample queues defined when you ran amqscos0.tst, or any other queue you have defined, for the Inquire sample.
To run the Request and Inquire samples, using triggering:

1. Check that the queues you want to use are defined. Run amqscos0.tst, to define the sample queues, and define a queue MYQUEUE.
2. Run the trigger monitor command RUNMQTRM:
   
   ```
   RUNMQTRM -m qmanagername -q SYSTEM.SAMPLE.TRIGGER
   ```
3. Run the request sample
   ```
   amqsreq SYSTEM.SAMPLE.INQ
   ```

   **Note:** The process object defines what is to be triggered. If the client and server are not running on the same platform, any processes started by the trigger monitor must define `ApplType`, otherwise the server takes its default definitions (that is, the type of application that is normally associated with the server machine) and causes a failure.

   For example, if the trigger monitor is running on a Windows systems client and wants to send a request to an OS/2 server, MQAT_WINDOWS_NT must be defined otherwise OS/2 uses its default definitions (that is, MQAT_OS2) and the process fails.

   For a list of application types, see [WebSphere MQ Application Programming Reference](#).

4. Enter the name of the queue you want the Inquire sample to use:
   ```
   MYQUEUE
   ```
5. Enter a blank line (to end the Request program).
6. The request sample will then display a message, containing the data the Inquire program obtained from MYQUEUE.

If you wish, you can use more than one queue. In this case, you enter the names of the other queues at step 4.

For more information on triggering see Chapter 14, “Starting WebSphere MQ applications using triggers”, on page 191.

**OS/400**

To try the samples using triggering on OS/400, start the sample trigger server, AMQSERV4, in one job, then start AMQSREQ4 in another. This means that the trigger server is ready when the Request sample program sends a message.

**Notes:**

1. The sample definitions created by AMQSAMP4 cause the C versions of the samples to be triggered. If you want to trigger the COBOL versions, you must change the process definitions SYSTEM.SAMPLE.ECHOPROCESS, SYSTEM.SAMPLE.INQPROCESS, and SYSTEM.SAMPLE.SETPROCESS. You can use the CHGMQMPRC command (described in [WebSphere MQ for iSeries V5.3 System Administration Guide](#)) to do this, or edit and run your own version of AMQSAMP4.

2. Source code for AMQSERV4 is supplied for the C language only. However, a compiled version (that you can use with the COBOL samples) is supplied in library QMQM.

You could put your request messages on these sample server queues:
- SYSTEM.SAMPLE.ECHO (for the Echo sample programs)
Request samples

- SYSTEM.SAMPLE.INQ (for the Inquire sample programs)
- SYSTEM.SAMPLE.SET (for the Set sample programs)

A flow chart for the SYSTEM.SAMPLE.ECHO program is shown in Figure 36 on page 441. Using the example data file the command to issue the C program request to this server is:

```call
CALL PGM(QMQMSAMP/AMQSREQ4) PARM('QMQMSAMP/AMQSDATA(ECHO)')
```

**Note:** This sample queue has a trigger type of FIRST, so if there are already messages on the queue before you run the Request sample, server applications are not triggered by the messages you send.

If you want to attempt further examples, you can try the following variations:

- **Use AMQSTRG4 (or its command line equivalent STRMQMTRM – see [WebSphere MQ for iSeries V5.3 System Administration Guide](#)) instead of AMQSERV4 to submit the job instead, but potential job submission delays could make it less easy to follow what is happening.**
- **Run the SYSTEM.SAMPLE.INQUIRE and SYSTEM.SAMPLE.SET sample programs. Using the example data file the commands to issue the C program requests to these servers are, respectively:**

  ```call
  CALL PGM(QMQMSAMP/AMQSREQ4) PARM('QMQMSAMP/AMQSDATA(INQ)')
  CALL PGM(QMQMSAMP/AMQSREQ4) PARM('QMQMSAMP/AMQSDATA(SET)')
  ```

These sample queues also have a trigger type of FIRST.

**Design of the Request sample program**

The program opens the target server queue so that it can put messages. It uses the MQOPEN call with the MQOO_OUTPUT option. If it cannot open the queue, the program displays an error message containing the reason code returned by the MQOPEN call.

The program then opens the reply-to queue called SYSTEM.SAMPLE.REPLY so that it can get reply messages. For this, the program uses the MQOPEN call with the MQOO_INPUT_EXCLUSIVE option. If it cannot open the queue, the program displays an error message containing the reason code returned by the MQOPEN call.

For each line of input, the program then reads the text into a buffer and uses the MQPUT call to create a request message containing the text of that line. On this call the program uses the MQRO_EXCEPTION_WITH_DATA report option to request that any report messages sent about the request message will include the first 100 bytes of the message data. The program continues until either it reaches the end of the input or the MQPUT call fails.

The program then uses the MQGET call to remove reply messages from the queue, and displays the data contained in the replies. The MQGET call uses the MQGMO_WAIT, MQGMO_CONVERT, and MQGMO_ACCEPT_TRUNCATED options. The `WaitInterval` is 5 minutes in the COBOL version, and 1 minute in the C version, for the first reply (to allow time for a server application to be triggered), and 15 seconds for subsequent replies. The program waits for these periods if there is no message on the queue. If no message arrives before this interval expires, the call fails and returns the MQRC_NO_MSG_AVAILABLE reason code. The call also uses the MQGMO_ACCEPT_TRUNCATED_MSG option, so messages longer than the declared buffer size are truncated.
The program demonstrates how you must clear the `MsgId` and `CorrelId` fields of the MQMD structure after each MQGET call because the call sets these fields to the values contained in the message it retrieves. Clearing these fields means that successive MQGET calls retrieve messages in the order in which the messages are held in the queue.

The program continues until either the MQGET call returns the MQRC_NO_MSG_AVAILABLE reason code or the MQGET call fails. If the call fails, the program displays an error message that contains the reason code.

The program then closes both the target server queue and the reply-to queue using the MQCLOSE call.

The Inquire sample programs inquire about some of the attributes of a queue using the MQINQ call. See "Features demonstrated in the sample programs" on page 406 for the names of these programs.

These programs are intended to run as triggered programs, so their only input is an MQTMC2 (trigger message) structure for OS/2, Windows systems, Compaq OpenVMS Alpha, and UNIX, and an MQTMC structure for OS/400. These
**Inquire samples**

structures contain the name of a target queue whose attributes are to be inquired. The C version also uses the queue manager name. The COBOL version uses the default queue manager.

For the triggering process to work, you must ensure that the Inquire sample program you want to use is triggered by messages arriving on queue SYSTEM.SAMPLE.INQ. To do this, specify the name of the Inquire sample program you want to use in the **ApplicId** field of the process definition SYSTEM.SAMPLE.INQPROCESS. For OS/400, you can use the CHGMQMPRC command described in [WebSphere MQ for iSeries V5.3 System Administration Guide](#) for this. The sample queue has a trigger type of FIRST; if there are already messages on the queue before you run the request sample, the inquire sample is not triggered by the messages you send.

When you have set the definition correctly:

- For OS/2, UNIX systems, Compaq OpenVMS Alpha, and Windows systems, start the runmqtrm program in one session, then start the amqsreq program in another.
- For OS/400, start the AMQSERV4 program in one session, then start the AMQSREQ4 program in another. You could use AMQSTRG4 instead of AMQSERV4, but potential job submission delays could make it less easy to follow what is happening.

Use the Request sample programs to send request messages, each containing just a queue name, to queue SYSTEM.SAMPLE.INQ. For each request message, the Inquire sample programs send a reply message containing information about the queue specified in the request message. The replies are sent to the reply-to queue specified in the request message.

On OS/400, if the sample input file member QMQMSAMP.AMQSDATA(INQ) is used, the last queue named does not exist, so the sample returns a report message with a reason code for the failure.

**Design of the Inquire sample program**

The program opens the queue named in the trigger message structure it was passed when it started. (For clarity, we will call this the request queue.) The program uses the MQOPEN call to open this queue for shared input.

The program uses the MQGET call to remove messages from this queue. This call uses the MQGMO_ACCEPT_TRUNCATED_MSG and MQGMO_WAIT options, with a wait interval of 5 seconds. The program tests the descriptor of each message to see if it is a request message; if it is not, the program discards the message and displays a warning message.

For each request message removed from the request queue, the program reads the name of the queue (which we will call the target queue) contained in the data and opens that queue using the MQOPEN call with the MQOO_INQ option. The program then uses the MQINQ call to inquire about the values of the InhibitGet, CurrentQDepth, and OpenInputCount attributes of the target queue.

If the MQINQ call is successful, the program uses the MQPUT1 call to put a reply message on the reply-to queue. This message contains the values of the 3 attributes.
If the MQOPEN or MQINQ call is unsuccessful, the program uses the MQPUT1 call to put a report message on the reply-to queue. In the Feedback field of the message descriptor of this report message is the reason code returned by either the MQOPEN or MQINQ call, depending on which one failed.

After the MQINQ call, the program closes the target queue using the MQCLOSE call.

When there are no messages remaining on the request queue, the program closes that queue and disconnects from the queue manager.

### The Set sample programs

The Set sample programs inhibit put operations on a queue by using the MQSET call to change the queue’s InhibitPut attribute. See “Features demonstrated in the sample programs” on page 406 for the names of these programs.

The programs are intended to run as triggered programs, so their only input is an MQTMC2 (trigger message) structure that contains the name of a target queue whose attributes are to be inquired. The C version also uses the queue manager name. The COBOL version uses the default queue manager.

For the triggering process to work, you must ensure that the Set sample program you want to use is triggered by messages arriving on queue SYSTEM.SAMPLE.SET. To do this, specify the name of the Set sample program you want to use in the ApplicId field of the process definition SYSTEM.SAMPLE.SETPROCESS. The sample queue has a trigger type of FIRST; if there are already messages on the queue before you run the Request sample, the Set sample is not triggered by the messages you send.

When you have set the definition correctly:

- For OS/2, UNIX systems, Compaq OpenVMS Alpha, and Windows systems, start the `runmqtrm` program in one session, then start the amqsreq program in another.

- For OS/400, start the AMQSERV4 program in one session, then start the AMQSREQ4 program in another. You could use AMQSTRG4 instead of AMQSERV4, but potential job submission delays could make it less easy to follow what is happening.

Use the Request sample programs to send request messages, each containing just a queue name, to queue SYSTEM.SAMPLE.SET. For each request message, the Set sample programs send a reply message containing a confirmation that put operations have been inhibited on the specified queue. The replies are sent to the reply-to queue specified in the request message.

### Design of the Set sample program

The program opens the queue named in the trigger message structure it was passed when it started. (For clarity, we will call this the request queue.) The program uses the MQOPEN call to open this queue for shared input.

The program uses the MQGET call to remove messages from this queue. This call uses the MQGMO_ACCEPT_TRUNCATED_MSG and MQGMO_WAIT options, with a wait interval of 5 seconds. The program tests the descriptor of each message to see if it is a request message; if it is not, the program discards the message and displays a warning message.
For each request message removed from the request queue, the program reads the
name of the queue (which we will call the target queue) contained in the data and
opens that queue using the MQOPEN call with the MQOO_SET option. The
program then uses the MQSET call to set the value of the InhibitPut attribute of
the target queue to MQQA_PUT_INHIBITED.

If the MQSET call is successful, the program uses the MQPUT1 call to put a reply
message on the reply-to queue. This message contains the string PUT inhibited.

If the MQOPEN or MQSET call is unsuccessful, the program uses the MQPUT1
call to put a report message on the reply-to queue. In the Feedback field of the
message descriptor of this report message is the reason code returned by either the
MQOPEN or MQSET call, depending on which one failed.

After the MQSET call, the program closes the target queue using the MQCLOSE
call.

When there are no messages remaining on the request queue, the program closes
that queue and disconnects from the queue manager.

The Echo sample programs

The Echo sample programs echo a message from a message queue to the reply
queue. See “Features demonstrated in the sample programs” on page 406 for the
names of these programs.

The programs are intended to run as triggered programs.

On OS/400, OS/2, UNIX systems, and Windows systems, their only input is an
MQTMC2 (trigger message) structure that contains the name of a target queue and
the queue manager. The COBOL version uses the default queue manager.

On OS/400, for the triggering process to work, you must ensure that the Echo
sample program you want to use is triggered by messages arriving on queue
SYSTEM.SAMPLE.ECHO. To do this, specify the name of the Echo sample
program you want to use in the ApplId field of the process definition
SYSTEM.SAMPLE.ECHOPROCESS. (For this, you can use the CHGMQMPRC
command, described in WebSphere MQ for iSeries V5.3 System Administration Guide.
The sample queue has a trigger type of FIRST, so, if there are already messages on
the queue before you run the Request sample, the Echo sample is not triggered by
the messages you send.

When you have set the definition correctly, first start AMQSERV4 in one job, then
start AMQSREQ4 in another. You could use AMQSTRG4 instead of AMQSERV4,
but potential job submission delays could make it less easy to follow what is
happening.

Use the Request sample programs to send messages to queue
SYSTEM.SAMPLE.ECHO. The Echo sample programs send a reply message
containing the data in the request message to the reply-to queue specified in the
request message.
Design of the Echo sample programs

The program opens the queue named in the trigger message structure it was passed when it started. (For clarity, we will call this the request queue.) The program uses the MQOPEN call to open this queue for shared input.

The program uses the MQGET call to remove messages from this queue. This call uses the MQGMO_ACCEPT_TRUNCATED_MSG, MQGMO_CONVERT, and MQGMO_WAIT options, with a wait interval of 5 seconds. The program tests the descriptor of each message to see if it is a request message; if it is not, the program discards the message and displays a warning message.

For each line of input, the program then reads the text into a buffer and uses the MQPUT1 call to put a request message, containing the text of that line, on to the reply-to queue.

If the MQGET call fails, the program puts a report message on the reply-to queue, setting the Feedback field of the message descriptor to the reason code returned by the MQGET.

When there are no messages remaining on the request queue, the program closes that queue and disconnects from the queue manager.

On OS/400, the program can also respond to messages sent to the queue from platforms other than WebSphere MQ for iSeries, although no sample is supplied for this situation. To make the ECHO program work, you:

- Write a program, correctly specifying the Format, Encoding, and CCSID parameters, to send text request messages.

The ECHO program requests the queue manager to perform message data conversion, if this is needed.

- Specify CONVERT(*YES) on the WebSphere MQ for iSeries sending channel, if the program you have written does not provide similar conversion for the reply.

The Data-Conversion sample program

The data-conversion sample program is a skeleton of a data conversion exit routine. See “Features demonstrated in the sample programs” on page 406 for the names of these programs.

Design of the data-conversion sample

Each data-conversion exit routine converts a single named message format. This skeleton is intended as a wrapper for code fragments generated by the data-conversion exit generation utility program.

The utility produces one code fragment for each data structure; several such structures make up a format, so several code fragments are added to this skeleton to produce a routine to do data conversion of the entire format.

The program then checks whether the conversion is a success or failure, and returns the values required to the caller.
The Triggering sample programs

The function provided in the triggering sample is a subset of that provided in the trigger monitor in the runmqtrm program. See “Features demonstrated in the sample programs” on page 406 for the names of these programs.

Running the amqstrg0.c, amqstrg, and amqstrgc samples

The program takes 2 parameters:
1. The name of the initiation queue (necessary)
2. The name of the queue manager (optional)

If a queue manager is not specified, it will connect to the default one. A sample initiation queue will have been defined when you ran amqscos0.tst. The name of that queue is SYSTEM.SAMPLE.TRIGGER, and you can use it when you run this program.

Note: The function in this sample is a subset of the full triggering function that is supplied in the runmqtrm program.

Running the AMQSTRG4 sample

This is a trigger monitor for the OS/400 environment. It submits one OS/400 job for each application to be started. This means there is a processing overhead associated with each trigger message.

AMQSTRG4 (in QCSRC) takes two parameters: the name of the initiation queue it is to serve, and the name of the queue manager (optional). AMQSAMP4 (in QCLSRC) defines a sample initiation queue, SYSTEM.SAMPLE.TRIGGER, that you can use when you try the sample programs.

Using the example trigger queue, the command to issue is:

\[
\text{CALL PGM(QMQM/AMQSTRG4) PARM('SYSTEM.SAMPLE.TRIGGER')}\]

Alternatively, you can use the CL equivalent STRMQMTRM – see WebSphere MQ for iSeries V5.3 System Administration Guide.

Design of the triggering sample

The triggering sample program opens the initiation queue using the MQOPEN call with the MQOO_INPUT_AS_Q_DEF option. It gets messages from the initiation queue using the MQGET call with the MQGMO_ACCEPT_TRUNCATED_MSG and MQGMO_WAIT options, specifying an unlimited wait interval. The program clears the MsgId and CorrelId fields before each MQGET call to get messages in sequence.

When it has retrieved a message from the initiation queue, the program tests the message:

- It checks the size of the message to make sure it is the same size as an MQTM structure.
- It checks the ApplType field to make sure it contains the value MQAT_UNIX.

If either of these tests fail, the program displays a warning.

For valid trigger messages, the triggering sample copies data from these fields: ApplicId, EnvrData, Version, and ApplType. The last two of these fields are
numeric, so the program creates character replacements to use in an MQTM2 structure for OS/2, UNIX, and Windows systems, and in an MQTM structure for OS/400.

The triggering sample issues a start command to the application specified in the ApplicId field of the trigger message, and passes an MQTM2 or MQTM (a character version of the trigger message) structure. In OS/2, UNIX systems, and Windows systems, the EnvData field is used as an extension to the invoking command string. In OS/400, it is used as job submission parameters, for example, the job priority or the job description. See [WebSphere MQ for iSeries V5.3 System Administration Guide](#) for a discussion of job priority and job description.

Finally, the program closes the initiation queue.

### Running the AMQSERV4 sample

This is a trigger server for the OS/400 environment. For each trigger message, this server runs the start command in its own job to start the specified application. The trigger server can call CICS transactions.

AMQSERV4 takes two parameters: the name of the initiation queue it is to serve, and the name of the queue manager (optional). AMQSAMP4 defines a sample initiation queue, SYSTEM.SAMPLE.TRIGGER, that you can use when you try the sample programs.

Using the example trigger queue the command to issue is:

```snippet
CALL PGM(QMQM/AMQSERV4) PARM('SYSTEM.SAMPLE.TRIGGER')
```

### Design of the trigger server

The design of the trigger server is similar to that of the trigger monitor, except the trigger server:
- Allows MQAT_CICS as well as MQAT_OS400 applications
- Calls OS/400 applications in its own job (or uses STRCICSUSR to start CICS applications) rather than submitting an OS/400 job
- For CICS applications, substitutes the EnvData, for example, to specify the CICS region, from the trigger message in the STRCICSUSR command
- Opens the initiation queue for shared input, so many trigger servers can run at the same time

**Note:** Programs started by AMQSERV4 must not use the MQDISC call because this will stop the trigger server. If programs started by AMQSERV4 use the MQCONN call, they will get the MQRC_ALREADY_CONNECTED reason code.

### Ending the triggering sample programs on OS/400

A trigger monitor program can be ended by the sysexit option 2 (ENDRQS) or by inhibiting gets from the trigger queue. If the sample trigger queue is used the command is:

```snippet
CHGMQMQ QNAME('SYSTEM.SAMPLE.TRIGGER') MQMNAME GETENBL(*NO)
```

**Note:** Before starting triggering again on this queue, you must enter the command:

```snippet
CHGMQMQ QNAME('SYSTEM.SAMPLE.TRIGGER') GETENBL(*YES)
```
Remote queuing

Running the samples using remote queues

You can demonstrate remote queuing by running the samples on connected queue managers.

Program amqscos0.tst provides a local definition of a remote queue (SYSTEM.SAMPLE.REMOTE) that uses a remote queue manager named OTHER. To use this sample definition, change OTHER to the name of the second queue manager you want to use. You must also set up a message channel between your two queue managers; for information on how to do this, see WebSphere MQ Intercommunication.

The Request sample programs put their own local queue manager name in the ReplyToQMgr field of messages they send. The Inquire and Set samples send reply messages to the queue and message queue manager named in the ReplyToQ and ReplyToQMgr fields of the request messages they process.

Database coordination samples

Two samples are provided which demonstrate how WebSphere MQ can coordinate both WebSphere MQ updates and database updates within the same unit of work:

1. AMQSXAS0 (in C) or AMQ0XAS0 (in COBOL), which updates a single database within a WebSphere MQ unit of work.
2. AMQSXAG0 (in C) or AMQ0XAG0 (in COBOL), AMQSXAB0 (in C) or AMQ0XAB0 (in COBOL), and AMQSXAF0 (in C) or AMQ0XAF0 (in COBOL), which together update two databases within a WebSphere MQ unit of work, showing how multiple databases can be accessed. These samples are provided to show the use of the MQBEGIN call, mixed SQL and WebSphere MQ calls, and where and when to connect to a database.

Figure 37 on page 449 shows how the samples provided are used to update databases:
The programs read a message from a queue (under syncpoint), then, using the information in the message, obtain the relevant information from the database and update it. The new status of the database is then printed.

The program logic is as follows:

1. Use name of input queue from program argument
2. Connect to default queue manager (or optionally supplied name in C) using MQCONN
3. Open queue (using MQOPEN) for input while no failures
4. Start a unit of work using MQBEGIN
5. Get next message (using MQGET) from queue under syncpoint
6. Get information from databases
7. Update information from databases
8. Commit changes using MQCMIT
9. Print updated information (no message available counts as failure, and loop ends)
10. Close queue using MQCLOSE
11. Disconnect from queue using MQDISC

SQL cursors are used in the samples, so that reads from the databases (that is, multiple instances) are locked whilst a message is being processed, thus multiple instances of these programs can be run simultaneously. The cursors are explicitly opened, but implicitly closed by the MQCMIT call.

The single database sample (AMQSXAS0 or AMQ0XAS0) has no SQL CONNECT statements and the connection to the database is implicitly made by WebSphere.
Database coordination samples

MQ with the MQBEGIN call. The multiple database sample (AMQSXAG0 or AMQ0XAG0, AMQSXAB0 or AMQ0XAB0, and AMQSXAFO or AMQ0XAFO) has SQL CONNECT statements, as some database products allow only one active connection. If this is not the case for your database product, or if you are accessing a single database in multiple database products, the SQL CONNECT statements can be removed.

The samples are prepared with the IBM DB2 database product, so they may need some modification to work with other database products.

The SQL error checking uses routines in UTIL.C and CHECKERR.CBL supplied by DB2. These must be compiled or replaced before compiling and linking.

Note: If you are using the Micro Focus COBOL source CHECKERR.MFC for SQL error checking, you must change the program ID to uppercase, that is CHECKERR, for AMQ0XAS0 to link correctly.

Creating the databases and tables

The databases and tables must be created before the samples can be compiled. To create the databases, use the normal method for your database product, for example:

```
DB2 CREATE DB MQBankDB
DB2 CREATE DB MQFeeDB
```

Create the tables using SQL statements as follows:

In C:

```sql
EXEC SQL CREATE TABLE MQBankT(Name VARCHAR(40) NOT NULL,
Account INTEGER NOT NULL,
Balance INTEGER NOT NULL,
PRIMARY KEY (Account));
```

```sql
EXEC SQL CREATE TABLE MQBankTB(Name VARCHAR(40) NOT NULL,
Account INTEGER NOT NULL,
Balance INTEGER NOT NULL,
Transactions INTEGER,
PRIMARY KEY (Account));
```

```sql
EXEC SQL CREATE TABLE MQFeeTB(Account INTEGER NOT NULL,
FeeDue INTEGER NOT NULL,
TranFee INTEGER NOT NULL,
Transactions INTEGER,
PRIMARY KEY (Account));
```

In COBOL:

```sql
EXEC SQL CREATE TABLE MQBankT(Name VARCHAR(40) NOT NULL,
Account INTEGER NOT NULL,
Balance INTEGER NOT NULL,
PRIMARY KEY (Account))
END-EXEC.
```

```sql
EXEC SQL CREATE TABLE MQBankTB(Name VARCHAR(40) NOT NULL,
Account INTEGER NOT NULL,
Balance INTEGER NOT NULL,
Transactions INTEGER,
PRIMARY KEY (Account))
END-EXEC.
```
EXEC SQL CREATE TABLE MQFeeTB(Account INTEGER NOT NULL,
      FeeDue INTEGER NOT NULL,
      TranFee INTEGER NOT NULL,
      Transactions INTEGER,
      PRIMARY KEY (Account))
END-EXEC.

Fill in the tables using SQL statements as follows:
EXEC SQL INSERT INTO MQBankT VALUES ('Mr Fred Bloggs',1,0);
EXEC SQL INSERT INTO MQBankT VALUES ('Mrs S Smith',2,0);
EXEC SQL INSERT INTO MQBankT VALUES ('Ms Mary Brown',3,0);
...
EXEC SQL INSERT INTO MQBankTB VALUES ('Mr Fred Bloggs',1,0,0);
EXEC SQL INSERT INTO MQBankTB VALUES ('Mrs S Smith',2,0,0);
EXEC SQL INSERT INTO MQBankTB VALUES ('Ms Mary Brown',3,0,0);
...
EXEC SQL INSERT INTO MQFeeTB VALUES (1,0,50,0);
EXEC SQL INSERT INTO MQFeeTB VALUES (2,0,50,0);
EXEC SQL INSERT INTO MQFeeTB VALUES (3,0,50,0);
...

Note: For COBOL, use the same SQL statements but add END_EXEC at the end of each line.

Precompiling, compiling, and linking the samples
The .SQC files (in C) and .SQB files (in COBOL) must be precompiled and bound against the appropriate database to produce the .C or .CBL files. To do this, use the normal method for your database product, as shown below.

Precompiling in C
db2 connect to MQBankDB
db2 prep AMQXAS0.SQC
db2 connect reset
db2 connect to MQBankDB
db2 prep AMQXAB0.SQC
db2 connect reset
db2 connect to MQFeeDB
db2 prep AMQXAF0.SQC
db2 connect reset

Precompiling in COBOL
db2 connect to MQBankDB
db2 prep AMQ0XAS0.SQB bindfile target ibmcob
db2 bind AMQ0XAS0.BND
db2 connect reset
db2 connect to MQBankDB
db2 prep AMQ0XAB0.SQB bindfile target ibmcob
db2 bind AMQ0XAB0.BND
db2 connect reset
db2 connect to MQFeeDB
db2 prep AMQ0XAF0.SQB bindfile target ibmcob
db2 bind AMQ0XAF0.BND
db2 connect reset

Compiling and linking
The following sample commands use the symbol <DB2TOP>. <DB2TOP> represents the installation directory for the DB2 product.
**Database coordination samples**

- On AIX the directory path is:
  /usr/lpp/db2_05_00
- On HP-UX and Solaris the directory path is:
  /opt/IBMdb2/V5.0
- On Windows systems and OS/2 the directory path depends on the path chosen when installing the product. If you chose the default settings the path is:
  c:\sql\lib

**Note:** Before issuing the link command on Windows systems or OS/2 ensure that the LIB environment variable contains paths to the DB2 and WebSphere MQ libraries.

Copy the following files into a temporary directory:
- The amqsxag0.c file from your WebSphere MQ installation

**Note:** This file can be found in the following directories:
- On UNIX:
  <MQMTOP>/samp/xatm
- On Windows systems and OS/2:
  <MQMTOP>\tools\c\samples\xatm
- The .c files that you have obtained by precompiling the .sqc source files, amqsxas0.sqc, amqsxaf0.sqc, and amqsxab0.sqc
- The files util.c and util.h from your DB2 installation.

**Note:** These files can be found in the directory:
  <DB2TOP>/samples/c

Build the object files for each .c file using the following compiler command for the platform that you are using:
- AIX
  xlc_r -I<MQMTOP>/inc -I<DB2TOP>/include -c -o <FILENAME>.o <FILENAME>.c
- HP-UX
  cc -Aa +z -I<MQMTOP>/inc -I<DB2TOP>/include -c -o <FILENAME>.o <FILENAME>.c
- OS/2
  icc /c /I<MQMTOP>/tools\c\include /I<DB2TOP>/include <FILENAME>.c
- Solaris
  cc -Aa -KPIC -mt -I<MQMTOP>/inc -I<DB2TOP>/include -c -o <FILENAME>.o <FILENAME>.c
- Windows systems
  cl /c /I<MQMTOP>/tools\c\include /I<DB2TOP>/include <FILENAME>.c

Build the amqsxag0 executable using the following link command for the platform that you are using:
- AIX
  xlc_r -H512 -T512 -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
  -lqmutil.o amqsxas0.o amqsxbo.o amqsxag0.o -o amqsxag0
- HP-UX Revision 10.20
Database coordination samples

AIX

xlc_r -H512 -T512 -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

HP-UX Revision 10.20

ld -E -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

HP-UX Revision 11.00

ld -E -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

OS/2

ilink util.obj amqsxas0.obj db2api.lib /out:amqsxas0.exe

Solaris

cc -mt -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

Windows systems

link util.obj amqsxas0.obj db2api.lib /out:amqsxas0.exe

Build the amqsxas0 executable using the following compile and link commands for the platform that you are using:

AIX

xlc_r -H512 -T512 -L<DB2TOP>/lib -ldb2
-L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

HP-UX Revision 10.20

ld -E -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

HP-UX Revision 11.00

ld -E -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

OS/2

ilink util.obj amqsxas0.obj db2api.lib /out:amqsxas0.exe

Solaris

cc -mt -L<DB2TOP>/lib -ldb2 -L<MQMTOP>/lib
util.o amqsxas0.o -o amqsxas0

Windows systems

link util.obj amqsxas0.obj db2api.lib /out:amqsxas0.exe

Additional information

If you are working on AIX or HP-UX and wish to access Oracle, use the xlc_r compiler and link to libmqm_r.a.

Running the samples

Before the samples can be run, the queue manager must be configured with the database product you are using. For information about how to do this, see WebSphere MQ System Administration Guide.

C samples

Messages must be in the following format to be read from a queue:

UPDATE Balance change=nnn WHERE Account=nnn

AMQSPUT can be used to put the messages on the queue.

The database coordination samples take two parameters:
1. Queue name (required)
2. Queue manager name (optional)

Assuming that you have created and configured a queue manager for the single database sample called singDBQM, with a queue called singDBQ, you increment Mr Fred Bloggs’s account by 50 as follows:

```
AMQSPUT singDBQ singDBQM
```

Then key in the following message:

```
UPDATE Balance change=50 WHERE Account=1
```

You can put multiple messages on the queue.

```
AMQSXAS0 singDBQ singDBQM
```

The updated status of Mr Fred Bloggs’s account is then printed.

Assuming that you have created and configured a queue manager for the multiple-database sample called multDBQM, with a queue called multDBQ, you decrement Ms Mary Brown’s account by 75 as follows:

```
AMQSPUT multDBQ multDBQM
```

Then key in the following message:

```
UPDATE Balance change=-75 WHERE Account=3
```

You can put multiple messages on the queue.

```
AMQSXAG0 multDBQ multDBQM
```

The updated status of Ms Mary Brown’s account is then printed.

**COBOL samples**

Messages must be in the following format to be read from a queue:

```
UPDATE Balance change=nnnnnnnn WHERE Account=nnnnnnnn
```

For simplicity, the Balance change must be a signed eight-character number and the Account must be an eight-character number.

The sample AMQSPUT can be used to put the messages on the queue.

The samples take no parameters and use the default queue manager. It can be configured to run only one of the samples at any time. Assuming that you have configured the default queue manager for the single database sample, with a queue called singDBQ, you increment Mr Fred Bloggs’s account by 50 as follows:

```
AMQSPUT singDBQ
```

Then key in the following message:

```
UPDATE Balance change=+00000050 WHERE Account=00000001
```

You can put multiple messages on the queue.

```
AMQ0XAS0
```

Type in the name of the queue:

```
singDBQ
```

The updated status of Mr Fred Bloggs’s account is then printed.
Assuming that you have configured the default queue manager for the multiple database sample, with a queue called multDBQ, you decrement Ms Mary Brown’s account by 75 as follows:

```amqspu
AMQSPUT multDBQ
```

Then key in the following message:

```sql
UPDATE Balance change=-00000075 WHERE Account=00000003
```

You can put multiple messages on the queue.

```amq0xag0
```

Type in the name of the queue:

```multDBQ```

The updated status of Ms Mary Brown’s account is then printed.

---

### The CICS transaction sample

A sample CICS transaction program is provided, named amqscic0.ccs for source code and amqscic0 for the executable version. Transactions may be built using the standard CICS facilities. See Part 3, “Building a WebSphere MQ application”, on page 329 for details on the commands needed for your platform.

The transaction reads messages from the transmission queue SYSTEM.SAMPLE.CICS.WORKQUEUE on the default queue manager and places them on to the local queue, the name of which is contained in the transmission header of the message. Any failures will be sent to the queue SYSTEM.SAMPLE.CICS.DLQ.

**Note:** A sample MQSC script amqscic0.tst may be used to create these queues and sample input queues.

---

### TUXEDO samples

Before running these samples, you must build the server environment.

**Note:** Throughout this section the “\” character is used to split long commands over more than one line. Do not enter this character, enter each command as a single line.

#### Building the server environment

It is assumed that you have a working TUXEDO environment.

**To build the server environment for WebSphere MQ for AIX:**

1. Create a directory (for example, `<APPDIR>`) in which the server environment is built and execute all commands in this directory.
2. Export the following environment variables, where TUXDIR is the root directory for TUXEDO:

```bash
$ export CFLAGS="-I /usr/mqm/inc -I <APPDIR> -L /usr/mqm/lib"
$ export LDOPTS="-lmqm -lmqmsize -lnc -lnsl -ls -ls -lc -ldl"
$ export FILEDTLS=/usr/mqm/samp/amqstxvx.flds
$ export VIEWFILES=/<APPDIR>/amqstxvx.V
$ export LIBPATH=$TUXDIR/lib:/usr/mqm/lib:/lib
```

3. Add the following to the TUXEDO file udataobj/RM

MQSeries_XA_RMI:MQRXASwitchDynamic: 

```bash
/usr/mqm/lib/libmqmxa.a /usr/mqm/lib/libmqm.a
```

4. Run the commands:

```bash
$ mkfldhdr /usr/mqm/samp/amqstxvx.flds
$ viewc /usr/mqm/samp/amqstxvx.v
$ buildserver -o MQSERV1 -f /usr/mqm/samp/amqstxv.c \
   -f /usr/mqm/lib/libmqm.a \
   -r MQSeries_XA_RMI -s MPUT1:MPUT \ 
   -s MGET1:MGET \ 
   -v -bshm
$ buildserver -o MQSERV2 -f /usr/mqm/samp/amqstxv.c \
   -f /usr/mqm/lib/libmqm.a \
   -r MQSeries_XA_RMI -s MPUT2:MPUT \ 
   -s MGET2:MGET \ 
   -v -bshm
$ buildclient -o doputs -f /usr/mqm/samp/amqstxp.c \
   -f /usr/mqm/lib/libmqm.a
$ buildclient -o dogets -f /usr/mqm/samp/amqstgx.c \
   -f /usr/mqm/lib/libmqm.a
```

5. Edit ubbstxcx.cfg (see [figure 38 on page 460](#)), and add details of the machine name, working directories, and queue manager as necessary:

```bash
$ tmloadcf -y /usr/mqm/samp/ubbstxcx.cfg
```

6. Create the TLOGDEVICE:

```
$ tmadmin -c
```

A prompt then appears. At this prompt, enter:

```
> crdl -z /<APPDIR>/TLOG1
```

7. Start the queue manager:

```
$ strmqm
```

8. Start Tuxedo:

```
$ tmboot -y
```

You can now use the doputs and dogets programs to put messages to a queue and retrieve them from a queue.

**To build the server environment for MQSeries for AT&T GIS UNIX and WebSphere MQ for Solaris:**

1. Create a directory (for example, `<APPDIR>`) in which the server environment is built and execute all commands in this directory.

2. Export the following environment variables, where TUXDIR is the root directory for TUXEDO:

```bash
$ export CFLAGS="-I /<APPDIR> -L /<APPDIR>"
$ export FIELDTLS=amqstxvx.flds
$ export VIEWFILES=amqstxvx.V
$ export SHLIB_PATH=$TUXDIR/lib:/opt/mqm/lib:/lib
$ export LD_LIBRARY_PATH=$TUXDIR/lib:/opt/mqm/lib:/lib
```

3. Add the following to the TUXEDO file udataobj/RM (RM must include /opt/mqm/lib/libmqmcs and /opt/mqm/lib/libmqmzse).
MQSeries_XA_RMI:MQRMIXASwitchDynamic: 
/opt/mqm/lib/libmqmxa.a /opt/mqm/lib/libmqm.so 
/opt/tuxedo/lib/libtux.a /opt/mqm/lib/libmqmcs.so 
/opt/mqm/lib/libmqmzse.so

4. Run the commands:
   $ mkfldhdr amqstxvx.flds
   $ viewc amqstxvx.v
   $ builtdms -o MQXA -r MQSeries_XA_RMI
   $ buildserver -o MQSERV1 -f amqstxsx.c 
   -f /opt/mqm/lib/libmqm.so 
   -r MQSeries_XA_RMI -s MPUT1:MGET 
   -v -bshm 
   -l -ldl
   $ buildserver -o MQSERV2 -f amqstxsx.c 
   -f /opt/mqm/lib/libmqm.so 
   -r MQSeries_XA_RMI -s MPUT2:MGET 
   -v -bshm 
   -l -ldl
   $ buildclient -o doputs -f amqstxpx.c 
   -f /opt/mqm/lib/libmqm.so 
   -f /opt/mqm/lib/libmqmzse.co 
   -f /opt/mqm/lib/libmqmcs.so
   $ buildclient -o dogets -f amqstxgx.c 
   -f /opt/mqm/lib/libmqm.so 
   -f /opt/mqm/lib/libmqmzse.co 
   -f /opt/mqm/lib/libmqmcs.so

5. Edit ubbstxcx.cfg (see Figure 38 on page 460), and add details of the machine name, working directories, and Queue Manager as necessary:
   $ tmloadcf -y ubbstxcx.cfg

6. Create the TLOGDEVICE:
   $tmadmin -c

   A prompt then appears. At this prompt, enter:
   > crdl -z /<APPDIR>/TLOG1

7. Start the queue manager:
   $ strmqm

8. Start Tuxedo:
   $ tmboot -y

You can now use the doputs and dogets programs to put messages to a queue and retrieve them from a queue.

To build the server environment for WebSphere MQ for HP-UX:
1. Create a directory (for example, <APPDIR>) in which the server environment is built and execute all commands in this directory.

2. Export the following environment variables, where TUXDIR is the root directory for TUXEDO:
   $ export CFLAGS="-Aa -D_HPUX_SOURCE"
   $ export LDOPTS="-lmqm"
   $ export FIELDTBLS=/opt/mqm/samp/amqstxvx.flds
   $ export VIEWFILES=<APPDIR>/amqstxvx.V
   $ export SHLIB_PATH=$TUXDIR/lib:/opt/mqm/lib:/lib
   $ export LPATH=$TUXDIR/lib:/opt/mqm/lib:/lib

3. Add the following to the TUXEDO file udataobj/RM
4. Run the commands:

```
$ mkfldhdr /opt/mqm/samp/amqstxvx.flds
$ viewc /opt/mqm/samp/amqstxvx.v
$ buildtms -o MQXA -r MQSeries_XA_RMI
$ buildserver -o MQSERV1 -f /opt/mqm/samp/amqstxxsx.c
   -f /opt/mqm/lib/libmqm.sl
   -r MQSeries_XA_RMI -s MPUT1:MPUT
   -s MGET1:MGET
   -v -bshm
$ buildserver -o MQSERV2 -f /opt/mqm/samp/amqstxxsx.c
   -f /opt/mqm/lib/libmqm.sl
   -r MQSeries_XA_RMI -s MPUT2:MPUT
   -s MGET2:MGET
   -v -bshm
$ buildclient -o doputs -f /opt/mqm/samp/amqstxp.x.c
   -f /opt/mqm/lib/libmqm.sl
$ buildclient -o dogets -f /opt/mqm/samp/amqstxgx.c
   -f /opt/mqm/lib/libmqm.sl
```

5. Edit ubbstxcx.cfg (see Figure 38 on page 460), and add details of the machine name, working directories, and Queue Manager as necessary:

```
$ tmloadcf -y /opt/mqm/samp/ubbstxcx.cfg
```

6. Create the TLOGDEVICE:

```
$ tmadmin -c
```

A prompt then appears. At this prompt, enter:

```
> crdl -z /<APPDIR>/TLOG1
```

7. Start the queue manager:

```
$ strmqm
```

8. Start Tuxedo:

```
$ tmboot -y
```

You can now use the doputs and dogets programs to put messages to a queue and retrieve them from a queue.

**To build the server environment for MQSeries for SINIX and DC/OSx**

1. Export the following environment variables where TUXDIR is the root directory for TUXEDO:

```
$ export CFLAGS="-lmqm -lmqmcs -lmqmzse -lmqmxa
   -lnsl -lsocket -ldl -lmproc -lext"
```

**Note:** For DC/OSx, add “-liconv” to the above.

```
$ export FIELDDBLST=amqstxvx.flds
$ export VIEWFILES=amqstxvx.V
$ export VIEWDIR=The path to the directory where the views are held
$ export TUXDIR=The path to the directory where TUXEDO is installed (/opt/tuxedo).
$ export CFLAGS="-lmqm -lmqmcs -lmqmzse -lmqmxa
   -lnsl -lsocket -ldl -lmproc -lext"
```

2. Add the following to the TUXEDO file udataobj/RM

```
MQSeries_XA_RMI:MQRMIXASwitchDynamic:\n/opt/mqm/lib/libmqmxa.a /opt/mqm/lib/libmqm.sl\n/opt/tuxedo/lib/libtux.sl
```

```
MQSeries_XA_RMI:MQRMIXASwitchDynamic:\n/opt/mqm/lib/libmqmxa.a /opt/mqm/lib/libmqm.sl\n/opt/tuxedo/lib/libtux.sl
```
3. Ensure that your LD_LIBRARY_PATH contains the path to the Tuxedo libraries (/opt/tuxedo/lib), and that it is exported.

4. Ensure that your PATH contains the path to the Tuxedo bin directory (/opt/tuxedo/bin), and that it is exported.

5. Run the commands:
   
   ```
   $ mkfldhdr amqstvxv.flds
   $ viewc amqstvxv.v
   ```

6. Alter the value of the CFLAGS variable:
   
   ```
   export CFLAGS="$CFLAGS -LDuMQRMIXASwitchDynamic -lmqmxa"
   ```

7. Run the commands:
   
   ```
   $ buildtms -o MQXA -r MQSeries_XA_RMI
   $ buildserver -o MQSERV1 -f amqstxxs.c \
     -f /opt/mqm/lib/libmqm.so i \
     -r MQSeries_XA_RMI -s MPUT1:MPUT \ 
     -s MGET1:MGET \ 
     -v -bshm
   $ buildserver -o MQSERV2 -f amqstxxs.c \
     -f /opt/mqm/lib/libmqm.so \ 
     -r MQSeries_XA_RMI -s MPUT2:MPUT \ 
     -s MGET2:MGET \ 
     -v -bshm
   $ buildclient -o doputs -f amqstpxx.c \
     -f /opt/mqm/lib/libmqm.so
   $ buildclient -o dogets -f amqstgx.c \
     -f /opt/mqm/lib/libmqm.so
   ```

8. Ensure that your NLS_PATH contains the path to the Tuxedo messages (/opt/tuxedo/locale/C/%N), and that it is exported.

9. Edit ubbstxcx.cfg (see Figure 38 on page 460), and add details of the machine name, working directories, and Queue Manager as necessary.

10. Set the environment variable TUXCONFIG to the value specified in the MACHINES section of the ubbstxcx.cfg file.

11. If you are using the Tuxedo main machine, run the following commands:

    ```
    tmadmin -c
    ```

    At the prompt (>), enter:

    ```
    crdl -z filename
    ```

    where `filename` is the path to the Tuxedo TLOG file.

12. Run the following command:

    ```
    $ tmloadcf -y ubbstxcx.cfg
    ```

13. Start the queue manager:

    ```
    $ strmqm
    ```

14. Start Tuxedo:

    ```
    $ tmboot -y
    ```

You can now use the doputs and dogets programs to put messages to a queue and retrieve them from a queue.

For further information on building the TUXEDO server environment, see the README file in the WebSphere MQ sample directory, /opt/mqm/samp.
### TUXEDO samples

```plaintext
*RESOURCES
IPCKEY  <IPCKey>

#Example:
#IPCKEY  123456

MASTER  <MachineName>
MAXACCESSERS  20
MAXSERVERS  20
MAXSERVICES  50
MODEL  SHM
LDBAL  N

*MACHINES
DEFAULT:

APPDIR="<WorkDirectory>"
TUXCONFIG="<WorkDirectory>/tuxconfig"
ROOTDIR="<RootDirectory>"

<MachineName>  LMID=<MachineName>
TLOGDEVICE="<WorkDirectory>/TLOG1"
TLOGNAME=TLOG

*GROUPS
GROUP1
LMID=<MachineName>  GRPNO=1
TMSNAME=MQXA
OPENINFO="MQSeries_XA_RMI:MYQUEUEMANAGER"

*SERVERS
DEFAULT:

CLOPT="-A -- -m MYQUEUEMANAGER"

MQSERV1  SRVGRP=GROUP1  SRVID=1
MQSERV2  SRVGRP=GROUP1  SRVID=2

*SERVICES
MPUT1
MGET1
MPUT2
MGET2
```

Figure 38. Example of ubbstxcx.cfg file for UNIX systems

**Note:** Other information that you need to add is identified by <> characters. In this file, the queue manager name has been changed to MYQUEUEMANAGER:

**To build the server environment for WebSphere MQ for Windows:**

**Note:** Change the fields identified by <> in the following, to the directory paths:

- `<MQMDIR>`
  - the directory path specified when WebSphere MQ was installed, for example `g:\Program Files\IBM\WebSphere MQ`
- `<TUXDIR>`
  - the directory path specified when TUXEDO was installed, for example `f:\tuxedo`
- `<APPPDIR>`
  - the directory path to be used for the sample application, for example `f:\tuxedo\apps\mqapp`
To build the server environment and samples:

1. Create an application directory in which to build the sample application, for example:
   
   \f:\tuxedo\apps\mqapp

2. Copy the following sample files from the WebSphere MQ sample directory to the application directory:
   
   \amqstxmn.mak
   \amqstxen.env
   \ubbstxcn.cfg

3. Edit each of these files to set the directory names and directory paths used on your installation.

4. Edit \ubbstxcn.cfg (see Figure 39 on page 462) to add details of the machine name and the Queue Manager that you wish to connect to.

5. Add the following line to the TUXEDO file <TUXDIR>\udataobj\rm
   
   MQSeries XA_RMI;MQRMIXASwitchDynamic;
   <MQMDIR>|\tools\lib\mqmtux.lib <MQMDIR>|\tools\lib\mqm.lib

   where <MQMDIR> is replaced as above. Although shown here as two lines, the new entry must be one line in the file.

6. Set the following environment variables:
   
   TUXDIR=<TUXDIR>
   TUXCONFIG=<APPDIR>|\tuxconfig
   FIELDTBLS=<MQMDIR>|\tools\c\samples\amqstxvx.fld
   LANG=C

7. Create a TLOG device for TUXEDO. To do this, invoke tmadmin -c, and enter the command:
   
   crdl -z <APPDIR>|\TLOG

   where <APPDIR> is replaced as above.

8. Set the current directory to <APPDIR>, and invoke the sample makefile (amqstxmn.mak) as an external project makefile. For example, with Microsoft Visual C++ Version 2.0, issue the command:
   
   msvc amqstxmn.mak

   Select build to build all the sample programs.
TUXEDO samples

*RESOURCES
IPCKEY 99999
UID 0
GID 0
MAXACCESSERS 20
MAXSERVERS 20
MAXSERVICES 50
MASTER SITE1
MODEL SHM
LDAL N

*MACHINES
<MachineName> LMID=SITE1
TUXDIR="f:\tuxedo"
APPDIR="f:\tuxedo\apps\mqapp\IBM\WebSphere MQ\bin"
ENVFILE="f:\tuxedo\apps\mqapp\amqstxen.env"
TUXCONFIG="f:\tuxedo\apps\mqapp\tuxconfig"
ULOGFPX="f:\tuxedo\apps\mqapp\ULOG"
TLOGDEVICE="f:\tuxedo\apps\mqapp\TLOG"
TLOGNAME=TLOG
TYPE="i386NT"
UID=0
GID=0

*GROUPS
GROUP1
LMID=SITE1 GRPNO=1
TMSNAME=MQXA
OPENINFO="MQSeries_XA_RMI:MYQUEUEMANAGER"

*SERVERS
DEFAULT: CLOPT="-A -- -m MYQUEUEMANAGER"
MQSERV1 SRVGRP=GROUP1 SRVID=1
MQSERV2 SRVGRP=GROUP1 SRVID=2

*SERVICES
MPUT1
MGET1
MPUT2
MGET2

Figure 39. Example of ubbstxcn.cfg file for WebSphere MQ for Windows

Note: The directory names and directory paths must be changed to match your installation. The queue manager name MYQUEUEMANAGER should also be changed to the name of the queue manager you wish to connect to. Other information that you need to add is identified by <> characters.

The sample ubbconfig file for WebSphere MQ for Windows is listed in Figure 39. It is supplied as ubbstxcn.cfg in the WebSphere MQ samples directory.

The sample makefile (see Figure 40 on page 463) supplied for WebSphere MQ for Windows is called ubbstxmn.mak, and is held in the WebSphere MQ samples directory.
To build the server environment for MQSeries for Compaq Tru64 UNIX

The procedure is the same on Compaq Tru64 UNIX Version 4.0 and Version 5.0. It is assumed that you have a working TUXEDO environment.

1. Create a directory (for example <appdir>) in which the server environment is built and execute all commands in this directory.

2. Export the following environment variables, where TUXDIR is the root directory for TUXEDO:

   $ TUXDIR=/TUXDIR; export TUXDIR
   $ PATH=$TUXDIR/bin:$PATH; export PATH
   $ COBCPY=$TUXDIR/cobinclude; export COBCPY
   $ COBOPT="-C ANS85 -C ALIGN=8 -C NOIBMCOMP -C TRUNC=ANSI -C OSEXT=cbl"; export COBOPT
   $ LD_LIBRARY_PATH=$TUXDIR/lib:$LD_LIBRARY_PATH; export LD_LIBRARY_PATH

3. Add the following to the TUXEDO file TUXDIR/udataobj/RM

   MQSeries_XA_RMI:MQMIXASwitchDynamic:-lmqm -lmqmzse -lmqmxa -lmqmcs -L/$TUXDIR/lib -ltux

4. Run the commands:

   $ mkfldhdr /opt/mqm/samp/amqstxvx.fld
   $ viewc /opt/mqm/samp/amqstxvx.v
   $ buildtms -o MQXAR -f $(MQMSAMP)/amqstxvx.c \ -r $(MQMLIB)/mqm.lib -v $(INC) $(DBG) \ -s MQSeries_XA_RMI \ -s MPUT1:MPUT -s MGET1:MGET
   $ buildserver -o MQSERV1 -f $(MQMSAMP)/amqstxvx.c \ -r $(MQMLIB)/mqm.lib -v $(INC) $(DBG) \ -s MQSeries_XA_RMI \ -s MPUT2:MPUT -s MGET2:MGET
   $ buildclient -o doputs -f $(MQMSAMP)/amqstxpx.c \ -r $(MQMLIB)/mqm.lib -v $(INC) $(DBG)
   $ buildclient -o dogets -f $(MQMSAMP)/amqstxpx.c \ -f $(MQMLIB)/mqm.lib $INC -v $(DBG)
   $ buildclient -o dogets -f $(MQMSAMP)/amqstxpx.c \ -f $(MQMLIB)/mqm.lib $INC -v $(DBG)

Figure 40. Sample TUXEDO makefile for WebSphere MQ for Windows

To build the server environment for MQSeries for Compaq Tru64 UNIX

The procedure is the same on Compaq Tru64 UNIX Version 4.0 and Version 5.0. It is assumed that you have a working TUXEDO environment.

1. Create a directory (for example <appdir>) in which the server environment is built and execute all commands in this directory.

2. Export the following environment variables, where TUXDIR is the root directory for TUXEDO:

   $ TUXDIR=/TUXDIR; export TUXDIR
   $ PATH=$TUXDIR/bin:$PATH; export PATH
   $ COBCPY=$TUXDIR/cobinclude; export COBCPY
   $ COBOPT="-C ANS85 -C ALIGN=8 -C NOIBMCOMP -C TRUNC=ANSI -C OSEXT=cbl"; export COBOPT
   $ LD_LIBRARY_PATH=$TUXDIR/lib:$LD_LIBRARY_PATH; export LD_LIBRARY_PATH

3. Add the following to the TUXEDO file TUXDIR/udataobj/RM

   MQSeries_XA_RMI:MQMIXASwitchDynamic:-lmqm -lmqmzse -lmqmxa -lmqmcs -L/$TUXDIR/lib -ltux

4. Run the commands:

   $ mkfldhdr /opt/mqm/samp/amqstxvx.fld
   $ viewc /opt/mqm/samp/amqstxvx.v
   $ buildtms -o MQXAR -f $(MQMSAMP)/amqstxvx.c \ -r $(MQMLIB)/mqm.lib -v $(INC) $(DBG) \ -s MPUT1:MPUT -s MGET1:MGET
   $ buildserver -o MQXAR -f $(MQMSAMP)/amqstxvx.c \ -r $(MQMLIB)/mqm.lib -v $(INC) $(DBG) \ -s MPUT1:MPUT -s MGET1:MGET
   $ buildserver -o MQXAR -f $(MQMSAMP)/amqstxvx.c \ -s MPUT1:MPUT -s MGET1:MGET -v -bshm
   $ buildserver -o MQXAR -f $(MQMSAMP)/amqstxvx.c \ -s MPUT2:MPUT -s MGET2:MGET -v -bshm
   $ buildclient -o doputs -f $(MQMSAMP)/amqstxpx.c \ -f $(MQMLIB)/mqm.lib -v $(INC) $(DBG)
   $ buildclient -o dogets -f $(MQMSAMP)/amqstxpx.c \ -f $(MQMLIB)/mqm.lib $INC -v $(DBG)

Figure 40. Sample TUXEDO makefile for WebSphere MQ for Windows
Building Tuxedo applications

5. Edit the file ubbstxcm.cfg and add details of the machine name, working directories, and queue manager as necessary. Execute the following command:
   $ tmloadcf -y ubbstxcm.cfg

6. Create the TLOGDEVICE:
   $ tmadmin -c

   A > prompt then appears. At this point, enter:
   > crdl -z /<appdir>/TLOG1

7. Start the queue manager MYQUEUEMANAGER
   $ strmqm MYQUEUEMANAGER

8. Start the Tuxedo server:
   $ tmboot -y

You can now use the doputs and dogets programs to put messages to a queue and retrieve them from a queue.

Server sample program for TUXEDO

This sample server program (amqstxssx) is designed to run with the Put (amqstxpx.c) and the Get (amqstxgx.c) sample programs. The program runs automatically when TUXEDO is started.

Note: You must start your queue manager before you start TUXEDO.

The sample server provides two TUXEDO services, MPUT1 and MGET1.

The MPUT1 service is driven by the PUT sample and uses MQPUT1 in syncpoint to put a message in a unit of work controlled by TUXEDO. It takes the parameters QName and Message Text, which are supplied by the PUT sample.

The MGET1 service opens and closes the queue each time it gets a message. It takes the parameters QName and Message Text, which are supplied by the GET sample.

Any error messages, reason codes, and status messages are written to the TUXEDO log file.
Put sample program for TUXEDO

This sample allows you to put a message on a queue multiple times, in batches, demonstrating syncpointing using TUXEDO as the resource manager. The sample server program amqstxsx must be running for the put sample to succeed - the server sample program makes the connection to the queue manager and uses the XA interface. To run the sample enter:

```
  doputs -n queuename -b batchsize -c trancount -t message
```

For example:

```
  doputs -n myqueue -b 5 -c 6 -t "Hello World"
```

This puts 30 messages on to the queue named myqueue, in 6 batches each with 5 messages in them. If there are any problems it will back a batch of messages out, otherwise it will commit them.

Any error messages are written to the TUXEDO log file and to stderr. Any reason codes are written to stderr.

Get sample for TUXEDO

This sample allows you to get messages from a queue in batches. The sample server program amqstxgx must be running for the put sample to succeed - the server sample program makes the connection to the queue manager and uses the XA interface. To run the sample enter:
Building Tuxedo applications

- dogets –n queuename –b batchsize –c trancount

For example:
- dogets -n myqueue -b 6 -c 4

This takes 24 messages off the queue named myqueue, in 6 batches each with 4 messages in them. If you ran this after the put example, which put 30 messages on myqueue, you would now have only 6 messages on myqueue. Note that the number of batches and the batch size can vary between the putting of messages and the getting of them.

Any error messages are written to the TUXEDO log file and to stderr. Any reason codes are written to stderr.

Encina sample program

This program puts 10 messages to the queue, backing out the odd numbered messages and committing the even numbered messages. The message is a 4-byte number.

The queue used by this sample is the SYSTEM.DEFAULT.MODEL.QUEUE, so a temporary dynamic queue is created each time the program is run. You will need to run trace to see what happens when the program runs.

Building the AMQ SXAE0.C sample

When compiling for a UNIX or OS/2 platform, ensure that the symbolic constant, WIN32 is not defined. This constant is used in the preprocessor statements for processing specific to Windows systems:

```
#if defined(WIN32)
```

Compiling and linking on Windows systems

When compiling, specify the following options (in addition to those usually specified for a WebSphere MQ application) to the C compiler:

```
-DM -DWIN32 -DDEC_DCE -Gz
```

The sample contains references to the Encina header files:

```
#include <tc/tc.h>
#include <tmxa/tmxa_status.h>
#include <tmxa/tmxa.h>
```

At compile time, also include the parent directory path name containing these files, using the compiler -I option with a value which names the directory. For example:

```
-Ic:\opt\encina\include
```

At link time, the directory path names containing the Encina and DCE library files must also be specified to the linker, by setting the LIB environment variable. For example:

```
SET LIB=C:\OPT\ENCINA\LIB;C:\OPT\DCE\LIB;%LIB%
```

When linking, specify the following library files:

- mqm.lib
- mqmenc.lib
- libEncServer.lib
- libEncina.lib
- msvcrt.lib
• pthreads.lib
• libdce.lib

Compiling and linking on Solaris
Use the following invocation:
```
cc -I/opt/encina/include -c amqsxae0.c && cc -mt -o amqsxae0 amqsxae0.o \
-L/opt/encina/lib -L/opt/mqm/lib -lmqm -lmqmcs_d -lmqmxse -lmqmxa \
-lsocket -lnsl -ldce -lthread -lEncServer -lEncina -lc -lm
```

Dead-letter queue handler sample

A sample dead-letter queue handler is provided, the name of the executable version is amqsdlq. If you want a dead-letter queue handler that is different to RUNMQDLQ, the source of the sample is available for you to use your base.

The sample is similar to the dead-letter handler provided within the product but trace and error reporting are different. There are two environment variables available to you:

**ODQ_TRACE**
- set to YES or yes to switch tracing on

**ODQ_MSG**
- set to the name of the file containing error and information messages. The file provided is called amqsdlq.msg.

These need to be made known to your environment using either the `export` or `set` commands, depending on your platform; trace is turned off using the `unset` command.

You can modify the error message file, amqsdlq.msg, to suit your own requirements. The sample puts messages out to stdout, not to the WebSphere MQ error log file.

The [WebSphere MQ System Administration Guide](#) or the System Management Guide for your platform explains how the dead-letter handler works, and how you run it.

The Connect sample program

The Connect sample program allows you to explore the MQCONNX call and its options from a client. The sample connects to the queue manager using the MQCONNX call, inquires about the name of the queue manager using the MQINQ call, and displays it.

**Note:** The Connect sample program is a client sample. You can compile and run it on a server but the function is meaningful only on a client, and only client executables are supplied.

Running the amqscnxc sample

The command-line syntax of the Connect sample program is:
```
amqscnxc [-x ConnName [-c SvrconnChannelName]] [QMgrName]
```

The parameters are optional and their order is not important with the exception that QMgrName, if it is specified, must come last. The parameters are:

**ConnName**
- The TCP/IP connection name of the server queue manager
**Connect sample program**

**SvrconnChannelName**  
The name of the server connection channel

**QMgrName**  
The name of the target queue manager

If you do not specify the TCP/IP connection name, MQCONNX is issued with the 
ClientConnPtr set to NULL. If you specify the TCP/IP connection name but not the 
server connection channel (the reverse is not allowed) the sample uses the name 
SYSTEM.DEF.SVRCONN. If you do not specify the target queue manager the 
sample connects to whichever queue manager is listening at the given TCP/IP 
connection name.

**Note:** If you enter a question mark as the only parameter or if you enter incorrect 
parameters you will see a message explaining how to use the program.

If you run the sample with no command-line options the contents of the 
MQSERVER environment variable are used to determine the connection 
information. (In this example MQSERVER is set to 
“SYSTEM.DEF.SVRCONN/TCP/machine.site.company.com”.) You see output like 
this:

Sample AMQSCNXC start  
Connecting to the default queue manager  
with no client connection information specified.  
Connection established to queue manager machine

Sample AMQSCNXC end

If you run the sample and provide a TCP/IP connection name and a server 
connection channel name but no target queue manager name, like this:

amqscnxc -x machine.site.company.com -c SYSTEM.ADMIN.SVRCONN

the default queue manager name is used and you see output like this:

Sample AMQSCNXC start  
Connecting to the default queue manager  
using the server connection channel SYSTEM.ADMIN.SVRCONN  
on connection name machine.site.company.com.  
Connection established to queue manager MACHINE

Sample AMQSCNXC end

If you run the sample and provide a TCP/IP connection name and a target queue 
manager name, like this:

amqscnxc -x machine.site.company.com MACHINE

you see output like this:

Sample AMQSCNXC start  
Connecting to queue manager MACHINE  
using the server connection channel SYSTEM.DEF.SVRCONN  
on connection name machine.site.company.com.  
Connection established to queue manager MACHINE

Sample AMQSCNXC end

**The API exit sample program**

The sample API exit generates an MQI trace to a user-specified file with a prefix 
defined in the MQS_TRACE_LOGFILE environment variable. For more information 
about API exits, see Chapter 15, “Using and writing API exits”, on page 215
Configuring for the sample exit

1. Add the following to the qm.ini file (or the registry on Windows). See the WebSphere MQ System Administration Guide for how to do this.

   Platforms other than Windows
   ApiExitLocal: Sequence=100
   Function=EntryPoint
   Module=install_dir\samp\bin\amqsaxe
   Name=SampleApiExit

   Platforms other than Windows
   ApiExitLocal: Sequence=100
   Function=EntryPoint
   Module=install_dir\Tools\c\Samples\bin\amqsaxe
   Name=SampleApiExit

   where install_dir is the directory where WebSphere MQ was installed.

   Windows
   ApiExitLocal: Sequence=100
   Function=EntryPoint
   Module=install_dir\Tools\c\Samples\bin\amqsaxe
   Name=SampleApiExit

   where install_dir is the directory where WebSphere MQ was installed.

   2. Set the environment variable
   MQS_TRACE_LOGFILE=/tmp/MqiTrace

   3. Run your application.
   Output files will appear in the /tmp directory with names like:
   MqiTrace.<pid>.<tid>.log

Using the SSPI security exit on Windows systems

This section describes how to use the SSPI channel-exit programs on Windows systems. The supplied exit code is in two formats: object and source.

Object code

The object code file is called amqrspin.dll. For both client and server, it is installed as a standard part of WebSphere MQ for Windows in the exits folder, and is loaded as a standard user exit. You can run the supplied security channel exit and use authentication services in your definition of the channel.

To do this, specify either of the following:
SCYEXIT('amqrspin(SCY_KERBEROS)')
SCYEXIT('amqrspin(SCY_NTLM)')

To provide support for a restricted channel, specify the following on the SRVCONN channel:
SCYDATA('remote_principal_name')

where remote_principal_name is in the form DOMAIN\user. The secure channel is established only if the name of the remote principal matches remote_principal_name.
Using the SSPI security exit

To use the supplied channel-exit programs between systems that operate within a Kerberos security domain, you must create a servicePrincipalName for the queue manager.

Source code

The exit source code file is called amqsspin.c. It is in C:\Program Files\IBM\WebSphere MQ\Tools\c\Samples.

If you modify the source code, you must recompile the modified source.

You compile and link it in the same way as any other channel exit for the relevant platform, except that SSPI headers need to be accessed at compile time, and the SSPI security libraries, together with any recommended associated libraries, need to be accessed at link time.

Before you execute the following command please make sure that cl.exe, and the Visual C++ library and the include folder are available in your path. For example:

cl /VERBOSE /LD /MT /I<path_to_Microsoft_platform_SDK\include> /I<path_to_WebSphere MQ\tools\c\include> amqsspin.c /DSECURITY_WIN32 -link /DLL /EXPORT:SCY_KERBEROS /EXPORT:SCY_NTLM STACK:8192

Note: The source code does not include any provision for tracing or error handling. If you choose to modify and use the source code, you should add your own tracing and error-handling routines.
Chapter 36. Sample programs for WebSphere MQ for z/OS

This chapter describes the sample applications that are delivered with WebSphere MQ for z/OS. These samples demonstrate typical uses of the Message Queue Interface (MQI).

WebSphere MQ for z/OS also provides a sample API-crossing exit program, described in “The API-crossing exit for z/OS” on page 267 and sample data-conversion exits, described in Chapter 11, “Writing data-conversion exits”, on page 153.

The sample applications are supplied in source form only. The source modules include pseudocode that describes the program logic.

Note: Although some of the sample applications have basic panel-driven interfaces, they do not aim to demonstrate how to design the “look and feel” of your applications. For more information on how to design panel-driven interfaces for nonprogrammable terminals, see SAA® Common User Access®: Basic Interface Design Guide (SC26-4583) and its addendum (GG22-9508). These provide guidelines to help you design applications that are consistent both within the application and across other applications.

This chapter introduces the sample programs, under these headings:
- “Features demonstrated in the sample applications”
- “Preparing and running sample applications for the batch environment” on page 475
- “Preparing sample applications for the TSO environment” on page 477
- “Preparing the sample applications for the CICS environment” on page 478
- “Preparing the sample application for the IMS environment” on page 481
- “The Put samples” on page 482
- “The Get samples” on page 485
- “The Browse sample” on page 487
- “The Print Message sample” on page 489
- “The Queue Attributes sample” on page 493
- “The Mail Manager sample” on page 494
- “The Credit Check sample” on page 501
- “The Message Handler sample” on page 514

Features demonstrated in the sample applications

This section summarizes the MQI features demonstrated in each of the sample applications, shows the programming languages in which each sample is written, and the environment in which each sample runs.

Put samples

The Put samples demonstrate how to put messages on a queue using the MQPUT call.

The application uses these MQI calls:
- MQCONN
- MQOPEN
- MQPUT
Features demonstrated

- MQCLOSE
- MQDISC

The program is delivered in COBOL and C, and runs in the batch and CICS environment. See Table 44 on page 476 for the batch application and Table 49 on page 479 for the CICS application.

Get samples

The Get samples demonstrate how to get messages from a queue using the MQGET call.

The application uses these MQI calls:
- MQCONN
- MQOPEN
- MQGET
- MQCLOSE
- MQDISC

The program is delivered in COBOL and C, and runs in the batch and CICS environment. See Table 44 on page 476 for the batch application and Table 49 on page 479 for the CICS application.

Browse sample

The Browse sample demonstrates how to browse a message, print it, then step through the messages on a queue.

The application uses these MQI calls:
- MQCONN
- MQOPEN
- MQGET for browsing messages
- MQCLOSE
- MQDISC

The program is delivered in the COBOL, assembler, PL/I, and C languages. The application runs in the batch environment. See Table 45 on page 476 for the batch application.

Print Message sample

The Print Message sample demonstrates how to remove a message from a queue and print the data in the message, together with all the fields of its message descriptor. By removing comment characters from two lines in the source module, you can change the program so that it browses, rather than removes, the messages on a queue. This program can usefully be used for diagnosing problems with an application that is putting messages on a queue.

The application uses these MQI calls:
- MQCONN
- MQOPEN
- MQGET for removing messages from a queue (with an option to browse)
- MQCLOSE
- MQDISC

The program is delivered in the C language. The application runs in the batch environment. See Table 46 on page 476 for the batch application.
Queue Attributes sample

The Queue Attributes sample demonstrates how to inquire about and set the values of WebSphere MQ for z/OS object attributes.

The application uses these MQI calls:
- MQOPEN
- MQINQ
- MQSET
- MQCLOSE

The program is delivered in the COBOL, assembler, and C languages. The application runs in the CICS environment. See Table 50 on page 480 for the CICS application.

Mail Manager sample

The Mail Manager sample demonstrates these techniques:
- Using alias queues
- Using a model queue to create a temporary dynamic queue
- Using reply-to queues
- Using syncpoints in the CICS and batch environments
- Sending commands to the system-command input queue
- Testing return codes
- Sending messages to remote queue managers, both by using a local definition of a remote queue and by putting messages directly on a named queue at a remote queue manager

The application uses these MQI calls:
- MQCONN
- MQOPEN
- MQPUT1
- MQGET
- MQINQ
- MQCMIT
- MQCLOSE
- MQDISC

Three versions of the application are provided:
- A CICS application written in COBOL
- A TSO application written in COBOL
- A TSO application written in C

The TSO applications use the WebSphere MQ for z/OS batch adapter and include some ISPF panels. See Table 47 on page 477 for the TSO application, and Table 51 on page 480 for the CICS application.

Credit Check sample

The Credit Check sample is a suite of programs that demonstrates these techniques:
- Developing an application that runs in more than one environment
- Using a model queue to create a temporary dynamic queue
- Using a correlation identifier
- The setting and passing of context information
Features demonstrated

- Using message priority and persistence
- Starting programs by using triggering
- Using reply-to queues
- Using alias queues
- Using a dead-letter queue
- Using a namelist
- Testing return codes

The application uses these MQI calls:

- MQOPEN
- MQPUT
- MQPUT1
- MQGET for browsing and getting messages, using the wait and signal options, and for getting a specific message
- MQINQ
- MQSET
- MQCLOSE

The sample can run as a stand-alone CICS application. However, to demonstrate how to design a message queuing application that uses the facilities provided by both the CICS and IMS environments, one module is also supplied as an IMS batch message processing program.

The CICS programs are delivered in C and COBOL. The single IMS program is delivered in C.

See Table 52 on page 480 for the CICS application, and Table 53 on page 482 for the IMS application.

The Message Handler sample

The Message Handler sample allows you to browse, forward, and delete messages on a queue.

The application uses these MQI calls:

- MQCONN
- MQOPEN
- MQINQ
- MQPUT1
- MQCMIT
- MQBACK
- MQGET
- MQCLOSE
- MQDISC

The program is delivered in C and COBOL programming languages. The application runs under TSO. See Table 48 on page 478 for the TSO application.
Distributed queuing exit samples

The names of the source programs of the distributed queuing exit samples are listed in the following table:

Table 42. Source for the distributed queuing exit samples

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4BAX0</td>
<td>Assembler</td>
<td>Source program</td>
<td>SCSQASMS</td>
</tr>
<tr>
<td>CSQ4BCX1</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4BCX2</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
</tbody>
</table>

Note: The source programs are link-edited with CSQXSTUB.

See [WebSphere MQ Intercommunication](#) for a description of the distributed queuing exit samples.

Data-conversion exit samples

A skeleton is provided for a data-conversion exit routine, and a sample is shipped with WebSphere MQ illustrating the MQXCNVC call. The names of the source programs of the data-conversion exit samples are listed in the following table:

Table 43. Source for the data conversion exit samples (Assembler language only)

<table>
<thead>
<tr>
<th>Member name</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4BAX8</td>
<td>Source program</td>
<td>SCSQASMS</td>
</tr>
<tr>
<td>CSQ4BAX9</td>
<td>Source program</td>
<td>SCSQASMS</td>
</tr>
<tr>
<td>CSQ4CAX9</td>
<td>Source program</td>
<td>SCSQASMS</td>
</tr>
</tbody>
</table>

Note: The source programs are link-edited with CSQASTUB.

See [Chapter 11, “Writing data-conversion exits”](#) on page 153 for more information.

Preparing and running sample applications for the batch environment

To prepare a sample application that runs in the batch environment, perform the same steps that you would when building any batch WebSphere MQ for z/OS application. These steps are listed in “Building z/OS batch applications” on page 384.

Note: The assembler language version of the Browse sample uses data control blocks (DCBs), so you must link-edit it using RMODE(24).

The library members that you will use are listed in Table 44, Table 45, and Table 46 on page 476.

You must edit the run JCL supplied for the samples that you want to use (see Table 44, Table 45, and Table 46 on page 476).

The PARM statement in the supplied JCL contains a number of parameters that you need to modify. To run the C sample programs, separate the parameters by spaces; to run the Assembler, COBOL, and PL/I sample programs, separate them by commas. For example, if the name of your queue manager is CSQ1 and you...
Preparing batch samples

want to run the application with a queue named LOCALQ1, in the COBOL, PL/I, and assembler-language JCL, your PARM statement should look like this:

\[ \text{PARM=(CSQ1,LOCALQ1)} \]

In the C language JCL, your PARM statement should look like this:

\[ \text{PARM=('CSQ1 LOCALQ1')} \]

You are now ready to submit the jobs.

Names of the sample batch applications

The names of the source programs and JCL that are supplied for each of the sample batch applications are listed in the following tables:

Put and Get samples Table 44
Browse sample Table 45
Print message sample Table 46

Table 44. Source and JCL for the Put and Get samples

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4BCJ1</td>
<td>C</td>
<td>Get source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4BCK1</td>
<td>C</td>
<td>Put source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4BVJ1</td>
<td>COBOL</td>
<td>Get source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4BVK1</td>
<td>COBOL</td>
<td>Put source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4BCJR</td>
<td>C</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4BVJR</td>
<td>COBOL</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>

Table 45. Source and JCL for the Browse sample

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4BVA1</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4BVAR</td>
<td>COBOL</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4BAAR</td>
<td>Assembler</td>
<td>Source program</td>
<td>SCSQASMS</td>
</tr>
<tr>
<td>CSQ4BAAR</td>
<td>Assembler</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4BCA1</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4BCAR</td>
<td>C</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4BPA1</td>
<td>PL/I</td>
<td>Source program</td>
<td>SCSQPLIS</td>
</tr>
<tr>
<td>CSQ4BPAR</td>
<td>PL/I</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>

Table 46. Source for the Print Message sample (C language only)

<table>
<thead>
<tr>
<th>Member name</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4BCG1</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4BCGR</td>
<td>Sample run JCL</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>
Preparing sample applications for the TSO environment

To prepare a sample application that runs in the TSO environment, perform the same steps that you would when building any batch WebSphere MQ for z/OS application—these steps are listed in “Building z/OS batch applications” on page 384. The library members you will use are listed in Table 47.

For the Mail Manager sample application, ensure that the queues it uses are available on your system. They are defined in the member thlqual.SCSQPROC(CSQ4CVD). To ensure that these queues are always available, you could add these members to your CSQINP2 initialization input data set, or use the CSQUTIL program to load these queue definitions.

Names of the sample TSO applications

The names of the source programs that are supplied for each of the sample TSO applications are listed in the following tables:

Mail manager sample
Message handler sample

These samples use ISPF panels. You must therefore include the ISPF stub, ISPLINK, when you link-edit the programs.

Table 47. Source and JCL for the Mail Manager (TSO) sample

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4CVD</td>
<td>independent</td>
<td>WebSphere MQ for z/OS object definitions</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ40</td>
<td>independent</td>
<td>ISPF messages</td>
<td>SCSQMSGE</td>
</tr>
<tr>
<td>CSQ4RVD1</td>
<td>COBOL</td>
<td>CLIST to initiate CSQ4TVD1</td>
<td>SCSQCLST</td>
</tr>
<tr>
<td>CSQ4TVD1</td>
<td>COBOL</td>
<td>Source program for Menu program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4TVD2</td>
<td>COBOL</td>
<td>Source program for Get Mail program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4TVD4</td>
<td>COBOL</td>
<td>Source program for Send Mail program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4TVD5</td>
<td>COBOL</td>
<td>Source program for Nickname program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4VDP1-6</td>
<td>COBOL</td>
<td>Panel definitions</td>
<td>SCSQPNLA</td>
</tr>
<tr>
<td>CSQ4VD0</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4VD1</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4VD2</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4VD4</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4RCD1</td>
<td>C</td>
<td>CLIST to initiate CSQ4TCD1</td>
<td>SCSQCLST</td>
</tr>
<tr>
<td>CSQ4TCD1</td>
<td>C</td>
<td>Source program for Menu program</td>
<td>SCSQC37S</td>
</tr>
</tbody>
</table>
Preparing the sample applications for the CICS environment

Before you run the CICS sample programs, you must log on to CICS using a LOGMODE of 32702. This is because the sample programs have been written to use a 3270 mode 2 screen.

To prepare a sample application that runs in the CICS environment, perform the following steps:

1. Create the symbolic description map and the physical screen map for the sample by assembling the BMS screen definition source (supplied in library thlqual.SCSQMAPPD, where thlqual is the high-level qualifier used by your installation). When you name the maps, use the name of the BMS screen definition source (not available for Put and Get sample programs), but omit the last character of that name.

2. Perform the same steps that you would when building any CICS WebSphere MQ for z/OS application—these steps are listed in “Building CICS applications” on page 385. The library members that you will use are listed in Table 49 on page 479, Table 50 on page 480, Table 51 on page 480, and Table 52 on page 480.

Preparing TSO samples

Table 47. Source and JCL for the Mail Manager (TSO) sample (continued)

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4TCD2</td>
<td>C</td>
<td>Source program for Get Mail program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4TCD4</td>
<td>C</td>
<td>Source program for Send Mail program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4TCD5</td>
<td>C</td>
<td>Source program for Nickname program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CDP1-6</td>
<td>C</td>
<td>Panel definitions</td>
<td>SCSQPNLX</td>
</tr>
<tr>
<td>CSQ4TC0</td>
<td>C</td>
<td>Include file</td>
<td>SCSQC370</td>
</tr>
</tbody>
</table>

Table 48. Source for the Message Handler sample

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4TCH0</td>
<td>C</td>
<td>Data definition</td>
<td>SCSQC370</td>
</tr>
<tr>
<td>CSQ4TCH1</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4TCH2</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4TCH3</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4RCH1</td>
<td>C and COBOL</td>
<td>CLIST to initiate CSQ4TCH1 or CSQ4TVH1</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CHP0</td>
<td>C and COBOL</td>
<td>Panel definition</td>
<td>SCSQPNLX</td>
</tr>
<tr>
<td>CSQ4CHP1</td>
<td>C and COBOL</td>
<td>Panel definition</td>
<td>SCSQPNLX</td>
</tr>
<tr>
<td>CSQ4CHP2</td>
<td>C and COBOL</td>
<td>Panel definition</td>
<td>SCSQPNLX</td>
</tr>
<tr>
<td>CSQ4CHP3</td>
<td>C and COBOL</td>
<td>Panel definition</td>
<td>SCSQPNLX</td>
</tr>
<tr>
<td>CSQ4CHP9</td>
<td>C and COBOL</td>
<td>Panel definition</td>
<td>SCSQPNLX</td>
</tr>
<tr>
<td>CSQ4TVH0</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4TVH1</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4TVH2</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4TVH3</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
</tbody>
</table>
3. Identify the map set, programs, and transaction to CICS by updating the CICS system definition (CSD) data set. The definitions you require are in the member \texttt{thlqual.SCSQPROC(CSQ4S100)}. For guidance on how to do this, see \texttt{WebSphere MQ for z/OS System Setup Guide}.

\textbf{Note:} For the Credit Check sample application, you will get an error message at this stage if you have not already created the VSAM data set that the sample uses.

4. For the Credit Check and Mail Manager sample applications, ensure that the queues they use are available on your system. For the Credit Check sample, they are defined in the member \texttt{thlqual.SCSQPROC(CSQ4CVB)} for COBOL, and \texttt{thlqual.SCSQPROC(CSQ4CCB)} for C. For the Mail Manager sample, they are defined in the member \texttt{thlqual.SCSQPROC(CSQ4CVD)}. To ensure that these queues are always available, you could add these members to your CSQINP2 initialization input data set, or use the CSQUTIL program to load these queue definitions.

For the Queue Attributes sample application, you could use one or more of the queues that are supplied for the other sample applications. Alternatively, you could use your own queues. However, note that in the form that it is supplied, this sample works only with queues that have the characters \texttt{CSQ4SAMP} in the first eight bytes of their name.

\section*{QLOP abend}

When the CICS sample applications supplied with WebSphere MQ for z/OS use MQI calls, they do not test for the return codes that indicate that the queue manager is not available. If the queue manager is not available when you attempt to run one of the CICS samples, the sample abends with the CICS abend code QLOP. If this happens, you must connect your queue manager to your CICS system before you attempt to start the sample application again. For information about starting a connection, see \texttt{WebSphere MQ for z/OS System Administration Guide}.

\section*{Names of the sample CICS applications}

The source and JCL files that are supplied for each of the sample CICS applications are listed in the following tables:

\begin{itemize}
  \item Put and Get samples
  \item Queue attributes sample
  \item Mail Manager (CICS) sample
  \item Credit Check (CICS) sample
\end{itemize}

\textbf{Table 49. Source and JCL for the Put and Get samples}

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4CCK1</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CCJ1</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CVJ1</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVK1</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4S100</td>
<td>independent</td>
<td>CICS system definition data set</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>
### Table 50. Source for the Queue Attributes sample

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4VC1</td>
<td>COBOL</td>
<td>Source program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4VMSG</td>
<td>COBOL</td>
<td>Message definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4VCM5</td>
<td>COBOL</td>
<td>BMS screen definition</td>
<td>SCSQMAPS</td>
</tr>
<tr>
<td>CSQ4CAC1</td>
<td>Assembler</td>
<td>Source program</td>
<td>SCSQASMS</td>
</tr>
<tr>
<td>CSQ4AMSG</td>
<td>Assembler</td>
<td>Message definition</td>
<td>SCSQMACS</td>
</tr>
<tr>
<td>CSQ4ACMS</td>
<td>Assembler</td>
<td>BMS screen definition</td>
<td>SCSQMAPS</td>
</tr>
<tr>
<td>CSQ4CCC1</td>
<td>C</td>
<td>Source program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CMMSG</td>
<td>C</td>
<td>Message definition</td>
<td>SCSQC370</td>
</tr>
<tr>
<td>CSQ4CCMS</td>
<td>C</td>
<td>BMS screen definition</td>
<td>SCSQMAPS</td>
</tr>
<tr>
<td>CSQ4S100</td>
<td>independent</td>
<td>CICS system definition data set</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>

### Table 51. Source and JCL for the Mail Manager (CICS) sample (COBOL only)

<table>
<thead>
<tr>
<th>Member name</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4CVD</td>
<td>WebSphere MQ for z/OS object definitions</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4CVD1</td>
<td>Source for Menu program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVD2</td>
<td>Source for Get Mail program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVD3</td>
<td>Source for Display Message program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVD4</td>
<td>Source for Send Mail program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVD5</td>
<td>Source for Nickname program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4VDMS</td>
<td>BMS screen definition source</td>
<td>SCSQMAPS</td>
</tr>
<tr>
<td>CSQ4S100</td>
<td>CICS system definition data set</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4VD0</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4VD3</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
<tr>
<td>CSQ4VD4</td>
<td>Data definition</td>
<td>SCSQCOBC</td>
</tr>
</tbody>
</table>

### Table 52. Source and JCL for the Credit Check CICS sample

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4CVB</td>
<td>independent</td>
<td>WebSphere MQ object definitions</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4CCB</td>
<td>independent</td>
<td>WebSphere MQ object definitions</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4CVB1</td>
<td>COBOL</td>
<td>Source for user-interface program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVB2</td>
<td>COBOL</td>
<td>Source for credit application manager</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVB3</td>
<td>COBOL</td>
<td>Source for checking-account program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVB4</td>
<td>COBOL</td>
<td>Source for distribution program</td>
<td>SCSQCOBS</td>
</tr>
<tr>
<td>CSQ4CVB5</td>
<td>COBOL</td>
<td>Source for agency-query program</td>
<td>SCSQCOBS</td>
</tr>
</tbody>
</table>
### Preparing the sample application for the IMS environment

Part of the Credit Check sample application can run in the IMS environment. To prepare this part of the application to run with the CICS sample you must first perform the steps described in ‘Preparing the sample applications for the CICS environment’ on page 478.

Then perform the following steps:

1. Perform the same steps that you would when building any IMS WebSphere MQ for z/OS application—these steps are listed in ‘Building IMS (BMP or MPP) applications’ on page 386. The library members that you will use are listed in Table 53 on page 482.

2. Identify the application program and database to IMS. Samples are provided with PSBGEN, DBDGEN, ACB definition, IMGSEN, and IMSDLLOC statements to enable this.

3. Load the database CSQ4CA by tailoring and running the sample JCL provided for this purpose (CSQ4ILDB). This JCL loads the database with data from the file CSQ4BAQ. Update the IMS control region with a DD statement for the database CSQ4CA.

---

**Table 52. Source and JCL for the Credit Check CICS sample (continued)**

<table>
<thead>
<tr>
<th>Member name</th>
<th>For language</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4CCB1</td>
<td>C</td>
<td>Source for user-interface program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CCB2</td>
<td>C</td>
<td>Source for credit application manager</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CCB3</td>
<td>C</td>
<td>Source for checking-account program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CCB4</td>
<td>C</td>
<td>Source for distribution program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CCB5</td>
<td>C</td>
<td>Source for agency-query program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CB0</td>
<td>C</td>
<td>Include file</td>
<td>SCSQC370</td>
</tr>
<tr>
<td>CSQ4CBMS</td>
<td></td>
<td>BMS screen definition source</td>
<td>SCSQMAPS</td>
</tr>
<tr>
<td>CSQ4VBMW5</td>
<td>COBOL</td>
<td>BMS screen definition source</td>
<td>SCSQMAPS</td>
</tr>
<tr>
<td>CSQ4VB0</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB1</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB2</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB3</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB4</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB5</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB6</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB7</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4VB8</td>
<td>COBOL</td>
<td>Data definition</td>
<td>SCSQCOCBC</td>
</tr>
<tr>
<td>CSQ4BAQ</td>
<td>independent</td>
<td>Source for VSAM data set</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4FILE</td>
<td>independent</td>
<td>JCL to build VSAM data set used by CSQ4CVB3</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4S100</td>
<td>independent</td>
<td>CICS system definition data set</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>
4. Start the checking-account program as a batch message processing (BMP) program by tailoring and running the sample JCL provided for this purpose. This JCL starts a batch-oriented BMP program. To run the program as a message-oriented BMP program, remove the comment characters from the line in the JCL that contains the IN= statement.

Names of the sample IMS application

The source and JCL that are supplied for the Credit Check sample IMS application are listed in Table 53.

<table>
<thead>
<tr>
<th>Member name</th>
<th>Description</th>
<th>Supplied in library</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSQ4CVB</td>
<td>WebSphere MQ object definitions</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4ICB3</td>
<td>Source for checking-account program</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4ICBL</td>
<td>Source for loading the checking-account database</td>
<td>SCSQC37S</td>
</tr>
<tr>
<td>CSQ4CBI</td>
<td>Data definition</td>
<td>SCSQC370</td>
</tr>
<tr>
<td>CSQ4PSBL</td>
<td>PSBGEN JCL for database-load program</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4PSB3</td>
<td>PSBGEN JCL for checking-account program</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4DBDS</td>
<td>DBDGEN JCL for database CSQ4CA</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4GIMS</td>
<td>IMSGEN macro definitions for CSQ4IVB3 and CSQ4CA</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4ACBG</td>
<td>Application control block (ACB) definition for CSQ4IVB3</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4BAQ</td>
<td>Source for database</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4ILDB</td>
<td>Sample run JCL for database-load job</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4ICBR</td>
<td>Sample run JCL for checking-account program</td>
<td>SCSQPROC</td>
</tr>
<tr>
<td>CSQ4DYNA</td>
<td>IMSDALOC macro definitions for database</td>
<td>SCSQPROC</td>
</tr>
</tbody>
</table>

The Put samples

The Put sample programs put messages on a queue using the MQPUT call. The source programs are supplied in C and COBOL in the batch and CICS environments (see Table 44 on page 476 and Table 49 on page 479).

Design of the Put sample

The flow through the program logic is:

1. Connect to the queue manager using the MQCONN call. If this call fails, print the completion and reason codes and stop processing.
Note: If you are running the sample in a CICS environment, you do not need to issue an MQCONN call; if you do, it returns DEF_HCONN. You can use the connection handle MQHC_DEF_HCONN for the MQI calls that follow.

2. Open the queue using the MQOPEN call with the MQOO_OUTPUT option. On input to this call, the program uses the connection handle that is returned in step 1. For the object descriptor structure (MQOD), it uses the default values for all fields except the queue name field which is passed as a parameter to the program. If the MQOPEN call fails, print the completion and reason codes and stop processing.

3. Create a loop within the program issuing MQPUT calls until the required number of messages are put on the queue. If an MQPUT call fails, the loop is abandoned early, no further MQPUT calls are attempted, and the completion and reason codes are returned.

4. Close the queue using the MQCLOSE call with the object handle returned in step 2. If this call fails, print the completion and reason codes.

5. Disconnect from the queue manager using the MQDISC call with the connection handle returned in step 1. If this call fails, print the completion and reason codes.

Note: If you are running the sample in a CICS environment, you do not need to issue an MQDISC call.

The Put samples for the batch environment

To run the samples, you must edit and run the sample JCL, as described in “Preparing and running sample applications for the batch environment” on page 475.

The programs take the following parameters in an EXEC PARM, separated by spaces in C and commas in COBOL:
1. The name of the queue manager (4 characters)
2. The name of the target queue (48 characters)
3. The number of messages (up to 4 digits)
4. The padding character to be written in the message (1 character)
5. The number of characters to write in the message (up to 4 digits)
6. The persistence of the message (1 character: ‘P’ for persistent or ‘N’ for nonpersistent)

If you enter any of the above parameters wrongly, you will receive appropriate error messages.

Any messages from the samples are written to the SYSPRINT data set.

Usage notes

- To keep the samples simple, there are some minor functional differences between language versions. However, these differences are minimized if the layout of the parameters shown in the sample run JCL, CSQ4BCJR, and CSQ4BVJR, is used. None of the differences relate to the MQI.
- CSQ4BCK1 allows you to enter more than four digits for the number of messages sent and the length of the messages.
- For the two numeric fields, enter any digit between 1 and 9999. The value you enter should be a positive number. For example, to put a single message, you can enter 1 or 01 or 001 or 0001 as the value. If you enter non-numeric or
negative values, you may receive an error. For example, if you enter ‘-1’, the
COBOL program will send a one-byte message, but the C program will receive
an error.

- For both programs, CSQ4BCK1 and CSQ4BVK1, you must enter ‘P’ in the
  persistence parameter, ++PER++, if you require the message to be persistent. If
  you fail to do so, the message will be nonpersistent.

The Put samples for the CICS environment
The transactions take the following parameters separated by commas:
1. The number of messages (up to 4 digits)
2. The padding character to be written in the message (1 character)
3. The number of characters to write in the message (up to 4 digits)
4. The persistence of the message (1 character: ‘P’ for persistent or ‘N’ for
   nonpersistent)
5. The name of the target queue (48 characters)

If you enter any of the above parameters wrongly, you will receive appropriate
error messages.

For the COBOL sample, invoke the Put sample in the CICS environment by
entering:
   MVPT,9999,*,9999,P,QUEUE.NAME

For the C sample, invoke the Put sample in the CICS environment by entering:
   MCPT,9999,*,9999,P,QUEUE.NAME

Any messages from the samples are displayed on the screen.

Usage notes
- To keep the samples simple, there are some minor functional differences
  between language versions. None of the differences relate to the MQI.
- If you enter a queue name that is longer than 48 characters, its length is
  truncated to the maximum of 48 characters but no error message is returned.
- Before entering the transaction, press the ‘CLEAR’ key.
- For the two numeric fields, enter any number between 1 and 9999. The value
  you enter should be a positive number. For example, to put a single message,
  you can enter the value 1 or 01 or 001 or 0001. If you enter non-numeric or
  negative values, you may receive an error. For example, if you enter ‘-1’, the
  COBOL program will send a 1 byte message, and the C program will abend
  with an error from malloc().
- For both programs, CSQ4CCK1 and CSQ4CVK1, you must enter ‘P’ in the
  persistence parameter, if you require the message to be persistent. For
  non-persistent messages, enter ‘N’ in the persistence parameter. If you enter any
  other value you will receive an error message.
- The messages are put in syncpoint because default values are used for all
  parameters except those set during program invocation.
The Get samples

The Get sample programs get messages from a queue using the MQGET call.

The source programs are supplied in C and COBOL in the batch and CICS environments (see Table 44 on page 476 and Table 49 on page 479).

Design of the Get sample

The flow through the program logic is:

1. Connect to the queue manager using the MQCONN call. If this call fails, print the completion and reason codes and stop processing.

   **Note:** If you are running the sample in a CICS environment, you do not need to issue an MQCONN call; if you do, it returns DEF_HCONN. You can use the connection handle MQHC_DEF_HCONN for the MQI calls that follow.

2. Open the queue using the MQOPEN call with the MQOO_INPUT_SHARED and MQOO_BROWSE options. On input to this call, the program uses the connection handle that is returned in step 1. For the object descriptor structure (MQOD), it uses the default values for all fields except the queue name field which is passed as a parameter to the program. If the MQOPEN call fails, print the completion and reason codes and stop processing.

3. Create a loop within the program issuing MQGET calls until the required number of messages are retrieved from the queue. If an MQGET call fails, the loop is abandoned early, no further MQGET calls are attempted, and the completion and reason codes are returned. The following options are specified on the MQGET call:
   - MQGMO_NO_WAIT
   - MQGMO_ACCEPT_TRUNCATED_MESSAGE
   - MQGMO_SYNCPOINT or MQGMO_NO_SYNCPOINT
   - MQGMO_BROWSE_FIRST and MQGMO_BROWSE_NEXT

   For a description of these options, see WebSphere MQ Application Programming Reference. For each message, the message number is printed followed by the length of the message and the message data.

4. Close the queue using the MQCLOSE call with the object handle returned in step 2. If this call fails, print the completion and reason codes.

5. Disconnect from the queue manager using the MQDISC call with the connection handle returned in step 1. If this call fails, print the completion and reason codes.

   **Note:** If you are running the sample in a CICS environment, you do not need to issue an MQDISC call.

The Get samples for the batch environment

To run the samples, you must edit and run the sample JCL, as described in “Preparing and running sample applications for the batch environment” on page 475.

The programs take the following parameters in an EXEC PARM, separated by spaces in C and commas in COBOL:

1. The name of the queue manager (4 characters)
2. The name of the target queue (48 characters)
3. The number of messages to get (up to 4 digits)
Get samples

4. The browse/get message option (1 character: ‘B’ to browse or ‘D’ to destructively get the messages)
5. The syncpoint control (1 character: ‘S’ for syncpoint or ‘N’ for no syncpoint)

If you enter any of the above parameters wrongly, you will receive appropriate error messages.

Output from the samples is written to the SYSPRINT data set:

=====================================  PARAMETERs PASSED :  PARAMETERs PASSED :
 QMGR      -  VC9          QMGR      -  VC9
 QNAME     -  A.Q          QNAME     -  A.Q
 NUMMSGs   -  000000002    NUMMSGs   -  000000002
 GET       -  D            GET       -  D
 SYNCPOINT -  N            SYNCPOINT -  N

MQCONN SUCCESSFUL
MQOPEN SUCCESSFUL
000000000 : 000000010 : **********
000000001 : 000000010 : **********
000000002 MESSAGES GOT FROM QUEUE
MQCLOSE SUCCESSFUL
MQDISC SUCCESSFUL

Usage notes

- To keep the samples simple, there are some minor functional differences between language versions. However, these differences are minimized if the layout of the parameters shown in the sample run JCL, CSQ4BCJR, and CSQ4BVJR, are used. None of the differences relate to the MQI.
- CSQ4BCJ1 allows you to enter more than four digits for the number of messages retrieved.
- Messages longer than 64 KB are truncated.
- CSQ4BCJ1 can only correctly display character messages as it only displays until the first NULL (\0) character is displayed.
- For the numeric number-of-messages field, enter any digit between 1 and 9999. The value you enter should be a positive number. For example, to get a single message, you can enter 1 or 01 or 001 or 0001 as the value. If you enter non-numeric or negative values, you may receive an error. For example, if you enter ‘-1’, the COBOL program will retrieve one message, but the C program will not retrieve any messages.
- For both programs, CSQ4BCJ1 and CSQ4BVJ1, you must enter ‘B’ in the get parameter, ++GET++, if you want to browse the messages.
- For both programs, CSQ4BCJ1 and CSQ4BVJ1, you must enter ‘S’ in the syncpoint parameter, ++SYNC++, for messages to be retrieved in syncpoint.

The Get samples for the CICS environment

The transactions take the following parameters in an EXEC PARM, separated by commas:

1. The number of messages to get (up to 4 digits)
2. The browse/get message option (1 character: ‘B’ to browse or ‘D’ to destructively get the messages)
3. The syncpoint control (1 character: ‘S’ for syncpoint or ‘N’ for no syncpoint)
4. The name of the target queue (48 characters)
If you enter any of the above parameters wrongly, you will receive appropriate error messages.

For the COBOL sample, invoke the Get sample in the CICS environment by entering:

```
MVGT,9999,B,S,QUEUE.NAME
```

For the C sample, invoke the Get sample in the CICS environment by entering:

```
MCGT,9999,B,S,QUEUE.NAME
```

When the messages are retrieved from the queue, they are put on a CICS temporary storage queue with the same name as the CICS transaction (for example, MCGT for the C sample).

Here is example output of the Get samples:

```
*************************** TOP OF QUEUE ***************************
000000000 : 000000010 : **********
000000001 : 000000010 : **********
*************************** BOTTOM OF QUEUE ********************
```

**Usage notes**

- To keep the samples simple, there are some minor functional differences between language versions. None of the differences relate to the MQI.
- If you enter a queue name that is longer than 48 characters, its length is truncated to the maximum of 48 characters but no error message is returned.
- Before entering the transaction, press the ‘CLEAR’ key.
- CSQ4CCJ1 can only correctly display character messages as it only displays until the first NULL (\0) character is displayed.
- For the numeric field, enter any number between 1 and 9999. The value you enter should be a positive number. For example, to get a single message, you can enter the value 1 or 01 or 001 or 0001. If you enter a non-numeric or negative value, you may receive an error.
- Messages longer than 24 526 bytes in C and 9 950 bytes in COBOL are truncated. This is due to the way the CICS temporary storage queues are used.
- For both programs, CSQ4CCJ1 and CSQ4CVJ1, you must enter ‘B’ in the get parameter if you want to browse the messages, otherwise enter ‘D’. This will perform destructive MQGET calls. If you enter any other value you will receive an error message.
- For both programs, CSQ4CCJ1 and CSQ4CVJ1, you must enter ‘S’ in the syncpoint parameter for messages to be retrieved in syncpoint. If you enter ‘N’ in the syncpoint parameter the MQGET calls will be issued out of syncpoint. If you enter any other value you will receive an error message.

**The Browse sample**

The Browse sample is a batch application that demonstrates how to browse messages on a queue using the MQGET call. The application steps through all the messages in a queue, printing the first 80 bytes of each one. You could use this application to look at the messages on a queue without changing them.

Source programs and sample run JCL are supplied in the COBOL, assembler, PL/I, and C languages (see Table 45 on page 476).
To start the application, you must edit and run the sample run JCL, as described in “Preparing and running sample applications for the batch environment” on page 475. You can look at messages on one of your own queues by specifying the name of the queue in the run JCL.

When you run the application (and there are some messages on the queue), the output data set looks like this:

```
07/12/1998 SAMPLE QUEUE REPORT PAGE 1
QUEUE MANAGER NAME : VC4
QUEUE NAME : CSQ4SAMP.DEAD.QUEUE
RELATIVE MESSAGE MESSAGE NUMBER LENGTH ------------------- MESSAGE DATA -------------
1 740 HELLO, PLEASE CALL ME WHEN YOU GET BACK.
2 429 CSQ4BQRM
3 429 CSQ4BQRM
4 429 CSQ4BQRM
5 22 THIS IS A TEST MESSAGE
6 8 CSQ4TEST
7 36 CSQ4MSG - ANOTHER TEST MESSAGE.....!
8 9 CSQ4STOP
********** END OF REPORT **********
```

If there are no messages on the queue, the data set contains the headings and the “End of report” message only. If an error occurs with any of the MQI calls, the completion and reason codes are added to the output data set.

**Design of the Browse sample**

The Browse sample application uses a single program module—one is provided in each of the supported programming languages.

The flow through the program logic is:

1. Open a print data set and print the title line of the report. Check that names of the queue manager and queue have been passed from the run JCL. If both names have been passed, print the lines of the report that contain the names. If they have not, print an error message, close the print data set, and stop processing.

   The way that the program tests the parameters it is passed from the JCL depends on the language in which the program is written—for more information, see “Language-dependent design considerations” on page 489.

2. Connect to the queue manager using the MQCONN call. If this call is not successful, print the completion and reason codes, close the print data set, and stop processing.

3. Open the queue using the MQOPEN call with the MQOO_BROWSE option. On input to this call, the program uses the connection handle returned in step 2. For the object descriptor structure (MQOD), it uses the default values for all the fields except the queue name (which was passed in step 1). If this call is not successful, print the completion and reason codes, close the print data set, and stop processing.

4. Browse the first message on the queue, using the MQGET call. On input to this call, the program specifies:

   - The connection and queue handles from steps 2 and 3
   - A MQMD structure with all fields set to their initial values
Two options:
- MQGMO_BROWSE_FIRST
- MQGMO_ACCEPT_TRUNCATED_MSG

A buffer of size 80 bytes to hold the data copied from the message.

The MQGMO_ACCEPT_TRUNCATED_MSG option allows the call to complete even if the message is longer than the 80-byte buffer specified in the call. If the message is longer than the buffer, the message is truncated to fit the buffer, and the completion and reason codes are set to show this. The sample was designed so that messages are truncated to 80 characters simply to make the report easy to read. The buffer size is set by a DEFINE statement, so you can easily change it if you want to.

5. Perform the following loop until the MQGET call fails:
   a. Print a line of the report showing:
      - The sequence number of the message (this is a count of the browse operations).
      - The true length of the message (not the truncated length). This value is returned in the DataLength field of the MQGET call.
      - The first 80 bytes of the message data.
   b. Reset the MsgId and CorrelId fields of the MQMD structure to nulls
   c. Browse the next message, using the MQGET call with these two options:
      - MQGMO_BROWSE_NEXT
      - MQGMO_ACCEPT_TRUNCATED_MSG

6. If the MQGET call fails, test the reason code to see if the call has failed because the browse cursor has got to the end of the queue. In this case, print the “End of report” message and go to step 7; otherwise, print the completion and reason codes, close the print data set, and stop processing.

7. Close the queue using the MQCLOSE call with the object handle returned in step 3 on page 488.

8. Disconnect from the queue manager using the MQDISC call with the connection handle returned in step 2 on page 488.

9. Close the print data set and stop processing.

Language-dependent design considerations

Source modules are provided for the Browse sample in four programming languages. There are two main differences between the source modules:

- When testing the parameters passed from the run JCL, the COBOL, PL/I, and assembler-language modules search for the comma character (,). If the JCL passes PARM=(,LOCALQ1), the application attempts to open queue LOCALQ1 on the default queue manager. If there is no name after the comma (or no comma), the application returns an error. The C module does not search for the comma character. If the JCL passes a single parameter (for example, PARM=('LOCALQ1')), the C module uses this as a queue name on the default queue manager.

- To keep the assembler-language module simple, it uses the date format yy/ddd (for example, 93/116) when it creates the print report. The other modules use the calendar date in mm/dd/yy format.

The Print Message sample

The Print Message sample is a simple batch application that demonstrates how to remove all the messages from a queue using the MQGET call. It also prints, for each message, the fields of the message descriptor, followed by the message data. The program prints the data both in hexadecimal and as characters (if they are...
printable). If a character is not printable, the program replaces it with a period character (.). You can use the program when diagnosing problems with an application that is putting messages on a queue.

You can change the application so that it browses the messages, rather than removing them from the queue. To do this, remove the comment characters from two lines in the code, as indicated in “Design of the sample” on page 491.

The application has a single source program, which is written in the C language. Sample run JCL code is also supplied (see Table 46 on page 476).

To start the application, you must edit and run the sample run JCL, as described in “Preparing and running sample applications for the batch environment” on page 475. When you run the application (and there are some messages on the queue), the output data set looks like that in Figure 42.

MQCONN to VC4
MQOPEN - 'CSQ4SAMP.DEAD.QUEUE'

MQGET of message number 1
****Message descriptor****
    StrucId : 'MD ' Version : 1
    Report : 0 MsgType : 2
    Expiry : -1 Feedback : 0
    Encoding : 785 CodedCharSetId : 500
    Format : ' '
    Priority : 3 Persistence : 0
    MsgId : X'C3E2D840E5C3F4404040404040404040A6FE06A95105C620'
    CorrelId : X'C3E2D840E5C3F4404040404040404040A6FE062950C2F125'
    BackoutCount : 0
    ReplyToQ : '
    ReplyToQMgr : 'VC4 '
    ** Identity Context
    UserIdentifier : 'CICSUSER '
    Account.Token :
        X'160DD5E3E2D5C5E34BC9C7D7C2F6F1FE060D3B55B60001000000000000000000'
    ApplIdentData : '
    ** Origin Context
    PutApplType : '1'
    PutApplName : 'VICAUT4 MVBS '
    PutDate : '19930203' PutTime : '20165982'
    ApplOriginData : '

Figure 42. Example of a report from the Print Message sample application (Part 1 of 2)
Design of the sample

The Print message sample application uses a single program written in the C language.

The flow through the program logic is:
1. Check that names of the queue manager and queue have been passed from the run JCL. If they have not, print an error message and stop processing.
2. Connect to the queue manager using the MQCONN call. If this call is not successful, print the completion and reason codes and stop processing; otherwise print the name of the queue manager.
3. Open the queue using the MQOPEN call with the MQOO_INPUT_SHARED option.

Note: If you want the application to browse the messages rather than remove them from the queue, remove the comment characters from the line in the program that adds the MQOO_BROWSE option.

On input to this call, the program uses the connection handle returned in step 2. For the object descriptor structure (MQOD), it uses the default values for all

**Figure 42. Example of a report from the Print Message sample application (Part 2 of 2)**
the fields except the queue name (which was passed in step 1). If this call is not successful, print the completion and reason codes and stop processing; otherwise, print the name of the queue.

4. Perform the following loop until the MQGET call fails:
   a. Initialize the buffer to blanks so that the message data does not get corrupted by any data already in the buffer.
   b. Set the `MsgId` and `CorrelId` fields of the MQMD structure to nulls so that the MQGET call selects the first message from the queue.
   c. Get a message from the queue, using the MQGET call. On input to this call, the program specifies:
      • The connection and object handles from steps 2 and 3.
      • A MQMD structure with all fields set to their initial values. (Note that `MsgId` and `CorrelId` are reset to nulls for each MQGET call.)
      • The option MQGMO_NO_WAIT.

      **Note:** If you want the application to browse the messages rather than remove them from the queue, remove the comment characters from the line in the program that adds the MQOO_BROWSE_NEXT option. When this option is used on a call against a queue for which no browse cursor has previously been used with the current object handle, the browse cursor is positioned logically before the first message.
      • A buffer of size 32 KB to hold the data copied from the message.
   d. Call the printMD subroutine. This prints the name of each field in the message descriptor, followed by its contents.
   e. Print the length of the message, followed by the message data. Each line of message data is in this format:
      • Relative position (in hexadecimal) of this part of the data
      • 16 bytes of hexadecimal data
      • The same 16 bytes of data in character format, if it is printable (nonprintable characters are replaced by periods)

5. If the MQGET call fails, test the reason code to see if the call failed because there are no more messages on the queue. In this case, print the message: “No more messages”; otherwise, print the completion and reason codes. In both cases, go to step 6.

      **Note:** The MQGET call fails if it finds a message that has more than 32 KB of data. To change the program to handle larger messages, you could do one of the following:
      • Add the MQGMO_ACCEPT_TRUNCATED_MSG option to the MQGET call, so that the call gets the first 32 KB of data and discards the remainder
      • Make the program leave the message on the queue when it finds one with this amount of data
      • Increase the size of the buffer

6. Close the queue using the MQCLOSE call with the object handle returned in step 3 on page 491.

7. Disconnect from the queue manager using the MQDISC call with the connection handle returned in step 2 on page 491.
The Queue Attributes sample

The Queue Attributes sample is a conversational-mode CICS application that demonstrates the use of the MQINQ and MQSET calls. It shows how to inquire about the values of the \textit{InhibitPut} and \textit{InhibitGet} attributes of queues, and how to change them so that programs cannot put messages on, or get messages from, a queue. You may want to \textit{lock} a queue in this way when you are testing a program.

To prevent accidental interference with your own queues, this sample works only on a queue object that has the characters CSQ4SAMP in the first eight bytes of its name. However, the source code includes comments to show you how to remove this restriction.

Source programs are supplied in the COBOL, assembler, and C languages (see Table 50 on page 480).

The assembler-language version of the sample uses reenterable code. To do this, you will notice that the code for each MQI call in that version of the sample includes the MF keyword; for example:

\begin{verbatim}
CALL MQCONN,(NAME,HCONN,COMPCODE,REASON),MF=(E,PARMAREA),VL
\end{verbatim}

(The VL keyword means that you can use the CICS Execution Diagnostic Facility (CEDF) supplied transaction for debugging the program.) For more information on writing reenterable programs, see “Writing reenterable programs” on page 78.

To start the application, start your CICS system and use the following CICS transactions:

- For COBOL, MVC1
- For Assembler language, MAC1
- For C, MCC1

You can change the name of any of these transactions by changing the CSD data set mentioned in step 3 on page 479.

Design of the sample

When you start the sample, firstly it displays a screen map that has fields for:

- Name of the queue
- User request (valid actions are: inquire, allow, or inhibit)
- Current status of put operations for the queue
- Current status of get operations for the queue

The first two fields are for user input. The last two fields are filled by the application: they show the word INHIBITED or the word ALLOWED.

The application validates the values you enter in the first two fields. It checks that the queue name starts with the characters \texttt{CSQ4SAMP} and that you entered one of the three valid requests in the Action field. The application converts all your input to uppercase, so you cannot use any queues with names that contain lowercase characters.

If you enter ‘inquire’ in the Action field, the flow through the program logic is:

1. Open the queue using the MQOPEN call with the MQOO_INQUIRE option
2. Call MQINQ using the selectors MQIA_INHIBIT_GET and MQIA_INHIBIT_PUT
3. Close the queue using the MQCLOSE call
Queue Attributes sample

4. Analyze the attributes that are returned in the IntAttrs parameter of the MQINQ call and move the words ‘INHIBITED’ or ‘ALLOWED’, as appropriate, to the relevant screen fields.

If you enter ‘inhibit’ in the Action field, the flow through the program logic is:
1. Open the queue using the MQOPEN call with the MQOO_SET option
2. Call MQSET using the selectors MQIA_INHIBIT_GET and MQIA_INHIBIT_PUT, and with the values MQQA_GET_INHIBITED and MQQA_PUT_INHIBITED in the IntAttrs parameter
3. Close the queue using the MQCLOSE call
4. Move the word ‘INHIBITED’ to the relevant screen fields

If you enter ‘allow’ in the Action field, the application performs similar processing to that for an ‘inhibit’ request. The only differences are the settings of the attributes and the words displayed on the screen.

When the application opens the queue, it uses the default connection handle to the queue manager. (CICS establishes a connection to the queue manager when you start your CICS system.) The application can trap the following errors at this stage:
- The application is not connected to the queue manager
- The queue does not exist
- The user is not authorized to access the queue
- The application is not authorized to open the queue

For other MQI errors, the application displays the completion and reason codes.

The Mail Manager sample

The Mail Manager sample application is a suite of programs that demonstrates the sending and receiving of messages, both within a single environment and across different environments. The application is a simple electronic mailing system that allows users to exchange messages, even if they use different queue managers.

The application demonstrates how to create queues using the MQOPEN call and by putting WebSphere MQ for z/OS commands on the system-command input queue.

Three versions of the application are provided:
- A CICS application written in COBOL
- A TSO application written in COBOL
- A TSO application written in C

Preparing the sample

The Mail Manager is provided in versions that run in two environments. The preparation you must carry out before you run the application depends on the environment you want to use.

A user can access mail queues and nickname queues from both TSO and CICS so long as their sign-on user IDs are the same on each system.

Before you can send messages to another queue manager, you must set up a message channel to that queue manager. To do this, use the channel control function of WebSphere MQ, described in [WebSphere MQ Intercommunication](#).
Preparing the sample for the TSO environment

Follow these steps:

1. Prepare the sample as described in “Preparing sample applications for the TSO environment” on page 477.

2. Tailor the CLIST provided for the sample to define:
   - The location of the panels
   - The location of the message file
   - The location of the load modules
   - The name of the queue manager you want to use with the application

A separate CLIST is provided for each language version of the sample:

   For the COBOL version: CSQ4RVD1
   For the C version: CSQ4RCD1

3. Ensure that the queues used by the application are available on the queue manager. (The queues are defined in CSQ4CVD.)

Note: VS COBOL II does not support multitasking with ISPF. This means that you cannot use the Mail Manager sample application on both sides of a split screen. If you do, the results are unpredictable.

Running the sample

To start the sample in the TSO environment, execute your tailored version of the CLIST from the TSO command processor within ISPF.

To start the sample in the CICS Transaction Server for z/OS environment, run transaction MAIL. If you have not already signed on to CICS, the application prompts you to enter a user ID to which it can send your mail.

When you start the application, it opens your mail queue. If this queue does not already exist, the application creates one for you. Mail queues have names of the form CSQ4SAMP.MAILMGR.userid, where userid depends on the environment:

   In TSO
   The user’s TSO ID

   In CICS
   The user’s CICS sign-on or the user ID entered by the user when prompted when the Mail Manager started

All parts of the queue names that the Mail Manager uses must be uppercase.

The application then presents a menu panel that has options for:
- Read incoming mail
- Send mail
- Create nickname

The menu panel also shows you how many messages are waiting on your mail queue. Each of the menu options displays a further panel:

Read incoming mail
The Mail Manager displays a list of the messages that are on your mail queue. (Note that only the first 99 messages on the queue are displayed.) For an example of this panel, see Figure 45 on page 499. When you select a message from this list, the contents of the message are displayed (see Figure 46 on page 500).
Send mail
A panel prompts you to enter:
- The name of the user to whom you want to send a message
- The name of the queue manager that owns their mail queue
- The text of your message

In the user name field you can enter either a user ID or a nickname that you created using the Mail Manager. You can leave the queue manager name field blank if the user’s mail queue is owned by the same queue manager that you are using, and you must leave it blank if you entered a nickname in the user name field:
- If you specify only a user name, the program first assumes that the name is a nickname, and sends the message to the object defined by that name. If there is no such nickname, the program attempts to send the message to a local queue of that name.
- If you specify both a user name and a queue manager name, the program sends the message to the mail queue that is defined by those two names.

For example, if you want to send a message to user JONESM on remote queue manager QM12, you could send them a message in either of two ways:
- Use both fields to specify user JONESM at queue manager QM12.
- Define a nickname (for example, MARY) for that user and send them a message by putting MARY in the user name field and nothing in the queue manager name field.

Create nickname
You can define an easy-to-remember name that you can use when you send a message to another user who you contact frequently. You are prompted to enter the user ID of the other user and the name of the queue manager that owns their mail queue.

Nicknames are queues that have names of the form CSQ4SAMP.MAILMGR.userid.nickname, where userid is your own user ID and nickname is the nickname that you want to use. With names structured in this way, users can each have their own set of nicknames.

The type of queue that the program creates depends on how you fill in the fields of the Create Nickname panel:
- If you specify only a user name, or the queue manager name is the same as that of the queue manager to which the Mail Manager is connected, the program creates an alias queue.
- If you specify both a user name and a queue manager name (and the queue manager is not the one to which the Mail Manager is connected), the program creates a local definition of a remote queue. The program does not check the existence of the queue to which this definition resolves, or even that the remote queue manager exists.

For example, if your own user ID is SMITHK and you create a nickname called MARY for user JONESM (who uses the remote queue manager QM12), the nickname program creates a local definition of a remote queue named CSQ4SAMP.MAILMGR.SMITHK.MARY. This definition resolves to Mary’s mail queue, which is CSQ4SAMP.MAILMGR.JONESM at queue manager QM12. If you are using queue manager QM12 yourself, the program instead creates an alias queue of the same name (CSQ4SAMP.MAILMGR.SMITHK.MARY).
The C version of the TSO application makes greater use of ISPF’s message-handling capabilities than does the COBOL version. You may notice that different error messages are displayed by the C and COBOL versions.

**Design of the sample**

The following sections describe each of the programs that comprise the Mail Manager sample application. The relationships between the programs and the panels that the application uses is shown in Figure 43 for the TSO version, and Figure 44 on page 498 for the CICS Transaction Server for z/OS version.

![Diagram of programs and panels for the TSO versions of the Mail Manager](image)

Figure 43. Programs and panels for the TSO versions of the Mail Manager. This figure shows the names for the COBOL version.
Menu program

In the TSO environment, the menu program is invoked by the CLIST. In the CICS environment, the program is invoked by transaction MAIL.

The menu program (CSQ4TVD1 for TSO, CSQ4CVD1 for CICS) is the initial program in the suite. It displays the menu (CSQ4VDP1 for TSO, VD1 for CICS) and invokes the other programs when they are selected from the menu.

The program first obtains the user’s ID:
- In the CICS version of the program, if the user has signed on to CICS, the user ID is obtained by using the CICS command ASSIGN USERID. If the user has not signed on, the program displays the sign-on panel (CSQ4VD0) to prompt the user to enter a user ID. There is no security processing within this program—the user can give any user ID.
- In the TSO version, the user’s ID is obtained from TSO in the CLIST. It is passed to the menu program as a variable in the ISPF shared pool.

Figure 44. Programs and panels for the CICS version of the Mail Manager

Mail Manager sample
After the program has obtained the user ID, it checks to ensure that the user has a mail queue (CSQ4SAMPMAILMGR.userid). If a mail queue does not exist, the program creates one by putting a message on the system-command input queue. The message contains the WebSphere MQ for z/OS command DEFINE QLOCAL. The object definition that this command uses sets the maximum depth of the queue to 9999 messages.

The program also creates a temporary dynamic queue to handle replies from the system-command input queue. To do this, the program uses the MQOPEN call, specifying the SYSTEM.DEFAULT.MODEL.QUEUE as the template for the dynamic queue. The queue manager creates the temporary dynamic queue with a name that has the prefix CSQ4SAMP; the remainder of the name is generated by the queue manager.

The program then opens the user’s mail queue and finds the number of messages on the queue by inquiring about the current depth of the queue. To do this, the program uses the MQINQ call, specifying the MQIA_CURRENT_Q_DEPTH selector.

The program then performs a loop that displays the menu and processes the selection that the user makes. The loop is stopped when the user presses the PF3 key. When a valid selection is made, the appropriate program is started; otherwise an error message is displayed.

**Get-mail and display-message programs**

In the TSO versions of the application, the get-mail and display-message functions are performed by the same program (CSQ4TVD2). In the CICS version of the application, these functions are performed by separate programs (CSQ4CVD2 and CSQ4CVD3).

The Mail Awaiting panel (CSQ4VDP2 for TSO, VD2 for CICS) - see Figure 45 for an example - shows all the messages that are on the user’s mail queue. To create this list, the program uses the MQGET call to browse all the messages on the queue, saving information about each one. In addition to the information displayed, the program records the MsgId and CorrelId of each message.

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**Figure 45. Example of a panel showing a list of waiting messages**
Mail Manager sample

From the Mail Awaiting panel the user can select one message and display the contents of the message (see Figure 46 for an example). The program uses the MQGET call to remove this message from the queue, using the MsgId and CorrelId that the program noted when it browsed all the messages. This MQGET call is performed using the MQGMO_SYNCPOINT option. The program displays the contents of the message, then declares a syncpoint: this commits the MQGET call, so the message now no longer exists.

An obvious extension to the function provided by the Mail Manager is to give the user the option to leave the message on the queue after viewing its contents. To do this, you would have to back out the MQGET call that removes the message from the queue, after displaying the message.

Send-mail program

When the user has completed the Send Mail panel (CSQ4VDP4 for TSO, VD4 for CICS), the send-mail program (CSQ4TVD4 for TSO, CSQ4CVD4 for CICS) puts the message on the receiver's mail queue. To do this, the program uses the MQPUT1 call. The destination of the message depends on how the user has filled the fields in the Send Mail panel:

- If the user has specified only a user name, the program first assumes that the name is a nickname, and sends the message to the object defined by that name. If there is no such nickname, the program attempts to send the message to a local queue of that name.
- If the user has specified both a user name and a queue manager name, the program sends the message to the mail queue that is defined by those two names.

The program does not accept blank messages, and it removes leading blanks from each line of the message text.

If the MQPUT1 call is successful, the program displays a message that shows the user name and queue manager name to which the message was put. If the call is unsuccessful, the program checks specifically for the reason codes that indicate the queue or the queue manager do not exist; these are MQRC_UNKNOWN_OBJECT_NAME and MQRC_UNKNOWN_OBJECT_Q_MGR.
The program displays its own error message for each of these errors; for other errors, the program displays the completion and reason codes returned by the call.

### Nickname program

When the user defines a nickname, the nickname program (CSQ4TVD5 for TSO, CSQ4CVD5 for CICS) creates a queue that has the nickname as part of its name. The program does this by putting a message on the system-command input queue. The message contains the WebSphere MQ for z/OS command DEFINE QALIAS or DEFINE QREMOTE. The type of queue that the program creates depends on how the user has filled the fields of the Create Nickname panel (CSQ4VDP5 for TSO, VD5 for CICS):

- If the user has specified only a user name, or the queue manager name is the same as that of the queue manager to which the Mail Manager is connected, the program creates an alias queue.
- If the user has specified both a user name and a queue manager name, (and the queue manager is not the one to which the Mail Manager is connected), the program creates a local definition of a remote queue. The program does not check the existence of the queue to which this definition resolves, or even that the remote queue manager exists.

The program also creates a temporary dynamic queue to handle replies from the system-command input queue.

If the queue manager cannot create the nickname queue for a reason that the program expects (for example, the queue already exists), the program displays its own error message. If the queue manager cannot create the queue for a reason that the program does not expect, the program displays up to two of the error messages that are returned to the program by the command server.

**Note:** For each nickname, the nickname program creates only an alias queue or a local definition of a remote queue. The local queues to which these queue names resolve are created only when the user ID that is contained in the nickname is used to start the Mail Manager application.

### The Credit Check sample

The Credit Check sample application is a suite of programs that demonstrates how to use many of the features provided by WebSphere MQ for z/OS. It shows how the many component programs of an application can pass messages to each other using message queuing techniques.

The sample can run as a stand-alone CICS application. However, to demonstrate how to design a message queuing application that uses the facilities provided by both the CICS and IMS environments, one module is also supplied as an IMS batch message processing program. This extension to the sample is described in “The IMS extension to the Credit Check sample” on page 512.

You can also run the sample on more than one queue manager, and send messages between each instance of the application. To do this, see “The Credit Check sample with multiple queue managers” on page 512.

The CICS programs are delivered in C and COBOL. The single IMS program is delivered only in C. The supplied data sets are shown in Table 52 on page 480 and Table 53 on page 482.
The application demonstrates a method of assessing the risk when bank customers ask for loans. The application shows how a bank could work in two ways to process loan requests:

- When dealing directly with a customer, bank staff want immediate access to account and credit-risk information.
- When dealing with written applications, bank staff can submit a series of requests for account and credit-risk information, and deal with the replies at a later time.

The financial and security details in the application have been kept simple so that the message queuing techniques are clear.

### Preparing and running the Credit Check sample

To prepare and run the Credit Check sample, perform the following steps:

1. Create the VSAM data set that holds information about some example accounts. Do this by editing and running the JCL supplied in data set CSQ4FILE.

2. Perform the steps in “Preparing the sample applications for the CICS environment” on page 478. (The additional steps you must perform if you want to use the IMS extension to the sample are described in “The IMS extension to the Credit Check sample” on page 512.)

3. Start the CKTI trigger monitor (supplied with WebSphere MQ for z/OS) against queue CSQ4SAMP.INITIATION.QUEUE, using the CICS transaction CKQC.

4. To start the application, start your CICS system and use the transaction MVB1.

5. Select **Immediate** or **Batch** inquiry from the first panel.

   The immediate and batch inquiry panels are similar—Figure 47 shows the Immediate Inquiry panel.

   ![Immediate Inquiry panel for the Credit Check sample application](image)

6. Enter an account number and loan amount in the appropriate fields. See “Entering information in the inquiry panels” on page 503 for guidance on what information you should enter in these fields.
Entering information in the inquiry panels

The Credit Check sample application checks that the data you enter in the ‘Amount requested’ field of the inquiry panels is in the form of integers.

If you enter one of the following account numbers, the application finds the appropriate account name, average account balance, and credit worthiness index in the VSAM data set CSQ4BAQ:

- 2222222222
- 3111234329
- 3256478962
- 3333333333
- 3501676212
- 3696879656
- 4444444444
- 5555555555
- 6666666666
- 7777777777

You can enter any, or no, information in the other fields. The application retains any information that you do enter and returns the same information in the reports that it generates.

Design of the sample

This section describes the design of each of the programs that comprise the Credit Check sample application. For a discussion of some of the techniques that were considered during the design of the application, see “Design considerations” on page 510.

Figure 48 on page 504 shows the programs that make up the application, and also the queues that these programs serve. In this figure, the prefix CSQ4SAMP has been omitted from all the queue names to make the figure easier to understand.
Figure 48. Programs and queues for the Credit Check sample application (COBOL programs only). In the sample application, the queue names shown in this figure have the prefix 'CSQ4SAMP.'
**User-interface program (CSQ4CVB1)**

When you start the conversational-mode CICS transaction MVB1, this starts the user-interface program for the application. This program puts inquiry messages on queue CSQ4SAMP.B2.INQUIRY and gets replies to those inquiries from a reply-to queue that it specifies when it makes the inquiry. From the user interface you can submit either immediate or batch inquiries:

- For immediate inquiries, the program creates a temporary dynamic queue that it uses as a reply-to queue. This means that each inquiry has its own reply-to queue.
- For batch inquiries, the user-interface program gets replies from the queue CSQ4SAMP.B2.RESPONSE. For simplicity, the program gets replies for all its inquiries from this one reply-to queue. It is easy to see that a bank might want to use a separate reply-to queue for each user of MVB1, so that they could each see replies to only those inquiries they had initiated.

Important differences between the properties of messages used in the application when in batch and immediate mode are:

- For batch working, the messages have a low priority, so they are processed after any loan requests that are entered in immediate mode. Also, the messages are persistent, so they are recovered if the application or the queue manager has to restart.
- For immediate working, the messages have a high priority, so they are processed before any loan requests that are entered in batch mode. Also, messages are not persistent so they are discarded if the application or the queue manager has to restart.

However, in all cases, the properties of loan request messages are propagated throughout the application. So, for example, all messages that result from a high-priority request will also have a high priority.

**Credit application manager (CSQ4CVB2)**

The Credit Application Manager (CAM) program performs most of the processing for the Credit Check application.

The CAM is started by the CKTI trigger monitor (supplied with WebSphere MQ for z/OS) when a trigger event occurs on either queue CSQ4SAMP.B2.INQUIRY or queue CSQ4SAMP.B2.REPLY.n, where n is an integer that identifies one of a set of reply queues. The trigger message contains data that includes the name of the queue on which the trigger event occurred.

The CAM uses queues with names of the form CSQ4SAMP.B2.WAITING.n to store information about inquiries it is processing. The queues are named so that they are each paired with a reply-to queue; for example, queue CSQ4SAMP.B2.WAITING.3 contains the input data for a particular inquiry, and queue CSQ4SAMP.B2.REPLY.3 contains a set of reply messages (from programs that query databases) all relating to that same inquiry. To understand the reasons behind this design, see “Separate inquiry and reply queues in the CAM” on page 510.

**Start-up logic:** If the trigger event occurs on queue CSQ4SAMP.B2.INQUIRY, the CAM opens the queue for shared access. It then tries to open each reply queue until a free one is found. If it cannot find a free reply queue, the CAM logs the fact and terminates normally.

If the trigger event occurs on queue CSQ4SAMP.B2.REPLY.n, the CAM opens the queue for exclusive access. If the return code reports that the object is already in
use, the CAM terminates normally. If any other error occurs, the CAM logs the error and terminates. The CAM opens the corresponding waiting queue and the inquiry queue, then starts getting and processing messages. From the waiting queue, the CAM recovers details of partially-completed inquiries.

For the sake of simplicity in this sample, the names of the queues used are held in the program. In a business environment, the queue names would probably be held in a file accessed by the program.

Getting a message: The CAM first attempts to get a message from the inquiry queue using the MQGET call with the MQGMO_SET_SIGNAL option. If a message is available immediately, the message is processed; if no message is available, a signal is set.

The CAM then attempts to get a message from the reply queue, again using the MQGET call with the same option. If a message is available immediately, the message is processed; otherwise a signal is set.

When both signals are set, the program waits until one of the signals is posted. If a signal is posted to indicate a message is available, the message is retrieved and processed. If the signal expires or the queue manager is terminating, the program terminates.

Processing the message retrieved: A message retrieved by the CAM may be one of four types:

- An inquiry message
- A reply message
- A propagation message
- An unexpected or unwanted message

The CAM processes these messages as follows:

Inquiry message

Inquiry messages come from the user-interface program. It creates an inquiry message for each loan request.

For all loan requests, the CAM requests the average balance of the customer’s checking account. It does this by putting a request message on alias queue CSQ4SAMP.B2.OUTPUT ALIAS. This queue name resolves to queue CSQ4SAMP.B3.MESSAGES, which is processed by the checking-account program, CSQ4CVB3. When the CAM puts a message on this alias queue, it specifies the appropriate CSQ4SAMP.B2.REPLY.n queue for the reply-to queue. An alias queue is used here so that program CSQ4CVB3 can easily be replaced by another program that processes a base queue of a different name. To do this, you simply redefine the alias queue so that its name resolves to the new queue. Also, you could assign differing access authorities to the alias queue and to the base queue.

If a user requests a loan that is larger than 10000 units, the CAM initiates checks on other databases as well. It does this by putting a request message on queue CSQ4SAMP.B4.MESSAGES, which is processed by the distribution program, CSQ4CVB4. The process serving this queue propagates the message to queues served by programs that have access to other records such as credit card history, savings accounts, and mortgage payments. The data from these programs is returned to the reply-to queue specified in the put operation. Additionally, a propagation message is sent to the reply-to queue by this program to specify how many propagation messages have been sent.
In a business environment, the distribution program would probably reformat the data provided to match the format required by each of the other types of bank account.

Any of the queues referred to here can be on a remote system.

For each inquiry message, the CAM initiates an entry in the memory-resident Inquiry Record Table (IRT). This record contains:

- The MsgId of the inquiry message
- In the ReplyExp field, the number of responses expected (equal to the number of messages sent)
- In the ReplyRec field, the number of replies received (zero at this stage)
- In the PropsOut field, an indication of whether a propagation message is expected

The CAM copies the inquiry message on to the waiting queue with:

- Priority set to 3
- CorrelId set to the MsgId of the inquiry message
- The other message-descriptor fields set to those of the inquiry message

**Propagation message**

A propagation message contains the number of queues to which the distribution program has forwarded the inquiry. The message is processed as follows:

1. Add to the ReplyExp field of the appropriate record in the IRT the number of messages sent. This information is in the message.
2. Increment by 1 the ReplyRec field of the record in the IRT.
3. Decrement by 1 the PropsOut field of the record in the IRT.
4. Copy the message on to the waiting queue. The CAM sets the Priority to 2 and the other fields of the message descriptor to those of the propagation message.

**Reply message**

A reply message contains the response to one of the requests to the checking-account program or to one of the agency-query programs. Reply messages are processed as follows:

1. Increment by 1 the ReplyRec field of the record in the IRT.
2. Copy the message on to the waiting queue with Priority set to 1 and the other fields of the message descriptor set to those of the reply message.
3. If ReplyRec = ReplyExp, and PropsOut = 0, set the MsgComplete flag.

**Other messages**

The application does not expect other messages. However, the application might receive messages broadcast by the system, or reply messages with unknown CorrelIds.

The CAM puts these messages on queue CSQ4SAMP.DEAD.QUEUE, where they can be examined. If this put operation fails, the message is lost and the program continues. For more information on the design of this part of the program, see “How the sample handles unexpected messages” on page 510.

**Sending an answer:** When the CAM has received all the replies it is expecting for an inquiry, it processes the replies and creates a single response message. It consolidates into one message all the data from all reply messages that have the
Credit Check sample

same CorrelId. This response is put on the reply-to queue specified in the original loan request. The response message is put within the same unit of work that contains the retrieval of the final reply message. This is to simplify recovery by ensuring that there is never a completed message on queue CSQ4SAMP.B2.WAITING.n.

**Recovery of partially-completed inquiries:** The CAM copies on to queue CSQ4SAMP.B2.WAITING.n all the messages that it receives. It sets the fields of the message descriptor like this:

- **Priority** is determined by the type of message:
  - For request messages, priority = 3
  - For datagrams, priority = 2
  - For reply messages, priority = 1
- **CorrelId** is set to the MsgId of the loan request message
- Other MQMD fields are copied from those of the received message

When an inquiry has been completed, the messages for a specific inquiry are removed from the waiting queue during answer processing. Therefore, at any time, the waiting queue contains all messages relevant to in-progress inquiries. These messages are used to recover details of in-progress inquiries if the program has to restart. The different priorities are set so that inquiry messages are recovered before propagations or reply messages.

**Checking-account program (CSQ4CVB3)**
The checking-account program is started by a trigger event on queue CSQ4SAMP.B3.MESSAGES. After it has opened the queue, this program gets a message from the queue using the MQGET call with the wait option, and with the wait interval set to 30 seconds.

The program searches VSAM data set CSQ4BAQ for the account number in the loan request message. It retrieves the corresponding account name, average balance, and credit worthiness index, or notes that the account number is not in the data set.

The program then puts a reply message (using the MQPUT1 call) on the reply-to queue named in the loan request message. For this reply message, the program:
- Copies the CorrelId of the loan request message
- Uses the MQPMO_PASSIDENTITYCONTEXT option

The program continues to get messages from the queue until the wait interval expires.

**Distribution program (CSQ4CVB4)**
The distribution program is started by a trigger event on queue CSQ4SAMP.B4.MESSAGES. To simulate the distribution of the loan request to other agencies that have access to records such as credit card history, savings accounts, and mortgage payments, the program puts a copy of the same message on all the queues in the namelist CSQ4SAMP.B4.NAMELIST. There are three of these queues, with names of the form CSQ4SAMP.Bn.MESSAGES, where n is 5, 6, or 7. In a business application, the agencies could be at separate locations, so these queues could be remote queues. If you want to modify the sample application to show this, see "The Credit Check sample with multiple queue managers" on page 512.
The distribution program performs the following steps:

1. From the namelist, gets the names of the queues the program is to use. The program does this by using the MQINQ call to inquire about the attributes of the namelist object.

2. Opens these queues and also CSQ4SAMP.B4.MESSAGES.

3. Performs the following loop until there are no more messages on queue CSQ4SAMP.B4.MESSAGES:
   a. Get a message using the MQGET call with the wait option, and with the wait interval set to 30 seconds.
   b. Put a message on each queue listed in the namelist, specifying the name of the appropriate CSQ4SAMP.B2.REPLY.n queue for the reply-to queue. The program copies the CorrelId of the loan request message to these copy messages, and it uses the MQPMO_PASS.IDENTITY_CONTEXT option on the MQPUT call.
   c. Send a datagram message to queue CSQ4SAMP.B2.REPLY.n to show how many messages it has successfully put.
   d. Declare a syncpoint.

Agency-query program (CSQ4CVB5/CSQ4CCB5)
The agency-query program is supplied as both a COBOL program and a C program. Both programs have the same design. This shows that programs of different types can easily coexist within a WebSphere MQ application, and that the program modules that comprise such an application can easily be replaced.

An instance of the program is started by a trigger event on any of these queues:
   - For the COBOL program (CSQ4CVB5):
     - CSQ4SAMP.B5.MESSAGES
     - CSQ4SAMP.B6.MESSAGES
     - CSQ4SAMP.B7.MESSAGES
   - For the C program (CSQ4CCB5), queue CSQ4SAMP.B8.MESSAGES

Note: If you want to use the C program, you must alter the definition of the namelist CSQ4SAMP.B4.NAMELIST to replace the queue CSQ4SAMP.B7.MESSAGES with CSQ4SAMP.B8.MESSAGES. To do this, you can use any one of:
   - The WebSphere MQ for z/OS operations and control panels
   - The ALTER NAMELIST command (described in WebSphere MQ Script (MQSC) Command Reference)
   - The CSQUTIL utility (described in WebSphere MQ for z/OS System Administration Guide)

After it has opened the appropriate queue, this program gets a message from the queue using the MQGET call with the wait option, and with the wait interval set to 30 seconds.

The program simulates the search of an agency’s database by searching the VSAM data set CSQ4BAQ for the account number that was passed in the loan request message. It then builds a reply that includes the name of the queue it is serving and a creditworthiness index. To simplify the processing, the creditworthiness index is selected at random.

When putting the reply message, the program uses the MQPUT1 call and:
   - Copies the CorrelId of the loan request message
Uses the MQPMO_PASS_IDENTITY_CONTEXT option

The program sends the reply message to the reply-to queue named in the loan request message. (The name of the queue manager that owns the reply-to queue is also specified in the loan request message.)

Design considerations

This section discusses:
• Why the CAM uses separate inquiry and reply queues
• How the sample handles errors
• How the sample handles unexpected messages
• How the sample uses syncpoints
• How the sample uses message context information

Separate inquiry and reply queues in the CAM

The application could use a single queue for both inquiries and replies, but it was designed to use separate queues for the following reasons:
• When the program is handling the maximum number of inquiries, further inquiries can be left on the queue. If a single queue were being used, these would have to be taken off the queue and stored elsewhere.
• Other instances of the CAM could be started automatically to service the same inquiry queue if message traffic was high enough to warrant it. But the program must track in-progress inquiries, and to do this it must get back all replies to inquiries it has initiated. If only one queue were used, the program would have to browse the messages to see if they were for this program or for another. This would make the operation much less efficient.

The application can support multiple CAMs and can recover in-progress inquiries effectively by using paired reply-to and waiting queues.
• The program can wait on multiple queues effectively by using signaling.

How the sample handles errors

The user-interface program handles errors very simply by reporting them directly to the user. The other programs do not have user interfaces, so they have to handle errors in other ways. Also, in many situations (for example, if an MQGET call fails) these other programs do not know the identity of the user of the application.

The other programs put error messages on a CICS temporary storage queue called CSQ4SAMP. You can browse this queue using the CICS-supplied transaction CEBR. The programs also write error messages to the CICS CSML log.

How the sample handles unexpected messages

When you design a message-queuing application, you must decide how to handle messages that arrive on a queue unexpectedly. The two basic choices are:
• The application must do no more work until it has processed the unexpected message. This probably means that the application must notify an operator, terminate itself, and ensure that it is not restarted automatically (it can do this by setting triggering off). This choice means that all processing for the application can be halted by a single unexpected message, and the intervention of an operator is required to restart the application.
• The application must remove the message from the queue it is serving, put the message in another location, and continue processing. The best place to put this message is on the system dead-letter queue.
If you choose the second option:

• An operator, or another program, should examine the messages that are put on the dead-letter queue to find out where the messages are coming from.
• An unexpected message is lost if it cannot be put on the dead-letter queue.
• An long unexpected message is truncated if it is longer than the limit for messages on the dead-letter queue, or longer than the buffer size in the program.

To ensure that the application smoothly handles all inquiries with minimal impact from outside activities, the Credit Check sample application uses the second option. To allow you to keep the sample separate from other applications that use the same queue manager, the Credit Check sample does not use the system dead-letter queue: instead, it uses its own dead-letter queue. This queue is named CSQ4SAMP.DEAD.QUEUE. The sample truncates any messages that are longer than the buffer area provided for the sample programs. You can use the Browse sample application to browse messages on this queue, or use the Print Message sample application to print the messages together with their message descriptors.

However, if you extend the sample to run across more than one queue manager, unexpected messages, or messages that cannot be delivered, could be put on the system dead-letter queue by the queue manager.

How the sample uses syncpoints
The programs in the Credit Check sample application declare syncpoints to ensure that:

• Only one reply message is sent in response to each expected message
• Multiple copies of unexpected messages are never put on the sample’s dead-letter queue
• The CAM can recover the state of all partially-completed inquiries by getting persistent messages from its waiting queue

To achieve this, a single unit of work is used to cover the getting of a message, the processing of that message, and any subsequent put operations.

How the sample uses message context information
When the user-interface program (CSQ4CVB1) sends messages, it uses the MQPMO_DEFAULT_CONTEXT option. This means that the queue manager generates both identity and origin context information. The queue manager gets this information from the transaction that started the program (MVB1) and from the user ID that started the transaction.

When the CAM sends inquiry messages, it uses the MQPMO_PASS_IDENTITY_CONTEXT option. This means that the identity context information of the message being put is copied from the identity context of the original inquiry message. With this option, origin context information is generated by the queue manager.

When the CAM sends reply messages, it uses the MQPMO_ALTERNATE_USER_AUTHORITY option. This causes the queue manager to use an alternate user ID for its security check when the CAM opens a reply-to queue. The CAM uses the user ID of the submitter of the original inquiry message. This means that users are allowed to see replies to only those inquiries they have originated. The alternate user ID is obtained from the identity context information in the message descriptor of the original inquiry message.
When the query programs (CSQ4CVB3/4/5) send reply messages, they use the MQPMO_PASS_IDENTITY_CONTEXT option. This means that the identity context information of the message being put is copied from the identity context of the original inquiry message. With this option, origin context information is generated by the queue manager.

Note: The user ID associated with the MVB3/4/5 transactions requires access to the B2.REPLY.n queues. These user IDs may not be the same as those associated with the request being processed. To get around this possible security exposure, the query programs could use the MQPMO_ALTERNATE_USER_AUTHORITY option when putting their replies. This would mean that each individual user of MVB1 needs authority to open the B2.REPLY.n queues.

Use of message and correlation identifiers in the CAM
The application has to monitor the progress of all the “live” inquiries it is processing at any one time. To do this it uses the unique message identifier of each loan request message to associate all the information it has about each inquiry.

The CAM copies the MsgId of the inquiry message into the CorrelId of all the request messages it sends for that inquiry. The other programs in the sample (CSQ4CVB3 - 5) copy the CorrelId of each message they receive into the CorrelId of their reply message.

The Credit Check sample with multiple queue managers
You can use the Credit Check sample application to demonstrate distributed queuing by installing the sample on two queue managers and CICS systems (with each queue manager connected to a different CICS system). When the sample program is installed, and the trigger monitor (CKTI) is running on each system, you need to:

1. Set up the communication link between the two queue managers. For information on how to do this, see WebSphere MQ Intercommunication.
2. On one queue manager, create a local definition for each of the remote queues (on the other queue manager) that you want to use. These queues can be any of CSQ4SAMP.Bn.MESSAGES, where n is 3, 5, 6, or 7. (These are the queues that are served by the checking-account program and the agency-query program.) For information on how to do this, see WebSphere MQ Script (MQSC) Command Reference.
3. Change the definition of the namelist (CSQ4SAMP.B4.NAMELIST) so that it contains the names of the remote queues you choose to use. For information on how to do this, see WebSphere MQ Script (MQSC) Command Reference.

The IMS extension to the Credit Check sample
A version of the checking-account program is supplied as an IMS batch message processing (BMP) program. It is written in the C language.

The program performs the same function as the CICS version, except that to obtain the account information, the program reads an IMS database instead of a VSAM file. If you replace the CICS version of the checking-account program with the IMS version, you see no difference in the method of using the application.

To prepare and run the IMS version you must:
1. Follow the steps in “Preparing and running the Credit Check sample” on page 502.
2. Follow the steps in “Preparing the sample application for the IMS environment” on page 481.

3. Alter the definition of the alias queue CSQ4SAMP.B2.OUTPUT.ALIAS to resolve to queue CSQ4SAMP.B3.IMS.MESSAGES (instead of CSQ4SAMP.B3.MESSAGES). To do this, you can use any one of:
   - The WebSphere MQ for z/OS operations and control panels
   - The ALTER QALIAS command (described in WebSphere MQ Script (MQSC) Command Reference)

Another way of using the IMS checking-account program is to make it serve one of the queues that receives messages from the distribution program. In the delivered form of the Credit Check sample application, there are three of these queues (B5/6/7.MESSAGES), all served by the agency-query program. This program searches a VSAM data set. To compare the use of the VSAM data set and the IMS database, you could make the IMS checking-account program serve one of these queues instead. To do this, you must alter the definition of the namelist CSQ4SAMP.B4.NAMELIST to replace one of the CSQ4SAMP.Bn.MESSAGES queues with the CSQ4SAMP.B3.IMS.MESSAGES queue. You can use any one of:
   - The WebSphere MQ for z/OS operations and control panels
   - The ALTER NAMELIST command (described in WebSphere MQ Script (MQSC) Command Reference)

You can then run the sample from CICS transaction MVB1 as usual. The user sees no difference in operation or response. The IMS BMP stops either after receiving a stop message or after being inactive for five minutes.

Design of the IMS checking-account program (CSQ4ICB3)
This program runs as a BMP. You must start the program using its JCL before any WebSphere MQ messages are sent to it.

The program searches an IMS database for the account number in the loan request messages. It retrieves the corresponding account name, average balance, and credit worthiness index.

The program sends the results of the database search to the reply-to queue named in the WebSphere MQ message being processed. The message returned appends the account type and the results of the search to the message received so that the transaction building the response can confirm that the correct query is being processed. The message is in the form of three 79-character groups, as follows:

```
'Response from CHECKING ACCOUNT for name: JONES J B'
'  Opened 870530, 3-month average balance = 000012.57'
'  Credit worthiness index - BBB'
```

When running as a message-oriented BMP, the program drains the IMS message queue, then reads messages from the WebSphere MQ for z/OS queue and processes them. No information is received from the IMS message queue. The program reconnects to the queue manager after each checkpoint because the handles have been closed.

When running in a batch-oriented BMP, the program continues to be connected to the queue manager after each checkpoint because the handles are not closed.
The Message Handler sample

The Message Handler sample TSO application allows you to browse, forward, and delete messages on a queue. The sample is available in C and COBOL.

Preparing and running the sample

Follow these steps:

1. Prepare the sample as described in “Preparing sample applications for the TSO environment” on page 477.
2. Tailor the CLIST (CSQ4RCH1) provided for the sample to define:
   - The location of the panels
   - The location of the message file
   - The location of the load modules

CLIST CSQ4RCH1 may be used to run both the C and the COBOL version of the sample. The supplied version of CSQ4RCH1 runs the C version, and contains instructions on the tailoring necessary for the COBOL version.

Notes:

1. There are no sample queue definitions provided with the sample.
2. VS COBOL II does not support multitasking with ISPF, so you should not use the Message Handler sample application on both sides of a split screen. If you do, the results are unpredictable.

Using the sample

Having installed the sample and invoked it from the tailored CLIST CSQ4RCH1, the screen shown in Figure 49 is displayed.

Enter the Queue Manager and Queue name to be viewed (case sensitive) and the message list screen is displayed (see Figure 50 on page 515).
This screen shows the first 99 messages on the queue and, for each, shows the following fields:

**Msg No**
Message number

**Put Date MM/DD/YYYY**
Date the message was put on the queue (GMT)

**Put Time HH:MM:SS**
Time the message was put on the queue (GMT)

**Format Name**
MQMD.Format field

**User Identifier**
MQMD.UserIdentifier field

**Put Application Type**
MQMD.PutApplType field

**Put Application Name**
MQMD.PutApplName field

The total number of messages on the queue is also displayed.

From this screen a message can be chosen, by number not by cursor position, and then displayed. For an example, see Figure 51 on page 516.
Once the message has been displayed it can be deleted, left on the queue, or forwarded to another queue. The Forward to Q Mgr and Forward to Queue fields are initialized with values from the MQMD, these can be changed prior to forwarding the message.

The sample design will only allow messages with unique MsgId / CorrelId combinations to be selected and displayed, this is because the message is retrieved using the MsgId and CorrelId as the key. If the key is not unique the sample cannot retrieve the chosen message with certainty.

**Design of the sample**

This section describes the design of each of the programs that comprise the Message Handler sample application.
Object validation program
This requests a valid queue and queue manager name. If you do not specify a
queue manager name, the default queue manager is used, if available. Only local
queues can be used; an MQINQ is issued to check the queue type and an error is
reported if the queue is not local. If the queue is not opened successfully, or the
MQGET call is inhibited on the queue, error messages are returned indicating the
CompCode and Reason return code.

Message list program
This displays a list of messages on a queue with information about them such as
the putdate, puttime and the message format. The maximum number of messages
stored in the list is 99. If there are more messages on the queue than this, the
current queue depth is also displayed. To choose a message for display, type the
message number into the entry field (the default is 01). If your entry is invalid, you
will receive an appropriate error message.

Message content program
This displays message content. The content is formatted and split into two parts:
1. the message descriptor
2. the message buffer

The message descriptor shows the contents of each field on a separate line.

The message buffer is formatted depending on its contents. If the buffer holds a
dead letter header (MQDLH) or a transmission queue header (MQXQH), these are
formatted and displayed before the buffer itself.

Before the buffer data is formatted, a title line shows the buffer length of the
message in bytes. The maximum buffer size is 32768 bytes, and any message
longer than this is truncated. The full size of the buffer is displayed along with a
message indicating that only the first 32768 bytes of the message are displayed.

The buffer data is formatted in two ways:
1. After the offset into the buffer is printed, the buffer data is displayed in HEX.
2. The buffer data is then displayed again as EBCDIC values. If any EBCDIC
   value cannot be printed, it prints a ‘.’ instead.

You may enter ‘D’ for delete, or ‘F’ for forward into the action field. If you choose
to forward the message, the forward-to queue and queue manager name must be
filled in appropriately. The defaults for these fields are read from the message
descriptor ReplyToQ and ReplyToQMgr fields.

If you forward a message, any header block stored in the buffer is stripped. If the
message is forwarded successfully, it is removed from the original queue. If you
enter invalid actions, error messages are displayed.

An example help panel is also available called CSQ4CHP9.
Part 5. Appendixes
### Appendix A. Language compilers and assemblers

The following tables list the language compilers and assemblers supported.

#### Table 54. Language compilers and assemblers for WebSphere MQ for AIX

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>IBM VisualAge C++ Professional, V5.0</td>
</tr>
<tr>
<td>C</td>
<td>IBM C for AIX, V5</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge C Professional, V5.0</td>
</tr>
<tr>
<td>COBOL</td>
<td>Micro Focus Server Express, V2.0.10</td>
</tr>
</tbody>
</table>

#### Table 55. Language compilers and assemblers for MQSeries for AT&T GIS UNIX

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>AT&amp;T C++ language system for AT&amp;T GIS UNIX</td>
</tr>
<tr>
<td>C</td>
<td>AT&amp;T GIS High Performance C, V1.0b</td>
</tr>
</tbody>
</table>

#### Table 56. Language compilers and assemblers for MQSeries for Compaq NonStop Kernel

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>D30 or later using WIDE memory model (32-bit integers)</td>
</tr>
<tr>
<td>COBOL</td>
<td>D30 or later</td>
</tr>
<tr>
<td>TAL</td>
<td>D30 or later</td>
</tr>
</tbody>
</table>

**Note:** For more detail of the support in different environments, see Table 16 on page 339.

#### Table 57. Language compilers and assemblers for MQSeries for Compaq OpenVMS Alpha

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>DEC C++, V5.0 (VAX), V5.2 (AXP)</td>
</tr>
<tr>
<td>C</td>
<td>DEC C, V5.0</td>
</tr>
<tr>
<td>COBOL</td>
<td>DEC COBOL, V5.0 (VAX), V2.2 (AXP)</td>
</tr>
</tbody>
</table>

#### Table 58. Language compilers and assemblers for MQSeries for Compaq Tru64 UNIX

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>Compaq C++ for Tru64 UNIX Version 6.2</td>
</tr>
<tr>
<td>C</td>
<td>Compaq C for Tru64 UNIX</td>
</tr>
<tr>
<td>COBOL</td>
<td>Micro Focus COBOL for UNIX Version 4.1B</td>
</tr>
<tr>
<td></td>
<td>Micro Focus COBOL for UNIX Version 4.1.00G</td>
</tr>
</tbody>
</table>
## Compilers and assemblers

### Table 59. Language compilers and assemblers for WebSphere MQ for HP-UX

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>aC++</td>
</tr>
<tr>
<td>C</td>
<td>C bundled compiler</td>
</tr>
<tr>
<td></td>
<td>C Softbench, V7.0</td>
</tr>
<tr>
<td>COBOL</td>
<td>Micro Focus Server Express, V2.0.10</td>
</tr>
</tbody>
</table>

### Table 60. Language compilers and assemblers for WebSphere MQ for iSeries

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>IBM ILE C++ for AS/400 (program 5799-GDW)</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for C++ for AS/400 compiler (program 5769-CX4)</td>
</tr>
<tr>
<td>C</td>
<td>IBM ILE C V5R1M0</td>
</tr>
<tr>
<td>COBOL</td>
<td>IBM ILE COBOL V5R1M0</td>
</tr>
<tr>
<td>RPG</td>
<td>IBM ILE RPG IV V5R1M0</td>
</tr>
</tbody>
</table>

### Table 61. Language compilers and assemblers for WebSphere MQ for Linux

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>GNU g++ v3.0</td>
</tr>
<tr>
<td>C</td>
<td>GNU gcc v3.0</td>
</tr>
</tbody>
</table>

### Table 62. Language compilers and assemblers for MQSeries for OS/2 Warp

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>IBM C++ compiler, V3.6</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for C++ for OS/2, V3.0</td>
</tr>
<tr>
<td>C</td>
<td>Borland C++, V2 (C bindings only)</td>
</tr>
<tr>
<td></td>
<td>IBM C compiler, V3.6</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for C++ for OS/2, V3.0 (C bindings only)</td>
</tr>
<tr>
<td>COBOL</td>
<td>IBM VisualAge for COBOL for OS/2, V1.1</td>
</tr>
<tr>
<td></td>
<td>Micro Focus COBOL, V4.0</td>
</tr>
<tr>
<td>PL/I</td>
<td>IBM PL/I for OS/2, V1.2</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for PL/I for OS/2</td>
</tr>
</tbody>
</table>

### Table 63. Language compilers and assemblers for MQSeries for SINIX and DC/OSx

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>DC/OSx: C4.0 compiler, V4.0.1</td>
</tr>
<tr>
<td></td>
<td>SINIX: C compiler (C-DS, MIPS), V1.1</td>
</tr>
<tr>
<td>COBOL</td>
<td>Micro Focus COBOL, V3.2</td>
</tr>
</tbody>
</table>
### Table 64. Language compilers and assemblers for WebSphere MQ for Solaris

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>Sun WorkShop compiler C++, V5.0, V6.0</td>
</tr>
<tr>
<td>C</td>
<td>Sun WorkShop compiler C, V5.0, V6.0</td>
</tr>
<tr>
<td>COBOL</td>
<td>Micro Focus Server Express, V2.0.10</td>
</tr>
</tbody>
</table>

### Table 65. Language compilers and assemblers for MQSeries for VSE/ESA

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>IBM C for VSE/ESA, V1.1</td>
</tr>
<tr>
<td>COBOL</td>
<td>IBM COBOL for VSE/ESA, V1.1</td>
</tr>
<tr>
<td>PL/I</td>
<td>IBM PL/I for VSE/ESA, V1.1</td>
</tr>
</tbody>
</table>

### Table 66. Language compilers and assemblers for WebSphere MQ for Windows

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Microsoft Visual Basic for Windows, V5.0</td>
</tr>
<tr>
<td>C++</td>
<td>IBM C++ compiler, V3.6.4</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for C++ for Windows, V3.5</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for C++ Professional, V4.0</td>
</tr>
<tr>
<td></td>
<td>Microsoft Visual C++ V4, V5, &amp; V6</td>
</tr>
<tr>
<td>C</td>
<td>IBM C compiler, V3.6.4</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for C++ for Windows, V3.5</td>
</tr>
<tr>
<td></td>
<td>Microsoft Visual C++ V4, V5, &amp; V6</td>
</tr>
<tr>
<td>COBOL</td>
<td>IBM VisualAge COBOL Enterprise, V3.0.1</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge COBOL for Windows NT, V2.1</td>
</tr>
<tr>
<td></td>
<td>Micro Focus Object COBOL for Windows NT, V3.3 or V4.0</td>
</tr>
<tr>
<td>PL/I</td>
<td>IBM PL/I for Windows, V1.2</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge for PL/I for Windows</td>
</tr>
<tr>
<td></td>
<td>IBM VisualAge PL/I Enterprise, V2.1</td>
</tr>
</tbody>
</table>

### Table 67. Language compilers and assemblers for WebSphere MQ for z/OS

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembler</td>
<td>Assembler H assembler</td>
</tr>
<tr>
<td></td>
<td>IBM High Level Assembler/MVS assembler</td>
</tr>
<tr>
<td>C++</td>
<td>IBM OS/390 C/C++, V2R4</td>
</tr>
<tr>
<td>C</td>
<td>C/370, Release 2.1.0</td>
</tr>
<tr>
<td></td>
<td>IBM OS/390 C/C++, V2R4</td>
</tr>
<tr>
<td></td>
<td>IBM SAA AD/Cycle® C/370</td>
</tr>
<tr>
<td>COBOL</td>
<td>IBM SAA AD/Cycle COBOL/370</td>
</tr>
<tr>
<td></td>
<td>VS COBOL II</td>
</tr>
<tr>
<td></td>
<td>COBOL for OS/390 &amp; VM</td>
</tr>
<tr>
<td>PL/I</td>
<td>IBM SAA AD/Cycle PL/I Compiler</td>
</tr>
<tr>
<td></td>
<td>OS PL/I Optimizing compiler</td>
</tr>
</tbody>
</table>
### Compilers and assemblers

**Table 68. Language compilers and assemblers for VM/ESA clients**

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembler</td>
<td>IBM Assembler</td>
</tr>
<tr>
<td>C</td>
<td>IBM C for VM Release, 3.1</td>
</tr>
<tr>
<td>COBOL</td>
<td>IBM VS COBOL II</td>
</tr>
<tr>
<td>PL/I</td>
<td>IBM OS/PL/I, Release 2.3</td>
</tr>
<tr>
<td>REXX</td>
<td>IBM VM/ESA REXX/VM</td>
</tr>
</tbody>
</table>

**Table 69. Language compilers and assemblers for Windows 98 clients**

<table>
<thead>
<tr>
<th>Language</th>
<th>Compiler/Assembler</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>IBM VisualAge for C++ for Windows, V3.5</td>
</tr>
<tr>
<td></td>
<td>Microsoft Visual C++, V4.0</td>
</tr>
<tr>
<td>C</td>
<td>Microsoft Visual C++, V4.0</td>
</tr>
<tr>
<td>COBOL</td>
<td>Micro Focus COBOL Workbench, V4.0</td>
</tr>
</tbody>
</table>
Appendix B. C language examples

The extracts in this appendix are mostly taken from the WebSphere MQ for z/OS sample applications. They are applicable to all platforms, except where noted.

The examples in this appendix demonstrate the following techniques:

- “Connecting to a queue manager” on page 526
- “Disconnecting from a queue manager” on page 526
- “Creating a dynamic queue” on page 527
- “Opening an existing queue” on page 528
- “Closing a queue” on page 529
- “Putting a message using MQPUT” on page 529
- “Putting a message using MQPUT1” on page 530
- “Getting a message” on page 532
- “Getting a message using the wait option” on page 533
- “Getting a message using signaling” on page 534
- “Inquiring about the attributes of an object” on page 536
- “Setting the attributes of a queue” on page 537
Connecting to a queue manager

This example demonstrates how to use the MQCONN call to connect a program to a queue manager in z/OS batch. This extract is taken from the Browse sample application (program CSQ4BCA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```c
#include <cmqc.h>
...
static char Parm1[MQ_Q_MGR_NAME_LENGTH] ;
...
int main(int argc, char *argv[] )
{
	/* Variables for MQ calls */
	MQHCONN Hconn; /* Connection handle */
	MQLONG CompCode; /* Completion code */
	MQLONG Reason; /* Qualifying reason */

	/* Copy the queue manager name, passed in the parm field, to Parm1 */
	strncpy(Parm1,argv[1],MQ_Q_MGR_NAME_LENGTH);

	/* Connect to the specified queue manager. */
	/* Test the output of the connect call. If the call fails, print an error message showing the */
	/* completion code and reason code, then leave the program. */
	MQCONN(Parm1,
		&Hconn,
		&CompCode,
		&Reason);

	if ((CompCode != MQCC_OK) | (Reason != MQRC_NONE))
	{
		/* Print error message showing completion code and reason code. */
		if (Reason != MQRC_NONE)
		{
			/* Print reason code. */
			PrintLine(pBuff);
			RetCode = CSQ4_ERROR;
		
goto AbnormalExit2;
		}
		/* Print completion code. */
		PrintLine(pBuff);
		RetCode = CSQ4_ERROR;
	
goto AbnormalExit2;
	}
	/* Disconnect from the queue manager. Test the output of the disconnect call. If the call */
```

Disconnecting from a queue manager

This example demonstrates how to use the MQDISC call to disconnect a program from a queue manager in z/OS batch. The variables used in this code extract are those that were set in “Connecting to a queue manager”. This extract is taken from the Browse sample application (program CSQ4BCA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.
Creating a dynamic queue

This example demonstrates how to use the MQOPEN call to create a dynamic queue. This extract is taken from the Mail Manager sample application (program CSQ4TC1D1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```c
MQLONG HCONN = 0; /* Connection handle */
MQOBJHOBJ OBJ; /* MailQ Object handle */
MQOBJHOBJ HobjTempQ; /* TempQ Object Handle */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Qualifying reason */
MQOD ObjDesc = {MQOD_DEFAULT}; /* Object descriptor */
MQLONG OpenOptions; /* Options control MQOPEN */

C: Disconnecting from a queue manager

/* fails, print an error message showing the completion code and reason code. */
MQDISC(&Hconn,
    &CompCode,
    &Reason);
if ((CompCode != MQCC_OK) || (Reason != MQRC_NONE))
{
    sprintf(pBuff, MESSAGE_4_E,
        ERROR_IN_MQDISC, CompCode, Reason);
    PrintLine(pBuff);
    RetCode = CSQ4_ERROR;
}
```

Appendix B. C language examples 527
C: Creating a dynamic queue

```c
/* queue */
/****************************************************************************/
MQMErrorHandling( "OPEN TEMPQ", CompCode,
  Reason );
ErrorFound = TRUE;
}
return ErrorFound;
```

Opening an existing queue

This example demonstrates how to use the MQOPEN call to open a queue that has already been defined. This extract is taken from the Browse sample application (program CSQ4BCA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```c
#include <cmqc.h>
:
static char Parm1[MQ_Q_MGR_NAME_LENGTH];
:
int main(int argc, char *argv[] )
{
/* Variables for MQ calls */
MQCONN Hconn ; /* Connection handle */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Qualifying reason */
MQOD ObjDesc = { MQOD_DEFAULT }; /* Object descriptor */
MQLONG OpenOptions; /* Options that control */
  /* the MQOPEN call */
MQOBJ Hobj; /* Object handle */
:
/* Copy the queue name, passed in the parm field, */
/* to Parm2 strncpy(Parm2,argv[2],MQ_Q_NAME_LENGTH); */
/* MQ_Q_NAME_LENGTH); */
/* */
/* Initialize the object descriptor (MQOD) control */
/* block. (The initialization default sets StrucId, */
/* Version, ObjectType, ObjectQMgrName, */
/* DynamicQName, and AlternateUserId fields) */
strncpy(ObjDesc.ObjectName,Parm2,MQ_Q_NAME_LENGTH);
:
/* Initialize the other fields required for the open */
/* call (Hobj is set by the MQCONN call). */
OpenOptions = MQOO_BROWSE;
:
/* Open the queue. */
/* Test the output of the open call. If the call */
/* fails, print an error message showing the */
/* completion code and reason code, then bypass */
/* processing, disconnect and leave the program. */
MQOPEN(Hconn,
&ObjDesc,
```
Closing a queue

This example demonstrates how to use the MQCLOSE call to close a queue. This extract is taken from the Browse sample application (program CSQ4BCA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```c
MQCLOSE(Hconn,
   &Hobj,
   MQCO_NONE,
   &CompCode,
   &Reason);
if ((CompCode != MQCC_OK) || (Reason != MQRC_NONE))
{
    sprintf(pBuff, MESSAGE_4_E,
            ERROR_IN_MQCLOSE, CompCode, Reason);
    PrintLine(pBuff);
    RetCode = CSQ4_ERROR;
    goto AbnormalExit1; /* disconnect processing */
}
```

Putting a message using MQPUT

This example demonstrates how to use the MQPUT call to put a message on a queue. This extract is not taken from the sample applications supplied with WebSphere MQ. For the names and locations of the sample applications, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405 and Chapter 36, “Sample programs for WebSphere MQ for z/OS”, on page 471.

```c
qput()
{
    MQMD    MsgDesc;
    MQPMO   PutMsgOpts;
    MQLONG  CompCode;
    MQLONG  Reason;
    MQHCONN Hconn;
```
C: Putting using MQPUT

MQHOBJ Hobj;
char message_buffer[] = "MY MESSAGE";
/* Set up PMO structure. */
memset(&PutMsgOpts, '\0', sizeof(PutMsgOpts));
memcpy(PutMsgOpts.StrucId, MQPMO_STRUC_ID, sizeof(PutMsgOpts.StrucId));
PutMsgOpts.Version = MQPMO_VERSION_1;
PutMsgOpts.Options = MQPMO_SYNCPOINT;
/* Set up MD structure. */
memset(&MsgDesc, '\0', sizeof(MsgDesc));
memcpy(MsgDesc.StrucId, MQMD_STRUC_ID, sizeof(MsgDesc.StrucId));
MsgDesc.Version = MQMD_VERSION_1;
MsgDesc.Expiry = MQEI_UNLIMITED;
MsgDesc.Report = MQRO_NONE;
MsgDesc.MsgType = MQMT_DATAGRAM;
MsgDesc.Priority = 1;
MsgDesc.Persistence = MQPER_PERSISTENT;
memset(MsgDesc.ReplyToQ, '\0', sizeof(MsgDesc.ReplyToQ));
MQPUT(Hconn, Hobj, &MsgDesc, &PutMsgOpts, sizeof(message_buffer), message_buffer, &CompCode, &Reason);
/* Check completion and reason codes. */
switch (CompCode)
{
    case MQCC_OK:
        break;
    case MQCC_FAILED:
        switch (Reason)
        {
            case MQRC_Q_FULL:
            case MQRC_MSG_TOO_BIG_FOR_Q:
                break;
            default:
                break; /* Perform error processing */
        }
        break;
    default:
        break; /* Perform error processing */
}

Putting a message using MQPUT1

This example demonstrates how to use the MQPUT1 call to open a queue, put a single message on the queue, then close the queue. This extract is taken from the Credit Check sample application (program CSQ4CCB5) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS), on page 405.
C: Putting using MQPUT1

```c
void Process_Query(void)
{
    /* */
    /* Build the reply message */
    /* */
    /* */
    /* */
    /* */
    /* Set the object descriptor, message descriptor and */
    /* put message options to the values required to */
    /* create the reply message. */
    /* */
    strncpy(ObjDesc.ObjectName, MsgDesc.ReplyToQ,
            MQ_Q_NAME_LENGTH);
    strncpy(ObjDesc.ObjectQMgrName, MsgDesc.ReplyToQMgr,
            MQ_Q_MGR_NAME_LENGTH);
    MsgDesc.MsgType = MQMT_REPLY;
    MsgDesc.Report = MQRO_NONE;
    memset(MsgDesc.ReplyToQ, ' ', MQ_Q_NAME_LENGTH);
    memset(MsgDesc.ReplyToQMgr, ' ', MQ_Q_MGR_NAME_LENGTH);
    memcpy(MsgDesc.MsgId, MQMI_NONE, sizeof(MsgDesc.MsgId));
    PutMsgOpts.Options = MQPMO_SYNCPOINT +
                         MQPMO_PASS_IDENTITY_CONTEXT;
    PutMsgOpts.Context = Hobj_CheckQ;
    PutBuffLen = sizeof(PutBuffer);
    MQPUT1(Hconn,
           &ObjDesc,
           &MsgDesc,
           &PutMsgOpts,
           PutBuffLen,
           &PutBuffer,
           &CompCode,
           &Reason);

    if (CompCode != MQCC_OK)
    {
        strncpy(TS_Operation, "MQPUT1",
                sizeof(TS_Operation));
        strncpy(TS_ObjName, ObjDesc.ObjectName,
                MQ_Q_NAME_LENGTH);
        Record_Call_Error();
        Forward_Msg_To_DLQ();
    }
}
```
C: Putting using MQPUT1

}  
return;
}  

Getting a message

This example demonstrates how to use the MQGET call to remove a message from
a queue. This extract is taken from the Browse sample application (program
CSQ4BCA1) supplied with WebSphere MQ for z/OS. For the names and locations
of the sample applications on other platforms, see Chapter 35, “Sample programs
(all platforms except z/OS)”, on page 405.

#include "cmqc.h"
...
#define BUFFERLENGTH 80
...
int main(int argc, char *argv[] )
{
    /* */  
    /* Variables for MQ calls */  
    /* */  
MQHCONN Hconn ; /* Connection handle */  
MQLONG CompCode; /* Completion code */  
MQLONG Reason; /* Qualifying reason */  
MQOBJ Hobj; /* Object handle */  
MQMD MsgDesc = { MQMD_DEFAULT };  
/* Message descriptor */  
MQLONG DataLength ; /* Length of the message */  
MQCHAR Buffer[BUFFERLENGTH+1];  
/* Area for message data */  
MQGMO GetMsgOpts = { MQGMO_DEFAULT };  
/* Options which control */  
/* the MQGET call */  
MQLONG BufferLength = BUFFERLENGTH ;  
/* Length of buffer */  

/* No need to change the message descriptor */  
/* (MQMD) control block because initialization */  
/* default sets all the fields. */  
/* */  
/* Initialize the get message options (MQGMO) */  
/* control block (the copy file initializes all */  
/* the other fields). */  
/* */  
GetMsgOpts.Options = MQGMO_NO_WAIT +  
MQGMO_BROWSE_FIRST +  
MQGMO_ACCEPT_TRUNCATED_MSG;
/* */  
/* Get the first message. */  
/* Test for the output of the call is carried out */  
/* in the 'for' loop. */  
/* */  
MQGET(Hconn,  
Hobj,  
&MsgDesc,  
&GetMsgOpts,  
BufferLength,  
Buffer,  
&DataLength,  
&CompCode,  
&Reason);  

532  WebSphere MQ Application Programming Guide
Getting a message using the wait option

This example demonstrates how to use the wait option of the MQGET call. This code accepts truncated messages. This extract is taken from the Credit Check sample application (program CSQ4CCB5) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS),” on page 405.

```c
MQLONG Hconn; /* Connection handle */
MQOBJ Hobj_CheckQ; /* Object handle */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Qualifying reason */
MQOD ObjDesc = {MQOD_DEFAULT};
    /* Object descriptor */
MQMD MsgDesc = {MQMD_DEFAULT};
    /* Message descriptor */
MQLONG OpenOptions; /* Control the MQOPEN call */
MQGMO GetMsgOpts = {MQGMO_DEFAULT}; /* Get Message Options */
MQLONG MsgBuffLen; /* Length of message buffer */
CSQ4BCAQ MsgBuffer; /* Message structure */
MQLONG DataLen; /* Length of message */

void main(void)
{
    /* Initialize options and open the queue for input */
    /* */
    /* */
    /* */
    /* Get and process messages */
    /* */
    GetMsgOpts.Options = MQGMO_WAIT +
        MQGMO_ACCEPT_TRUNCATED_MSG +
        MQGMO_SYNCPOINT;
    GetMsgOpts.WaitInterval = WAIT_INTERVAL;
}```
C: Get with wait option

```c
MsgBuffLen = sizeof(MsgBuffer);
memcpy(MsgDesc.MsgId, MQMI_NONE,
sizeof(MsgDesc.MsgId));
memcpy(MsgDesc.CorrelId, MQCI_NONE,
sizeof(MsgDesc.CorrelId));
/* */
/* Make the first MQGET call outside the loop */
/* */
MQGET(Hconn,
    Hobj_CheckQ,
    &MsgDesc,
    &GetMsgOpts,
    MsgBuffLen,
    &MsgBuffer,
    &DataLen,
    &CompCode,
    &Reason);

/* */
/* Test the output of the MQGET call. If the call */
/* failed, send an error message showing the */
/* completion code and reason code, unless the */
/* reason code is NO_MSG AVAILABLE. */
/* */
if (Reason != MQRC_NO_MSG_AVAILABLE)
{
    strncpy(TS_Operation, "MQGET", sizeof(TS_Operation));
    strncpy(TS_ObjName, ObjDesc.ObjectName,
            MQ_Q_NAME_LENGTH);
    Record_Call_Error();
}
```

Getting a message using signaling

Signaling is available only with WebSphere MQ for z/OS.

This example demonstrates how to use the MQGET call to set a signal so that you are notified when a suitable message arrives on a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```c
get_set_signal()
{
    MQMD MsgDesc;
    MQGMO GetMsgOpts;
    MQLONG CompCode;
    MQLONG Reason;
    MQHCONN Hconn;
    MQHOBJ Hobj;
    MQLONG BufferLength;
    MQLONG DataLength;
    char message_buffer[100];
    long int q_ecb, work_ecb;
    short int signal_sw, endloop;
    long int mask = 255;

    /*--------------------*/
    /* Set up GMO structure. */
    /*--------------------*/
    memset(&GetMsgOpts,'\0',sizeof(GetMsgOpts));
    memcpy(GetMsgOpts.StrucId, MQGMO_STRUC_ID,
            sizeof(GetMsgOpts.StrucId));
    GetMsgOpts.Version = MQGMO_VERSION_1;
```
GetMsgOpts.WaitInterval = 1000;
GetMsgOpts.Options = MQGMO_SET_SIGNAL +
MQGMO_BROWSE_FIRST;
q_ecb = 0;
GetMsgOpts.Signal1 = &q_ecb;
/*-----------------------------------------------------------*/
/* Set up MD structure. */
/*-----------------------------------------------------------*/
memset(&MsgDesc, '0', sizeof(MsgDesc));
memcpy(MsgDesc.StrucId, MQMD_STRUC_ID,
sizeof(MsgDesc.StrucId));
MsgDesc.Version = MQMD_VERSION_1;
MsgDesc.Report = MQRO_NONE;
memcpy(MsgDesc.MsgId, MQMI_NONE,
sizeof(MsgDesc.MsgId));
memcpy(MsgDesc.CorrelId, MQCI_NONE,
sizeof(MsgDesc.CorrelId));
/*-----------------------------------------------------------*/
/* Issue the MQGET call. */
/*-----------------------------------------------------------*/
BufferLength = sizeof(message_buffer);
signal_sw = 0;
MQGET(Hconn, Hobj, &MsgDesc, &GetMsgOpts,
BufferLength, message_buffer, &DataLength,
&CompCode, &Reason);
/*-----------------------------------------------------------*/
/* Check completion and reason codes. */
/*-----------------------------------------------------------*/
switch (CompCode)
{
  case (MQCC_OK): /* Message retrieved */
    break;
  case (MQCC_WARNING):
    switch (Reason)
    {
      case (MQRC_SIGNAL_REQUEST_ACCEPTED):
        signal_sw = 1;
        break;
      default:
        break; /* Perform error processing */
    }
    break;
  case (MQCC_FAILED):
    switch (Reason)
    {
      case (MQRC_Q_MGR_NOT_AVAILABLE):
      case (MQRC_CONNECTION_BROKEN):
      case (MQRC_Q_MGR_STOPPING):
        break;
      default:
        break; /* Perform error processing. */
    }
    break;
  default:
    break; /* Perform error processing. */
}
/*-----------------------------------------------------------*/
/* If the SET_SIGNAL was accepted, set up a loop to */
/* check whether a message has arrived at one second */
/* intervals. The loop ends if a message arrives or */
/* the wait interval specified in the MQGMO */
/* structure has expired. */
/* */
/* If a message arrives on the queue, another MQGET */
/* must be issued to retrieve the message. If other */
/* MQM calls have been made in the intervening */

C: Getting with signaling

Appendix B. C language examples  535
C: Getting with signaling

/* period, this may necessitate reinitializing the */
/* MQMD and MQGMO structures. */
/* In this code, no intervening calls */
/* have been made, so the only change required to */
/* the structures is to specify MQGMO_NO_WAIT, */
/* since we now know the message is there. */
/* */
/* This code uses the EXEC CICS DELAY command to */
/* suspend the program for a second. A batch program */
/* may achieve the same effect by calling an */
/* assembler language subroutine which issues a */
/* z/OS STIMER macro. */
/*---------------------------------------------------*/

if (signal_sw == 1)
{   
    endloop = 0;
    do
    
    EXEC CICS DELAY FOR HOURS(0) MINUTES(0) SECONDS(1);
    work_ecb = q_ecb & mask;
    switch (work_ecb)
    
    case (MQEC_MSG_ARRIVED):
        endloop = 1;
        mqgmo_options = MQGMO_NO_WAIT;
        MQGET(Hconn, Hobj, &MsgDesc, &GetMsgOpts,
        BufferLength, message_buffer,
        &DataLength, &CompCode, &Reason);
        if (CompCode != MQCC_OK)
            /* Perform error processing. */
            break;
        case (MQEC_WAIT_INTERVAL_EXPIRED):
        case (MQEC_WAIT_CANCELED):
            endloop = 1;
            break;
        default:
            break;
    }
    while (endloop == 0);
}
return;

Inquiring about the attributes of an object

This example demonstrates how to use the MQINQ call to inquire about the attributes of a queue. This extract is taken from the Queue Attributes sample application (program CSQ4CCC1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405

#include <cmqc.h> /* MQ API header file */

#define NUMBEROFSELECTORS 2

const MQHCONN Hconn = MQHC_DEF_HCONN;

static void InquireGetAndPut(char *Message,
    PMQHOBJ pHobj,
    char *Object)
{
    /* Declare local variables */
    MQLONGLONG SelectorCount = NUMBEROFSELECTORS;
C: Inquiring about attributes

```c
/* Number of selectors */
MQLONG IntAttrCount = NUMBEROFSELECTORS;
/* Number of int attrs */
MQLONG CharAttrLength = 0;
/* Length of char attribute buffer */
MQCHAR *CharAttrs ;
/* Character attribute buffer */
MQLONG SelectorsTable[NUMBEROFSELECTORS];
/* attribute selectors */
MQLONG IntAttrsTable[NUMBEROFSELECTORS];
/* integer attributes */
MQLONG CompCode; /* Completion code */
MQLONG Reason; /* Qualifying reason */
/* Open the queue. If successful, do the inquire */
/* call. */
/* */
/* Initialize the variables for the inquire */
/* call: */
/* - Set SelectorsTable to the attributes whose */
/* status is */
/* required */
/* - All other variables are already set */
SelectorsTable[0] = MQIA_INHIBIT_GET;
SelectorsTable[1] = MQIA_INHIBIT_PUT;
/* */
/* Issue the inquire call */
/* */
/* Test the output of the inquire call. If the */
/* call failed, display an error message */
/* showing the completion code and reason code, */
/* otherwise display the status of the */
/* INHIBIT-GET and INHIBIT-PUT attributes */
MQINQ(Hconn, *pHobj, SelectorCount, SelectorsTable, IntAttrCount, IntAttrsTable, CharAttrLength, CharAttrs, &CompCode, &Reason);
if (CompCode != MQCC_OK)
{
    sprintf(Message, MESSAGE_4_E, ERROR_IN_MQINQ, CompCode, Reason);
    SetMsg(Message);
}
else
{
    /* Process the changes */
} /* end if CompCode */
```

Setting the attributes of a queue

This example demonstrates how to use the MQSET call to change the attributes of a queue. This extract is taken from the Queue Attributes sample application (program CSQ4CCC1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.
C: Setting queue attributes

```c
#include <cmqc.h> /* MQ API header file */
:
#define NUMBEROFSELECTORS 2
const MQCONN Hconn = MQHC_DEF_HCONN;

static void InhibitGetAndPut(char *Message,
                          PMQHOBJ pHobj,
                          char *Object)
{
    /* Declare local variables */
    MQLONG SelectorCount = NUMBEROFSELECTORS; /* Number of selectors */
    MQLONG IntAttrCount = NUMBEROFSELECTORS;  /* Number of int attrs */
    MQLONG CharAttrLength = 0; /* Length of char attribute buffer */
    MQCHAR *CharAttrs; /* Character attribute buffer */
    MQLONG SelectorsTable[NUMBEROFSELECTORS]; /* attribute selectors */
    MQLONG IntAttrsTable[NUMBEROFSELECTORS]; /* integer attributes */
    MQLONG CompCode; /* Completion code */
    MQLONG Reason; /* Qualifying reason */
    :
    /* Open the queue. If successful, do the */
    /* inquire call. */
    :
    /* Initialize the variables for the set call: */
    /* - Set SelectorsTable to the attributes to be */
    /*   set */
    /* - Set IntAttrsTable to the required status */
    /* - All other variables are already set */
    SelectorsTable[0] = MQIA_INHIBIT_GET;
    SelectorsTable[1] = MQIA_INHIBIT_PUT;
    IntAttrsTable[0] = MQQA_GET_INHIBITED;
    IntAttrsTable[1] = MQQA_PUT_INHIBITED;
    :
    /* Issue the set call. */
    MQSET(Hconn,
          *pHobj,
          SelectorCount,
          SelectorsTable,
          IntAttrCount,
          IntAttrsTable,
          CharAttrLength,
          CharAttrs,
          &CompCode,
          &Reason);
    if (CompCode != MQCC_OK)
    {
```
C: Setting queue attributes

```c
    sprintf(Message, MESSAGE_4_E,
            ERROR_IN_MQSET, CompCode, Reason);
    SetMsg(Message);
} else
    { /* Process the changes */
    } /* end if CompCode */
```
Appendix C. COBOL examples

The examples in this appendix are taken from the WebSphere MQ for z/OS sample applications. They are applicable to all platforms, except where noted.

The examples in this appendix demonstrate the following techniques:

- “Connecting to a queue manager” on page 542
- “Disconnecting from a queue manager” on page 542
- “Creating a dynamic queue” on page 543
- “Opening an existing queue” on page 544
- “Closing a queue” on page 546
- “Putting a message using MQPUT” on page 546
- “Putting a message using MQPUT1” on page 548
- “Getting a message” on page 549
- “Getting a message using the wait option” on page 551
- “Getting a message using signaling” on page 552
- “Inquiring about the attributes of an object” on page 555
- “Setting the attributes of a queue” on page 556
Connecting to a queue manager

This example demonstrates how to use the MQCONN call to connect a program to a queue manager in z/OS batch. This extract is taken from the Browse sample application (program CSQ4BVA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```cobol
* WORKING-STORAGE SECTION.
* W02 - Data fields derived from the PARM field
  01 W02-MQM PIC X(48) VALUE SPACES.
* W03 - MQM API fields
  01 W03-HCONN PIC S9(9) BINARY.
  01 W03-COMPCODE PIC S9(9) BINARY.
  01 W03-REASON PIC S9(9) BINARY.
* MQV contains constants (for filling in the control blocks) and return codes (for testing the result of a call)
  01 W05-MQM-CONSTANTS.
  COPY CMQV SUPPRESS.
  ...
  UNSTRING PARM-STRING DELIMITED BY ALL ','
     INTO W02-MQM
     W02-OBJECT.
  ...
  Connect to the specified queue manager.
  CALL 'MQCONN' USING W02-MQM
    W03-HCONN
    W03-COMPCODE
    W03-REASON.
  * Test the output of the connect call. If the call fails, print an error message showing the completion code and reason code.
  IF (W03-COMPCODE NOT = MQCC-OK) THEN
    ...
  END-IF.
  ...
```

Disconnecting from a queue manager

This example demonstrates how to use the MQDISC call to disconnect a program from a queue manager in z/OS batch. The variables used in this code extract are those that were set in “Connecting to a queue manager”. This extract is taken from the Browse sample application (program CSQ4BVA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```cobol
  ...
  * Disconnect from the queue manager
```
CALL 'MQDISC' USING W03-HCONN
   W03-COMPCODE
   W03-REASON.

Test the output of the disconnect call. If the
call fails, print an error message showing the
completion code and reason code.

IF (W03-COMPCODE NOT = MQCC-OK) THEN...
   END-IF.

Creating a dynamic queue

This example demonstrates how to use the MQOPEN call to create a dynamic
queue. This extract is taken from the Credit Check sample application (program
CSQ4CVB1) supplied with WebSphere MQ for z/OS. For the names and locations
of the sample applications on other platforms, see Chapter 35, “Sample programs
(all platforms except z/OS)”, on page 405.
COBOL: Creating a dynamic queue

* This section creates a temporary dynamic queue
* using a model queue
* -------------------------------------------------------*
* Change three fields in the Object Descriptor (MQOD)
* control block. (MQODV initializes the other fields)
* MOVE MQOT-Q TO MQOD-OBJECTTYPE.
MOVE W02-MODEL-QNAME TO MQOD-OBJECTNAME.
MOVE W02-NAME-PREFIX TO MQOD-DYNAMICQNAME.
* COMPUTE W03-OPTIONS = MQOO-INPUT-EXCLUSIVE.
* CALL 'MQOPEN' USING W03-HCONN
  MQOD
  W03-OPTIONS
  W03-HOBJ-MODEL
  W03-COMPCODE
  W03-REASON.
* IF W03-COMPCODE NOT = MQCC-OK
  MOVE 'MQOPEN' TO M01-MSG4-OPERATION
  MOVE W03-COMPCODE TO M01-MSG4-COMPCODE
  MOVE W03-REASON TO M01-MSG4-REASON
  MOVE M01-MESSAGE-4 TO M00-MESSAGE
ELSE
  MOVE MQOD-OBJECTNAME TO W02-TEMPORARY-Q
END-IF.
* OPEN-TEMP-RESPONSE-QUEUE-EXIT.
* Return to performing section.
* EXIT.
EJECT
*

Opening an existing queue

This example demonstrates how to use the MQOPEN call to open an existing queue. This extract is taken from the Browse sample application (program CSQ4BVA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405
CMQODV defines the object descriptor (MQOD)

01 MQM-OBJECT-DESCRIPTOR.
   COPY CMQODV.

CMQV contains constants (for setting or testing
* field values) and return codes (for testing the
* result of a call)

01 MQM-CONSTANTS.
   COPY CMQV SUPPRESS.

-----------------------------------------------
E-OPEN-QUEUE SECTION.
-----------------------------------------------

This section opens the queue

Initialize the Object Descriptor (MQOD) control
block
(The copy file initializes the remaining fields.)

MOVE MQOT-Q TO MQOD-OBJECTTYPE.
MOVE W01-OBJECT TO MQOD-OBJECTNAME.

Initialize W02-OPTIONS to open the queue for both
inquiring about and setting attributes

COMPUTE W02-OPTIONS = MQOO-INQUIRE + MQOO-SET.

Open the queue

CALL 'MQOPEN' USING W02-HCONN
   MQOD
   W02-OPTIONS
   W02-HOBJ
   W02-COMPCODE
   W02-REASON.

Test the output from the open

If the completion code is not OK, display a
* separate error message for each of the following
* errors:
* Q-MGR-NOT-AVAILABLE - MQM is not available
* CONNECTION-BROKEN - MQM is no longer connected to CICS
* UNKNOWN-OBJECT-NAME - The queue does not exist
* NOT-AUTHORIZED - The user is not authorized to open
* the queue

For any other error, display an error message
* showing the completion and reason codes

IF W02-COMPCODE NOT = MQCC-OK
   EVALUATE TRUE
* WHEN W02-REASON = MQRC-Q-MGR-NOT-AVAILABLE
   MOVE M01-MESSAGE-6 TO M00-MESSAGE
* WHEN W02-REASON = MQRC-CONNECTION-BROKEN
   MOVE M01-MESSAGE-6 TO M00-MESSAGE
* WHEN W02-REASON = MQRC-UNKNOWN-OBJECT-NAME
   MOVE M01-MESSAGE-2 TO M00-MESSAGE
* WHEN W02-REASON = MQRC-NOT-AUTHORIZED
   MOVE M01-MESSAGE-3 TO M00-MESSAGE
COBOL: Opening an existing queue

* WHEN OTHER
  MOVE 'MQOPEN' TO M01-MSG4-OPERATION
  MOVE W02-COMPCODE TO M01-MSG4-COMPCODE
  MOVE W02-REASON TO M01-MSG4-REASON
  MOVE M01-MESSAGE-4 TO M00-MESSAGE
END-EVALUATE
E-EXIT.
* *
* Return to performing section
* EXIT.
EJECT

Closing a queue

This example demonstrates how to use the MQCLOSE call. The variables used in this code extract are those that were set in “Connecting to a queue manager” on page 542. This extract is taken from the Browse sample application (program CSQ4BVA1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

*: *
* Close the queue
* MOVE MQCO-NONE TO W03-OPTIONS.
* CALL 'MQCLOSE' USING W03-HCONN
  W03-HOBJ
  W03-OPTIONS
  W03-COMPCODE
  W03-REASON.
* *
* Test the output of the MQCLOSE call. If the call fails, print an error message showing the completion code and reason code.
* IF (W03-COMPCODE NOT = MQCC-OK) THEN
  MOVE 'CLOSE' TO W04-MSG4-TYPE
  MOVE W03-COMPCODE TO W04-MSG4-COMPCODE
  MOVE W03-REASON TO W04-MSG4-REASON
  MOVE W04-MESSAGE-4 TO W00-PRINT-DATA
  PERFORM PRINT-LINE
  MOVE W06-CSQ4-ERROR TO W00-RETURN-CODE
END-IF.
*

Putting a message using MQPUT

This example demonstrates how to use the MQPUT call using context. This extract is taken from the Credit Check sample application (program CSQ4CVB1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

*: *
* -------------------------------------------------------*
WORKING-STORAGE SECTION.
* -------------------------------------------------------*
* W02 - Queues processed in this program
* W03 - MQM API fields
* 01 W02-TEMPORARY-Q PIC X(48).
* 01 W03-HCONN PIC S9(9) BINARY VALUE ZERO.
 01 W03-HOBJ-INQUIRY PIC S9(9) BINARY.
 01 W03-OPTIONS PIC S9(9) BINARY.
 01 W03-BUFFLEN PIC S9(9) BINARY.
 01 W03-COMPCODE PIC S9(9) BINARY.
 01 W03-REASON PIC S9(9) BINARY.
* 01 W03-PUT-BUFFER.
* 05 W03-CSQ4BIIM.
  COPY CSQ4VB1.
* API control blocks
* 01 MQM-MESSAGE-DESCRIPTR.
  COPY CMQMDV.
  01 MQM-PUT-MESSAGE-OPTIONS.
  COPY CMQPMOV.
* MQV contains constants (for filling in the control blocks) and return codes (for testing the result of a call).
* 01 MQV-CONSTANTS.
  COPY CMQV SUPPRESS.
* -------------------------------------------------------*
PROCEDURE DIVISION.
* -------------------------------------------------------*
* Open queue and build message.
* Set the message descriptor and put-message options to the values required to create the message.
* Set the length of the message.
* MOVE MQMT-REQUEST TO MQMD-MSGTYPE.
  MOVE MQCI-NONE TO MQMD-CORRELID.
  MOVE MQMI-NONE TO MQMD-MSGID.
  MOVE W02-TEMPORARY-Q TO MQMD-REPLYTOQ.
  MOVE SPACES TO MQMD-REPLYTOQMGR.
  MOVE 5 TO MQMD-PRIORITY.
  MOVE MQPER-NOT-PERSISTENT TO MQMD-PERSISTENCE.
  COMPUTE MQPMO-OPTIONS = MQPMO-NO-SYNCPOINT + MQPMO-DEFAULT-CONTEXT.
  MOVE LENGTH OF CSQ4BIIM-MSG TO W03-BUFFLEN.
* CALL 'MQPUT' USING W03-HCONN
  W03-HOBJ-INQUIRY
  MQMD
  MQPMO
  W03-BUFFLEN
  W03-PUT-BUFFER
  W03-COMPCODE
  W03-REASON.
  IF W03-COMPCODE NOT = MQCC-OK
COBOL: Putting using MQPUT

putting a message using MQPUT1

This example demonstrates how to use the MQPUT1 call. This extract is taken from the Credit Check sample application (program CSQ4CVB5) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)” on page 405.

* -------------------------------------------------------*
WORKING-STORAGE SECTION.
* -------------------------------------------------------*
* W03 - MQM API fields
* 01 W03-HCONN    PIC S9(9) BINARY VALUE ZERO.
  01 W03-OPTIONS  PIC S9(9) BINARY.
  01 W03-COMPCODE PIC S9(9) BINARY.
  01 W03-REASON   PIC S9(9) BINARY.
  01 W03-BUFFLEN  PIC S9(9) BINARY.
  01 W03-PUT-BUFFER.
      05 W03-CSQ4BQR.
          COPY CSQ4VB4.
*  API control blocks
*  01 MQM-OBJECT-DESCRIPTOR.
      COPY CMQODV.
  01 MQM-MESSAGE-DESCRIPTOR.
      COPY CMQMDV.
  01 MQM-PUT-MESSAGE-OPTIONS.
      COPY CMQPMOV.
*  CMQV contains constants (for filling in the
*  control blocks) and return codes (for testing
*  the result of a call).
*  01 MQM-MQV.
      COPY CMQV SUPPRESS.
* -------------------------------------------------------*
PROCEDURE DIVISION.
* -------------------------------------------------------*
* Get the request message.
* -------------------------------------------------------*
PROCESS-QUERY SECTION.
* -------------------------------------------------------*
* Build the reply message.
* -------------------------------------------------------*
  * Set the object descriptor, message descriptor and
  * put-message options to the values required to create
  * the message.
  * Set the length of the message.
  MOVE MQMD-REPLYTOQ TO MQOD-OBJECTNAME.
move mqmd-replytoqmgr to mqod-objectqmgrname.
move mqmt-reply to mqmd-msgtype.
move spaces to mqmd-replytoq.
move spaces to mqmd-replytoqmgr.
move low-values to mqmd-msgid.
compute mqpmo-options = mqpmo-syncpoint +
mqpmo-pass-identity-context.
move w03-hobj-checkq to mqpmo-context.
move length of csq4bqrm-msg to w03-bufflen.

* call 'mqput1' using w03-hconn
  mqod
  mqmd
  mqpmo
  w03-bufflen
  w03-put-buffer
  w03-compcode
  w03-reason.
if w03-compcode not = mqcc-ok
  move 'mqput1' to m02-operation
  move mqod-objectname to m02-objectname
  perform record-call-error
  perform forward-msg-to-dlq
end-if.

getting a message

this example demonstrates how to use the mqget call to remove a message from
a queue. this extract is taken from the credit check sample application (program
csq4cvb1) supplied with websphere mq for z/os. for the names and locations
of the sample applications on other platforms, see chapter 35, “sample programs
(all platforms except z/os)”, on page 405.

* -------------------------------------------------------*
* working-storage section.
* -------------------------------------------------------*
* w03 - mqm api fields
* 01 w03-hconn pic s9(9) binary value zero.
  01 w03-hobj-response pic s9(9) binary.
  01 w03-options pic s9(9) binary.
  01 w03-bufflen pic s9(9) binary.
  01 w03-datalen pic s9(9) binary.
  01 w03-compcode pic s9(9) binary.
  01 w03-reason pic s9(9) binary.
* 01 w03-get-buffer.
   05 w03-csq4bam.
   copy csq4vb2.
* api control blocks
* 01 mqm-message-descriptor.
   copy cmqmdv.
  01 mqm-get-message-options.
   copy cmqmov.
* mqv contains constants (for filling in the
* control blocks) and return codes (for testing
* the result of a call).
COBOL: Getting a message

01 MQM-CONSTANTS.
   COPY CMQV SUPPRESS.
* -------------------------------------------------------*
A-MAIN SECTION.
* -------------------------------------------------------*
:  
* Open response queue.
:  
* -------------------------------------------------------*
PROCESS-RESPONSE-SCREEN SECTION.
* -------------------------------------------------------*
**
* This section gets a message from the response queue. *
* When a correct response is received, it is *
* transferred to the map for display; otherwise *
* an error message is built. *
* -------------------------------------------------------*
**
* Set get-message options
* COMPUTE MQGMO-OPTIONS = MQGMO-SYNCPPOINT +
   MQGMO-ACCEPT-TRUNCATED-MSG +
   MQGMO-NO-WAIT.
* Set msgid and correlid in MQMD to nulls so that any *
* message will qualify.
* Set length to available buffer length.
* MOVE MQMI-NONE TO MQMD-MSGID.
MOVE MQCI-NONE TO MQMD-CORRELID.
MOVE LENGTH OF W03-GET-BUFFER TO W03-BUFFLEN.
* CALL MQGET USING W03-HCONN
   W03-HOBJ-RESPONSE
   MQMD
   MQGMO
   W03-BUFFLEN
   W03-GET-BUFFER
   W03-DATALEN
   W03-COMPCODE
   W03-REASON.
EVALUATE TRUE
  WHEN W03-COMPCODE NOT = MQCC-FAILED...
  WHEN (W03-COMPCODE = MQCC-FAILED AND
   W03-REASON = MQRC-NO-MSG-AVAILABLE)
    MOVE M01-MESSAGE-9 TO M00-MESSAGE
    PERFORM CLEAR-RESPONSE-SCREEN
  WHEN OTHER
    MOVE 'MQGET ' TO M01-MSG4-OPERATION
    MOVE W03-COMPCODE TO M01-MSG4-COMPCODE
    MOVE W03-REASON TO M01-MSG4-REASON
    MOVE M01-MESSAGE-4 TO M00-MESSAGE
    PERFORM CLEAR-RESPONSE-SCREEN
END-EVALUATE.
Getting a message using the wait option

This example demonstrates how to use the MQGET call with the wait option and accepting truncated messages. This extract is taken from the Credit Check sample application (program CSQ4CVB5) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS),” on page 405.

```
WORKING-STORAGE SECTION.
* -------------------------------------------------------*
* W00 - General work fields
* 01 W00-WAIT-INTERVAL PIC S9(09) BINARY VALUE 30000.
* W03 - MQM API fields
* 01 W03-HCONN PIC S9(9) BINARY VALUE ZERO.
  01 W03-OPTIONS PIC S9(9) BINARY.
  01 W03-HOBJ-CHECKQ PIC S9(9) BINARY.
  01 W03-COMPCODE PIC S9(9) BINARY.
  01 W03-REASON PIC S9(9) BINARY.
  01 W03-DATALEN PIC S9(9) BINARY.
  01 W03-BUFFLEN PIC S9(9) BINARY.
* 01 W03-MSG-BUFFER.
   05 W03-CSQ4BCAQ.
      COPY CSQ4VB3.
* API control blocks
* 01 MQM-MESSAGE-DESCRIPTOR.
   COPY CMQMDV.
  01 MQM-GET-MESSAGE-OPTIONS.
   COPY CMQGMOV.
* CMQV contains constants (for filling in the
* control blocks) and return codes (for testing
* the result of a call).
* 01 MQM-MQV.
   COPY CMQV SUPPRESS.
* -------------------------------------------------------*
PROCEDURE DIVISION.
* -------------------------------------------------------*
   :  Open input queue.
   :
   :
   * Get and process messages.
   * COMPUTE MQGMO-OPTIONS = MQGMO-WAIT +
      MQGMO-ACCEPT-TRUNCATED-MSG +
      MQGMO-SYNCPPOINT.
   MOVE LENGTH OF W03-MSG-BUFFER TO W03-BUFFLEN.
   MOVE W00-WAIT-INTERVAL TO MQGMO-WAITINTERVAL.
   MOVE MQMI-NONE TO MQMO-MSGID.
   MOVE MQCI-NONE TO MQMO-CORRELID.
* Make the first MQGET call outside the loop.
*```
CALL 'MQGET' USING W03-HCONN
W03-HOBJ-CHECKQ
MQMD
MQGMO
W03-BUFFLEN
W03-MSG-BUFFER
W03-DATALEN
W03-COMPCODE
W03-REASON.

* Test the output of the MQGET call using the
* PERFORM loop that follows.
* 
* Perform whilst no failure occurs
* - process this message
* - reset the call parameters
* - get another message
* End-perform
* ...
* Test the output of the MQGET call. If the call
* fails, send an error message showing the
* completion code and reason code, unless the
* completion code is NO-MSG-AVAILABLE.
* 
* IF (W03-COMPCODE NOT = MQCC-FAILED) OR
* (W03-REASON NOT = MQRC-NO-MSG-AVAILABLE)
* MOVE 'MQGET ' TO M02-OPERATION
* MOVE MQOD-OBJECTNAME TO M02-OBJECTNAME
* PERFORM RECORD-CALL-ERROR
* END-IF.

Getting a message using signaling

Signaling is available only with WebSphere MQ for z/OS.

This example demonstrates how to use the MQGET call with signaling. This
extract is taken from the Credit Check sample application (program CSQ4CVB2)
supplied with WebSphere MQ for z/OS.

* -------------------------------------------------------*
* WORKING-STORAGE SECTION.                             *
* -------------------------------------------------------*
* * W00 - General work fields                          *
* * W03 - MQM API fields                               *
* 01 W00-WAIT-INTERVAL PIC S9(09) BINARY VALUE 30000. *
* 01 W03-HCONN PIC S9(9) BINARY VALUE ZERO.            *
* 01 W03-HOBJ-REPLYQ PIC S9(9) BINARY.                 *
* 01 W03-COMPCODE PIC S9(9) BINARY.                    *
* 01 W03-REASON PIC S9(9) BINARY.                      *
* 01 W03-DATALEN PIC S9(9) BINARY.                     *
* 01 W03-BUFFLEN PIC S9(9) BINARY.                     *
* 01 W03-GET-BUFFER.                                   *
* 05 W03-CSQ4BQRM.                                      *
* COPY CSQ4VB4.
* 05 W03-CSQ4BIIM REDEFINES W03-CSQ4BQRM.
  COPY CSQ4VB1.
* 05 W03-CSQ4BPQM REDEFINES W03-CSQ4BIIM.
  COPY CSQ4VB5.
::
* API control blocks
* 01 MQM-MESSAGE-DECORATOR.
  COPY CMQMDV.
  01 MQM-GET-MESSAGE-OPTIONS.
  COPY CMQGMOV.
::
* MQV contains constants (for filling in the
* control blocks) and return codes (for testing
* the result of a call).
* 01 MQM-MQV.
  COPY CMQV SUPPRESS.
* -------------------------------------------------------*
LINKAGE SECTION.
* -------------------------------------------------------*
  01 L01-ECB-ADDR-LIST.
    05 L01-ECB-ADDR1 POINTER.
    05 L01-ECB-ADDR2 POINTER.
* 01 L02-ECBS.
    05 L02-INQUIRY-ECB1 PIC S9(09) BINARY.
    05 L02-REPLY-ECB2 PIC S9(09) BINARY.
  01 REDEFINES L02-ECBS.
    05 PIC X(02).
    05 L02-INQUIRY-ECB1-CC PIC S9(04) BINARY.
    05 PIC X(02).
    05 L02-REPLY-ECB2-CC PIC S9(04) BINARY.
* -------------------------------------------------------*
PROCEDURE DIVISION.
* -------------------------------------------------------*
  ...
* Initialize variables, open queues, set signal on
* inquiry queue.
  ...
* -------------------------------------------------------*
PROCESS-SIGNAL-ACCEPTED SECTION.
* -------------------------------------------------------*
* This section gets a message with signal. If a
* message is received, process it. If the signal
* is set or is already set, the program goes into
* an operating system wait.
* Otherwise an error is reported and call error set.
  *--------------------------------------------------------*
* PERFORM REPLYQ-GETSIGNAL.
* EVALUATE TRUE
  WHEN (W03-COMPCODE = MQCC-OK AND
        W03-REASON = MQRC-NONE)
    PERFORM PROCESS-REPLYQ-MESSAGE
*  WHEN (W03-COMPCODE = MQCC-WARNING AND
        W03-REASON = MQRC-SIGNAL-REQUEST-ACCEPTED)
        OR
        (W03-COMPCODE = MQCC-FAILED AND
         W03-REASON = MQRC-SIGNAL-OUTSTANDING)
    PERFORM EXTERNAL-WAIT

Appendix C. COBOL examples 553
WHEN OTHER
  MOVE 'MQGET SIGNAL' TO M02-OPERATION
  MOVE MQOD-OBJECTNAME TO M02-OBJECTNAME
  PERFORM RECORD-CALL-ERROR
  MOVE W06-CALL-ERROR TO W06-CALL-STATUS
END-EVALUATE.
*
PROCESS-SIGNAL-ACCEPTED-EXIT.
  * Return to performing section
  EXIT.
  EJECT

EXTERNAL-WAIT SECTION.
* This section performs an external CICS wait on two ECBs until at least one is posted. It then calls the sections to handle the posted ECB.
* EXEC CICS WAIT EXTERNAL
  ECBLIST(W04-ECB-ADDR-LIST-PTR)
  NUMEVENTS(2)
END-EXEC.
*
  At least one ECB must have been posted to get to this point. Test which ECB has been posted and perform the appropriate section.
*
  IF L02-INQUIRY-ECB1 NOT = 0
    PERFORM TEST-INQUIRYQ-ECB
  ELSE
    PERFORM TEST-REPLYQ-ECB
  END-IF.
*
EXTERNAL-WAIT-EXIT.
*  * Return to performing section.
*  EXIT.
  EJECT
:
REPLYQ-GETSIGNAL SECTION.
* This section performs an MQGET call (in syncpoint with signal) on the reply queue. The signal field in the MQGMO is set to the address of the ECB. Response handling is done by the performing section.
*
  COMPUTE MQGMO-OPTIONS = MQGMO-SYNCPOINT + MQGMO-SET-SIGNAL.
  MOVE W00-WAIT-INTERVAL TO MQGMO-WAITINTERVAL.
  MOVE LENGTH OF W03-GET-BUFFER TO W03-BUFFLEN.
*
  MOVE ZEROS TO L02-REPLY-ECB2.
  SET MQGMO-SIGNAL1 TO ADDRESS OF L02-REPLY-ECB2.
*
  Set msgid and correlid to nulls so that any message will qualify.
*
  MOVE MQMI-NONE TO MQMD-MSGID.
  MOVE MQCI-NONE TO MQMD-CORRELID.
Inquiring about the attributes of an object

This example demonstrates how to use the MQINQ call to inquire about the attributes of a queue. This extract is taken from the Queue Attributes sample application (program CSQ4CVC1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

```cobol
* -------------------------------------------------------*
WORKING-STORAGE SECTION.
* -------------------------------------------------------*
* W02 - MQM API fields
* 01 W02-SELECTORCOUNT PIC S9(9) BINARY VALUE 2.
  01 W02-INTATTRCOUNT PIC S9(9) BINARY VALUE 2.
  01 W02-CHARATTRLENGTH PIC S9(9) BINARY VALUE ZERO.
  01 W02-CHARATTRS PIC X VALUE LOW-VALUES.
  01 W02-HCONN PIC S9(9) BINARY VALUE ZERO.
  01 W02-HOBJ PIC S9(9) BINARY.
  01 W02-COMPCODE PIC S9(9) BINARY.
  01 W02-REASON PIC S9(9) BINARY.
  01 W02-SELECTORS-TABLE.
    05 W02-SELECTORS PIC S9(9) BINARY OCCURS 2 TIMES
  01 W02-INTATTR-TABLE.
    05 W02-INTATTR PIC S9(9) BINARY OCCURS 2 TIMES
* CMQODV defines the object descriptor (MQOD).
* 01 MQM-OBJECT-DESCRIPTOR.
  COPY CMQODV.
* CMQV contains constants (for setting or testing field values) and return codes (for testing the result of a call).
* 01 MQM-CONSTANTS.
  COPY CMQV SUPPRESS.
* PROCEDURE DIVISION.
* Get the queue name and open the queue.
```
COBOL: Inquiring about attributes

* Initialize the variables for the inquiry call:
* - Set W02-SELECTORS-TABLE to the attributes whose
  status is required
* - All other variables are already set
  
  MOVE MQIA-INHIBIT-GET TO W02-SELECTORS(1).
  MOVE MQIA-INHIBIT-PUT TO W02-SELECTORS(2).

  * Inquire about the attributes.
  
  CALL 'MQINQ' USING W02-HCONN,
          W02-HOBJ,
          W02-SELECTORCOUNT,
          W02-SELECTORS-TABLE,
          W02-INTATTRCOUNT,
          W02-INTATTRS-TABLE,
          W02-CHARATTRLENGTH,
          W02-CHARATTRS,
          W02-COMPCODE,
          W02-REASON.

  * Test the output from the inquiry:
  * - If the completion code is not OK, display an error
    message showing the completion and reason codes
  * - Otherwise, move the correct attribute status into
    the relevant screen map fields
  *
  IF W02-COMPCODE NOT = MQCC-OK
    MOVE 'MQINQ' TO M01-MSG4-OPERATION
    MOVE W02-COMPCODE TO M01-MSG4-COMPCODE
    MOVE W02-REASON TO M01-MSG4-REASON
    MOVE M01-MESSAGE-4 TO M00-MESSAGE
  *
  ELSE
    * Process the changes.
      :
      END-IF.
      :

Setting the attributes of a queue

This example demonstrates how to use the MQSET call to change the attributes of a queue. This extract is taken from the Queue Attributes sample application (program CSQ4CVC1) supplied with WebSphere MQ for z/OS. For the names and locations of the sample applications on other platforms, see Chapter 35, “Sample programs (all platforms except z/OS)”, on page 405.

  :
  * Working-storage section.
  * Working-storage section.
  *
  * W02 - MQM API fields
  *
  01 W02-SELECTORCOUNT PIC S9(9) BINARY VALUE 2.
  01 W02-INTATTRCOUNT PIC S9(9) BINARY VALUE 2.
  01 W02-CHARATTRLENGTH PIC S9(9) BINARY VALUE ZERO.
  01 W02-CHARATTRS PIC X VALUE LOW-VALUES.
01 W02-HCONN PIC S9(9) BINARY VALUE ZERO.
01 W02-HOBJ PIC S9(9) BINARY.
01 W02-COMPCODE PIC S9(9) BINARY.
01 W02-REASON PIC S9(9) BINARY.
01 W02-SELECTORS-TABLE.
   05 W02-SELECTORS PIC S9(9) BINARY OCCURS 2 TIMES.
01 W02-INTATTRS-TABLE.
   05 W02-INTATTRS PIC S9(9) BINARY OCCURS 2 TIMES.
*
* CMQODV defines the object descriptor (MQOD).
* 01 MQM-OBJECT-DESCRIPTOR.
   COPY CMQODV.
*
* CMQV contains constants (for setting or testing
* field values) and return codes (for testing the
* result of a call).
* 01 MQM-CONSTANTS.
   COPY CMQV SUPPRESS.
*
* -------------------------------------------------------*
PROCEDURE DIVISION.
* -------------------------------------------------------*
*
* Get the queue name and open the queue.
* ...
* *
* Initialize the variables required for the set call:
* - Set W02-SELECTORS-TABLE to the attributes to be set
* - Set W02-INTATTRS-TABLE to the required status
* - All other variables are already set
* MOVE MQIA-INHIBIT-GET TO W02-SELECTORS(1).
MOVE MQIA-INHIBIT-PUT TO W02-SELECTORS(2).
MOVE MQQA-GET-INHIBITED TO W02-INTATTRS(1).
MOVE MQQA-PUT-INHIBITED TO W02-INTATTRS(2).
*
* Set the attributes.
*
CALL 'MQSET' USING W02-HCONN,
   W02-HOBJ,
   W02-SELECTORCOUNT,
   W02-SELECTORS-TABLE,
   W02-INTATTRCOUNT,
   W02-INTATTRS-TABLE,
   W02-CHARATTRLENGTH,
   W02-CHARATTRS,
   W02-COMPCODE,
   W02-REASON.
*
* Test the output from the call:
*
* - If the completion code is not OK, display an error
* message showing the completion and reason codes
*
* - Otherwise, move 'INHIBITED' into the relevant
* screen map fields
*
IF W02-COMPCODE NOT = MQCC-OK
   MOVE 'MQSET' TO M01-MSG4-OPERATION
   MOVE W02-COMPCODE TO M01-MSG4-COMPCODE
   MOVE W02-REASON TO M01-MSG4-REASON
   MOVE M01-MESSAGE-4 TO M00-MESSAGE
   ELSE
   *

Appendix C. COBOL examples 557
COBOL: Setting queue attributes

* Process the changes.
  
  END-IF.
Appendix D. System/390 assembler-language examples

The extracts in this appendix are mostly taken from the WebSphere MQ for z/OS sample applications.

The examples in this appendix demonstrate the following techniques:

- “Connecting to a queue manager” on page 560
- “Disconnecting from a queue manager” on page 561
- “Creating a dynamic queue” on page 561
- “Opening an existing queue” on page 563
- “Closing a queue” on page 564
- “Putting a message using MQPUT” on page 564
- “Putting a message using MQPUT1” on page 566
- “Getting a message” on page 567
- “Getting a message using the wait option” on page 569
- “Getting a message using signaling” on page 570
- “Inquiring about and setting the attributes of a queue” on page 572
Connecting to a queue manager

This example demonstrates how to use the MQCONN call to connect a program to a queue manager in z/OS batch. This extract is taken from the Browse sample program (CSQ4BAA1) supplied with WebSphere MQ for z/OS.

: WORKAREA DSECT
 * PARMLIST CALL ,(0,0,0,0,0,0,0,0,0,0,0),VL,MF=L
 * COMPCODE DS F Completion code
 REASON DS F Reason code
 HCONN DS F Connection handle
 ORG
 PARMADDR DS F Address of parm field
 PARMLEN DS H Length of parm field
 * MQMNAME DS CL48 Queue manager name
 *
 **********************************************************
 * SECTION NAME : MAINPARM *
 **********************************************************
MAINPARM DS 0H
 MVI MQMNAME,X'40'
 MVC MQMNAME+1(L'MQMNAME-1),MQMNAME
 *
 *
 **********************************************************
 * EXECUTES *
 **********************************************************
MOVEPARM MVC 0(*-*),R4,0(R3)
 *
 EJECT
 **********************************************************
 * SECTION NAME : MAINCONN *
 **********************************************************
 *
 *
MAINCONN DS OH
 XC HCONN,HCONN Null connection handle
 *
 CALL MQCONN,
 (MQMNAME,
 HCONN,
 COMPCODE,
 REASON),
 MF=(E,PARMLIST),VL
 *
 LA R0,MQCC_OK Expected compcode
 C R0,COMPCODE As expected?
 BER R6 Yes .. return to caller
**Disconnecting from a queue manager**

This example demonstrates how to use the MQDISC call to disconnect a program from a queue manager in z/OS batch. This extract is not taken from the sample applications supplied with WebSphere MQ.

```assembly
* ISSUE MQI DISC REQUEST USING REENTRANT FORM
* OF CALL MACRO
* HCONN WAS SET BY A PREVIOUS MQCONN REQUEST
* R5 = WORK REGISTER
* DISC DS OH
CALL MQDISC, X (HCONN, X COMPCODE, X REASON), X
VL, MF=(E,CALLLST)
* LA R5, MQCC_OK
C R5, COMPCODE
BNE BADCALL

BADCALL DS OH
* CONSTANTS
* CMQA
* WORKING STORAGE (RE-ENTRANT)
* WEG3 DSECT
* CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0,0,0), VL, MF=L
* HCONN DS F
COMPCODE DS F
REASON DS F
* *
LEG3 EQU **WEG3
END
```

**Creating a dynamic queue**

This example demonstrates how to use the MQOPEN call to create a dynamic queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```assembly
* * MIVC INF4_TYP, "CL10"CONNECT '
BAL R7, ERRCODE Translate error
LA R0, 8 Set exit code
ST R0, EXITCODE to 8
B ENDPREG End the program
```
* R5 = WORK REGISTER.
* OPEN DS 0H
* MVC WOD_AREA,MQOD_AREA INITIALIZE WORKING VERSION OF MQOD WITH DEFAULTS
* MVC WOD_OBJECTNAME,MOD_Q COPY IN THE MODEL Q NAME
* MVC WOD_DYNAMICQNAME,DYN_Q COPY IN THE DYNAMIC Q NAME
L R5,=AL4(MQOO_OUTPUT) OPEN FOR OUTPUT AND
A R5,=AL4(MQOO_INQUIRE) INQUIRE
ST R5,OPTIONS
*
* ISSUE MQI OPEN REQUEST USING REENTRANT FORM OF CALL MACRO
*
CALL MQOPEN, X (HCONN, X WOD, X OPTIONS, X HOBJ, X COMPCODE, X REASON), VL, MF=(E,CALLLST)
*
LA R5, MQCC_OK CHECK THE COMPLETION CODE
C R5, COMPCODE FROM THE REQUEST AND BRANCH
BNE BADCALL TO ERROR ROUTINE IF NOT MQCC_OK
*
MVC TEMP_Q, WOD_OBJECTNAME SAVE NAME OF TEMPORARY Q
* CREATED BY OPEN OF MODEL Q
*
BADCALL DS 0H
*
*
* CONSTANTS:
*
MOD_Q DC CL48'QUERY.REPLY.MODEL' MODEL QUEUE NAME
DYN_Q DC CL48'QUERY.TEMPQ.*' DYNAMIC QUEUE NAME
*
CMQODA DSECT=NO,LIST=YES CONSTANT VERSION OF MQOD
CMQA MQI VALUE EQUATES
*
* WORKING STORAGE
*
DFHEISTG
HCONN DS F CONNECTION HANDLE
OPTIONS DS F OPEN OPTIONS
HOBJ DS F OBJECT HANDLE
COMPCODE DS F MQI COMPLETION CODE
REASON DS F MQI REASON CODE
TEMP_Q DS CL(MQ_Q_NAME_LENGTH) SAVED QNAME AFTER OPEN
*
WOD CMQODA DSECT=NO,LIST=YES WORKING VERSION OF MQOD
*
CALLLST CALL , (0,0,0,0,0,0,0,0,0,0,VL, MF=L) LIST FORM
OF CALL MACRO
*
:
END
Opening an existing queue

This example demonstrates how to use the MQOPEN call to open a queue that has already been defined. It shows how to specify two options. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
*: 
* R5 = WORK REGISTER.
* 
OPEN   DS  OH
* 
MVC  WOD_AREA,MQOD_AREA  INITIALIZE WORKING VERSION OF
*       MQOD WITH DEFAULTS
MVC  WOD_OBJECTNAME,Q_NAME  SPECIFY Q NAME TO OPEN
LA   R5,MQOO_INPUT_EXCLUSIVE OPEN FOR MQGET CALLS
* 
ST   R5,OPTIONS
* 
* ISSUE MQI OPEN REQUEST USING REENTRANT FORM
* OF CALL MACRO
* 
  CALL MQOPEN, X(HCONN, XWO, XOPTIONS, XHOBJ, XCOMPCODE, XREASON),VL, MF=(E,CALLLST)
* 
  LA R5,MQCC_OK CHECK THE COMPLETION CODE
  C R5,COMPCODE FROM THE REQUEST AND BRANCH BNE BADCALL TO ERROR ROUTINE IF NOT MQCC_OK
* ...
BADCALL   DS  OH
* ..
* 
* CONSTANTS:
* 
Q_NAME   DC   CL48'REQUEST.QUEUE'  NAME OF QUEUE TO OPEN
* 
CMQODA   DSECT=NO,LIST=YES  CONSTANT VERSION OF MQOD
CMQA     MQI VALUE EQUATES
* 
* WORKING STORAGE
* 
  DFHEISTG
HCONN   DS F  CONNECTION HANDLE
OPTIONS  DS F  OPEN OPTIONS
HOBJ    DS F  OBJECT HANDLE
COMPCODE DS F  MQI COMPLETION CODE
REASON   DS F  MQI REASON CODE
* 
WO      CMQODA DSECT=NO,LIST=YES WORKING VERSION OF MQOD
* 
CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0),VL, MF=L LIST FORM OF CALL
*MACRO
* ..
END
```
Assembler: Closing a queue

Closing a queue

This example demonstrates how to use the MQCLOSE call to close a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
:  *
* ISSUE MQI CLOSE REQUEST USING REENTRANT FROM OF
* CALL MACRO
* *
* HCONN WAS SET BY A PREVIOUS MQCONN REQUEST
* HOBJ WAS SET BY A PREVIOUS MQOPEN REQUEST
* R5 = WORK REGISTER
* *
CLOSE DS 0H
LA R5,MQCO_NONE NO SPECIAL CLOSE OPTIONS
ST R5,OPTIONS ARE REQUIRED.
*
CALL MQCLOSE, X
(HCONN, X
HOBJ, X
OPTIONS, X
COMPCODE, X
REASON), X
VL, MF=(E,CALLLST)
*
LA R5,MQCC_OK
C R5,COMPCODE
BNE BADCALL
*
...
BADCALL DS 0H
*
* CONSTANTS
*
CMQA
*
* WORKING STORAGE (REENTRANT)
*
WEG4 DSECT
*
CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0,0),VL, MF=L
*
HCONN DS F
HOBJ DS F
OPTIONS DS F
COMPCODE DS F
REASON DS F
*
*
LEG4 EQU *-WKEG4
END
```

Putting a message using MQPUT

This example demonstrates how to use the MQPUT call to put a message on a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
:  *
* CONNECT TO QUEUE MANAGER
```
Assembler: Putting using MQPUT

* CONN DS 0H
  :
  *
  * OPEN A QUEUE
  *
  OPEN DS 0H
  :
  *
  * R4,R5,R6,R7 = WORK REGISTER.
  *
  PUT DS 0H
  LA R4,MQMD    SET UP ADDRESSES AND
  LA R5,MQMD_LENGTH LENGTH FOR USE BY MVCL
  LA R6,WMD    INSTRUCTION, AS MQMD IS
  LA R7,WMD_LENGTH OVER 256 BYES LONG.
  MVCL R6,R4    INITIALIZE WORKING VERSION
  *
  * OF MESSAGE DESCRIPTOR
  *
  MVC WPMO_AREA,MQPMO_AREA INITIALIZE WORKING MQPMO
  *
  LA R5,BUFFER_LEN RETRIEVE THE BUFFER LENGTH
  ST R5,BUFFLEN AND SAVE IT FOR MQM USE
  *
  MVC BUFFER,TEST_MSG SET THE MESSAGE TO BE PUT
  *
  * ISSUE MQI PUT REQUEST USING REENTRANT FORM
  * OF CALL MACRO
  *
  HCONN WAS SET BY PREVIOUS MQCONN REQUEST
  * HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST
  *
  CALL MQPUT, X
  (HCONN, X
  HOBJ, X
  WMD, X
  WPMO, X
  BUFFLEN, X
  BUFFER, X
  COMPCODE,
  REASON),VL,MF=(E,CALLLST)
  *
  LA R5,MQCC_OK
  C R5,COMPCODE
  BNE BADCALL
  *
  BADCALL DS 0H
  :
  *
  * CONSTANTS
  *
  CMQMDA DSECT=NO,LIST=YES,PERSISTENCE=MQPER_PERSISTENT
  CMQPMOA DSECT=NO,LIST=YES
  CMOA
  TEST_MSG DC CL80'THIS IS A TEST MESSAGE'
  *
  * WORKING STORAGE DSECT
  *
  WORKSTG DSECT
  *
  COMPCODE DS F
  REASON DS F
  BUFFLEN DS F
  OPTIONS DS F
**Assembler: Putting using MQPUT**

```
HCONN   DS F
HOBJ    DS F
*
BUFFER  DS CL80
BUFFER_LEN EQU **-BUFFER
*
WMD     CMQMDA DSECT=NO,LIST=NO
WPMO    CMQPMOA DSECT=NO,LIST=NO
*
CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0,0),VL,MF=L
*
END
```

**Putting a message using MQPUT1**

This example demonstrates how to use the MQPUT1 call to open a queue, put a single message on the queue, then close the queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```assembly
:  
  *  CONNECT TO QUEUE MANAGER  
  
CONN   DS OH  
:  
  *  R4,R5,R6,R7 = WORK REGISTER.  
  
PUT    DS OH  
  
MVC WOD_AREA,MQOD_AREA INITIALIZE WORKING VERSION OF  
  MQOD WITH DEFAULTS  
MVC WOD_OBJECTNAME,Q_NAME SPECIFY Q NAME FOR PUT1  
  
LA R4,MQMD SET UP ADDRESSES AND  
LA R5,MQMD_LENGTH LENGTH FOR USE BY MVCL  
LA R6,WMD INSTRUCTION, AS MQMD IS  
LA R7,WMD_LENGTH OVER 256 BYES LONG.  
MVCL R6,R4 INITIALIZE WORKING VERSION  
OF MESSAGE DESCRIPTOR  
  
MVC WPMO_AREA,MQPMO_AREA INITIALIZE WORKING MQPMO  
  
LA R5,BUFFER_LEN RETRIEVE THE BUFFER LENGTH  
ST R5,BUFFLEN AND SAVE IT FOR MQM USE  
  
MVC BUFFER,TEST_MSG SET THE MESSAGE TO BE PUT  
  
*  ISSUE MQI PUT REQUEST USING REENTRANT FORM OF CALL MACRO  
  
*  HCONN WAS SET BY PREVIOUS MQCONN REQUEST  
*  HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST  
*  
CALL MQPUT1,  
  (HCONN,  
   LMQOD,  
   LMQMD,  
   LMQPMO,  
   BUFFERLENGTH,  
   BUFFER,  
   COMPCODE,  
   ) 
```
ASSMBLER: Putting using MQPUT1

REASON),VL,MF=(E,CALLLST)
*
  LA  R5,MQCC_OK
  C  R5,COMPCODE
  BNE BADCALL
*
  :
BADCALL DS  OH
  :
  *
  CONSTANTS
*
  CMQMDA DSECT=NO,LIST=YES,PERSISTENCE=MQPER_PERSISTENT
  CMQPMOA DSECT=NO,LIST=YES
  CMQODA DSECT=NO,LIST=YES
  CMQA
*
  TEST_MSG DC CL80'THIS IS ANOTHER TEST MESSAGE'
  Q_NAME  DC CL48'TEST.QUEUE.NAME'
  *
  * WORKING STORAGE DSECT
  *
  WORKSTG  DSECT
  *
  COMPCODE DS F
  REASON  DS F
  BUFFLEN  DS F
  OPTIONS  DS F
  HCONN   DS F
  HOBJ    DS F
  *
  BUFFER  DS CL80
  BUFFER_LEN EQU *-BUFFER
  *
  WOD  CMQODA DSECT=NO,LIST=YES WORKING VERSION OF MQOD
  WMD  CMQMDA DSECT=NO,LIST=NO
  WPMO  CMQPMOA DSECT=NO,LIST=NO
  *
  CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0,0),VL,MF=L
  *
  :
  END

Getting a message

This example demonstrates how to use the MQGET call to remove a message from a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.
Assembler: Getting a message

```
GET DS OH
LA R4,MQMD  SET UP ADDRESSES AND
LA R5,MQMD_LENGTH LENGTH FOR USE BY MVCL
LA R6,WMD    INSTRUCTION, AS MQMD IS
LA R7,WMD_LENGTH OVER 256 BYES LONG.
MVCL R6,R4   INITIALIZE WORKING VERSION
             OF MESSAGE DESCRIP'TOR
MVC WGMO_AREA,MQGMO_AREA INITIALIZE WORKING MQGMO

LA R5,BUFFER_LEN RETRIEVE THE BUFFER LENGTH
ST R5,BUFFLEN AND SAVE IT FOR MQM USE

* ISSUE MQI GET REQUEST USING REENTRANT FORM OF CALL MACRO
* HCONN WAS SET BY PREVIOUS MQCONN REQUEST
* HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST
* CALL MQGET, X
  (HCONN, X
   HOBJ, X
   WMD, X
   WGMO, X
   BUFFLEN, X
   BUFFER, X
   DATALEN, X
   COMPCODE, X
   REASON), X
VL,MF=(E,CALLLST)

LA R5,MQCC_OK
C R5,COMPCODE
BNE BADCALL

BADCALL DS OH
:

* CONSTANTS
* CMQMDA DSECT=NO,LIST=YES
CMQGMOA DSECT=NO,LIST=YES
CMQA

* WORKING STORAGE DSECT
* WORKSTG DSECT
* COMPCODE DS F
REASON DS F
BUFFLEN DS F
DATALEN DS F
OPTIONS DS F
HCONN DS F
HOBJ DS F
* BUFFER DS CL80
BUFFER_LEN EQU *-BUFFER
* WMD CMQMDA DSECT=NO,LIST=NO
WGMO CMQGMOA DSECT=NO,LIST=NO
* CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0,0,0),VL,MF=L
```
Getting a message using the wait option

This example demonstrates how to use the wait option of the MQGET call. This code accepts truncated messages. This extract is not taken from the sample applications supplied with WebSphere MQ.

Assembler: Getting a message

::

END

CONNECT TO QUEUE MANAGER

OPEN A QUEUE FOR GET

* R4,R5,R6,R7 = WORK REGISTER.

GET

SET UP ADDRESSES AND LENGTH FOR USE BY MVCL

INSTRUCTION, AS MQMD IS OVER 256 BYTES LONG.

INITIALIZE WORKING VERSION OF MESSAGE DESCRIPTOR

INITIALIZE WORKING MQGMO

WAIT UP TO TWO MINUTES BEFORE FAILING THE CALL

RETRIEVE THE BUFFER LENGTH

AND SAVE IT FOR MQM USE

ISSUE MQI GET REQUEST USING REENTRANT FORM OF CALL MACRO

HCONN WAS SET BY PREVIOUS MQCONN REQUEST

HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST

DID THE MQGET REQUEST WORK OK?

YES, SO GO AND PROCESS.

NO, SO CHECK FOR A WARNING.

IS THIS A WARNING?

YES, SO CHECK THE REASON.

IT MUST BE AN ERROR.

IS IT DUE TO AN EMPTY
**Assembler: Getting with wait option**

```
C R5,REASON QUEUE?
BE NOMSG YES, SO HANDLE THE ERROR
B BADCALL NO, SO GO TO ERROR ROUTINE
*
CHECK_W DS 0H
    LA R5,MQRC_TRUNCATED_MSG_ACCEPTED IS THIS A
    TRUNCATED
    C R5,REASON MESSAGE?
    BE GETOK YES, SO GO AND PROCESS.
    B BADCALL NO, SOME OTHER WARNING
*
NOMSG DS 0H...
GETOK DS 0H...
BADCALL DS 0H :
*
    * CONSTANTS
*
    CMQMDA DSECT=NO,LIST=YES
    CMQGMOA DSECT=NO,LIST=YES
    CMQA
*
    TWO_MINUTES DC F'120000' GET WAIT INTERVAL
*
    WORKING STORAGE DSECT
*
    WORKSTG DSECT
*
    COMPCODE DS F
    REASON DS F
    BUFFLEN DS F
    DATALEN DS F
    OPTIONS DS F
    HCONN DS F
    HOBJ DS F
*
    BUFFER DS CL80
    BUFFER_LEN EQU *-BUFFER
*
    WMD CMQMDA DSECT=NO,LIST=NO
    WGMO CMQGMOA DSECT=NO,LIST=NO
*
    CALLLLST CALL ,(0,0,0,0,0,0,0,0,0,0),VL,MF=L
*
    END
```

---

**Getting a message using signaling**

This example demonstrates how to use the MQGET call to set a signal so that you are notified when a suitable message arrives on a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.
Assembler: Getting using signaling

OPEN DS OH

:* R4,R5,R6,R7 = WORK REGISTER.*

GET DS OH
LA R4,MQMD SET UP ADDRESSES AND
LA R5,MQMD_LENGTH LENGTH FOR USE BY MVCL
LA R6,WMD INSTRUCTION, AS MQMD IS
LA R7,WMD_LENGTH OVER 256 BYTES LONG.
MVCL R6,R4 INITIALIZE WORKING VERSION
* OF MESSAGE DESCRIPTOR

MVC W GMO_AREA,MQ GMO_AREA INITIALIZE WORKING MQ GMO
LA R5,MQ GMO_SET SIGNAL
ST R5,W GMO_OPTIONS
MVC W GMO_WAIT_INTERVAL,FIVE_MINUTES WAIT UP TO FIVE
* MINUTES BEFORE FAILING THE CALL

XC SIG_ECB,SIG_ECB CLEAR THE ECB
LA R5,SIG_ECB GET THE ADDRESS OF THE ECB
ST R5,W GMO_SIGNAL1 AND PUT IT IN THE WORKING
* MQ GMO

LA R5,BUFFER_LEN RETRIEVE THE BUFFER LENGTH
ST R5,BUFFLEN AND SAVE IT FOR MQM USE

* ISSUE MQI GET REQUEST USING REENTRANT FORM OF CALL MACRO
* HCONN WAS SET BY PREVIOUS MQCONN REQUEST
* HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST
*
CALL MQ GET,
( HCONN,
HOBJ,
WMD,
W GMO,
BUFFLEN,
BUFFER,
DATALEN,
COMPCODE,
REASON),
VL, MF = ( E, CALL LST )

LA R5,MQC C_OK DID THE MQ GET REQUEST
C R5,COMPCODE WORK OK?
BE GETOK YES, SO GO AND PROCESS.
LA R5,MQC C WARNING NO, SO CHECK FOR A WARNING.
C R5,COMPCODE IS THIS A WARNING?
BE CHECK_W YES, SO CHECK THE REASON.
B BADCALL NO, SO GO TO ERROR ROUTINE

CHECK_W DS OH
LA R5,MQC RC SIGNAL_REQUEST_ACCEPTED
C R5,REASON SIGNAL REQUEST SIGNAL SET?
BNE BADCALL NO, SOME ERROR OCCURRED
B DOWORK YES, SO DO SOMETHING
* ELSE
*
CHECKSIG DS OH
CLC SIG_ECB+1(3),=AL3(MQEC_MSG_ARRIVED)
IS A MESSAGE AVAILABLE?
Assembler: Getting using signaling

BE GET YES, SO GO AND GET IT
*  
  CLC SIG_ECB+1(3),=AL3(MQEC_WAIT_INTERVAL_EXPIRED)
  HAVE WE WAITED LONG ENOUGH?
  BE NOMSG YES, SO SAY NO MSG AVAILABLE
  B BADCALL IF IT'S ANYTHING ELSE
*  
*  
*  DOWORK DS 0H...
  :  
  TM SIG_ECB,X'40' HAS THE SIGNAL ECB BEEN POSTED?
  BO CHECKSIG YES, SO GO AND CHECK WHY
  B DOWORK NO, SO GO AND DO MORE WORK
*  
*  NOMSG DS 0H...
  GETOK DS 0H...
  BADCALL DS 0H...
  :  
  *  
  * CONSTANTS
  *  
  CMQMDA DSECT=NO,LIST=YES
  CMQGMOA DSECT=NO,LIST=YES
  CMQA
  *  
  FIVE_MINUTES DC F'300000' GET SIGNAL INTERVAL
  *  
  * WORKING STORAGE DSECT
  *  
  WORKSTG DSECT
  *  
  * COMPCODE DS F
  *  
  REASON DS F
  *  
  BUFFLEN DS F
  *  
  DATALEN DS F
  *  
  OPTIONS DS F
  *  
  HCONN DS F
  *  
  HOBJ DS F
  *  
  SIG_ECB DS F
  *  
  BUFFER DS CL80
  BUFFER_LEN EQU *=BUFFER
  *  
  WMD CMQMDA DSECT=NO,LIST=NO
  WGMD CMQGMOA DSECT=NO,LIST=NO
  *  
  CALLLST CALL ,(0,0,0,0,0,0,0,0,0,0,0),VL,MF=L
  *  
  :  
  END

Inquiring about and setting the attributes of a queue

This example demonstrates how to use the MQINQ call to inquire about the attributes of a queue and to use the MQSET call to change the attributes of a queue. This extract is taken from the Queue Attributes sample application (program CSQ4CAC1) supplied with WebSphere MQ for z/OS.
OBJDESC CMQODA LIST=YES Working object descriptor

*  
SELETOCOUNT DS F Number of selectors
INTATTRCOUNT DS F Number of integer attributes
CHARATTRLENGTH DS F Character attributes length
CHARATTRS DS C Area for character attributes

*  
OPTIONS DS F Command options
HCONN DS F Handle of connection
HOBJ DS F Handle of object
COMPCODE DS F Completion code
REASON DS F Reason code
SELECTOR DS 2F Array of selectors
INTATTRS DS 2F Array of integer attributes

OBJECT DS CL(MQ_Q_NAME_LENGTH) Name of queue

CALLLIST CALL ,(0,0,0,0,0,0,0,0,0,0,0),VL,MF=L

**********************************************************
* PROGRAM EXECUTION STARTS HERE *
**********************************************************

CSQ4CAC1 DFHEIENT CODEREG=(R3),DATAREG=(R13)

* Initialize the variables for the set call
*  
SR R0,R0 Clear register zero
ST R0,CHARATTRLENGTH Set character length to zero
LA R0,2 Load to set
ST R0,SELETOCOUNT selectors add
ST R0,INTATTRCOUNT integer attributes

*  
LA R0,MQIA_INHIBIT_GET Load q attribute selector
ST R0,SELECTOR+0 Place in field
LA R0,MQIA_INHIBIT_PUT Load q attribute selector
ST R0,SELECTOR+4 Place in field

*  
UPDTEST DS 0H
CLC ACTION,CINHIB Are we inhibiting?
BE UPDINHBT Yes branch to section

*  
CLC ACTION,CALLOW Are we allowing?
BE UPDALLOW Yes branch to section

*  
MVC M00_MSG,M01_MSG1 Invalid request
BR R6 Return to caller

*  
UPDINHBT DS 0H
MVC UDPTYPE,CINHIBIT Indicate action type
LA R0,MQQA_GET_INHIBITED Load attribute value
ST R0,INTATTRS+0 Place in field
LA R0,MQQA_PUT_INHIBITED Load attribute value
ST R0,INTATTRS+4 Place in field
B UPDCALL Go and do call

*  
UPDALLOW DS 0H
MVC UDPTYPE,CALLOWED Indicate action type
LA R0,MQQA_GET_ALLOWED Load attribute value
ST R0,INTATTRS+0 Place in field
LA R0,MQQA_PUT_ALLOWED Load attribute value
ST R0,INTATTRS+4 Place in field
B UPDCALL Go and do call

*  
UPDCALL DS 0H
CALL MQSET, C
(HCONN, C
Assembler: Inquiring about and setting attributes

HOBJ, C
SELECTORCOUNT, C
SELECTOR, C
INTATTRCOUNT, C
INTATTRS, C
CHARATTRLENGTH, C
CHARATTS, C
COMPCODE, C
REASON), C
VL, MF=(E, CALLLIST)

LA R0, MQCC_OK Load expected compcode
C R0, COMP CODE Was set successful?
...

* SECTION NAME : INQUIRE *
* FUNCTION : Inquires on the objects attributes *
* CALLED BY : PROCESS *
* CALLS : OPEN, CLOSE, CODES *
* RETURN : To Register 6 *
INQUIRE DS 0H
...

* Initialize the variables for the inquire call *
* SR R0, R0 Clear register zero
ST R0, CHARATTRLENGTH Set char length to zero
LA R0, 2 Load to set
ST R0, SELECTORCOUNT selectors add
ST R0, INTATTRCOUNT integer attributes

* LA R0, MQIA_INHIBIT_GET Load attribute value
ST R0, SELECTOR+0 Place in field
LA R0, MQIA_INHIBIT_PUT Load attribute value
ST R0, SELECTOR+4 Place in field
CALL MQINQ, C
(HCONN, C
HOBJ, C
SELECTORCOUNT, C
SELECTOR, C
INTATTRCOUNT, C
INTATTRS, C
CHARATTRLENGTH, C
CHARATTS, C
COMPCODE, C
REASON), C
VL, MF=(E, CALLLIST)

LA R0, MQCC_OK Load expected compcode
C R0, COMP CODE Was inquire successful?
...
Appendix E. PL/I examples

The use of PL/I is supported by OS/2 Warp, z/OS, VSE/ESA, and Windows systems only.

The examples demonstrate the following techniques:

- “Connecting to a queue manager” on page 576
- “Disconnecting from a queue manager” on page 576
- “Creating a dynamic queue” on page 577
- “Opening an existing queue” on page 578
- “Closing a queue” on page 579
- “Putting a message using MQPUT” on page 579
- “Putting a message using MQPUT1” on page 581
- “Getting a message” on page 582
- “Getting a message using the wait option” on page 583
- “Getting a message using signaling” on page 585
- “Inquiring about the attributes of an object” on page 587
- “Setting the attributes of a queue” on page 588
Connecting to a queue manager

This example demonstrates how to use the MQCONN call to connect a program to a queue manager in z/OS batch. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);
:
/***************************************************************
/* STRUCTURE BASED ON PARAMETER INPUT AREA (PARAM) */
/***************************************************************
DCL 1 INPUT_PARAM BASED(ADDR(PARAM)),
   2 PARAM_LENGTH FIXED BIN(15),
   2 PARAM_MQMNAME CHAR(48);
:
/***************************************************************
/* WORKING STORAGE DECLARATIONS */
/***************************************************************
DCL MQMNAME CHAR(48);
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);
:
/***************************************************************
/* COPY QUEUE MANAGER NAME PARAMETER TO LOCAL STORAGE */
/***************************************************************
MQMNAME='' ;
MQMNAME = SUBSTR(PARAM_MQMNAME,1,PARAM_LENGTH);
:
/***************************************************************
/* CONNECT FROM THE QUEUE MANAGER */
/***************************************************************
CALL MQCONN (MQMNAME, /* MQM SYSTEM NAME */
   HCONN, /* CONNECTION HANDLE */
   COMPCODE, /* COMPLETION CODE */
   REASON); /* REASON CODE */
/***************************************************************
/* TEST THE COMPLETION CODE OF THE CONNECT CALL. */
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE */
/* SHOWING THE COMPLETION CODE AND THE REASON CODE. */
IF COMPCODE ¬= MQCC_OK
   THEN DO;
      ...
      CALL ERROR_ROUTINE;
      END;
:
CALL ERROR_ROUTINE;
END;
```

Disconnecting from a queue manager

This example demonstrates how to use the MQDISC call to disconnect a program from a queue manager in z/OS batch. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);
:
/***************************************************************
/* WORKING STORAGE DECLARATIONS */
/***************************************************************
```
Creating a dynamic queue

This example demonstrates how to use the MQOPEN call to create a dynamic queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);

/***********************************************************/
/* WORKING STORAGE DECLARATIONS */
/***********************************************************/
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);
DCL HOBJ BINARY FIXED (31);
DCL OPTIONS BINARY FIXED (31);
DCL MODEL_QUEUE_NAME CHAR(48) INIT('PL1.REPLY.MODEL');
DCL DYNAMIC_NAME_PREFIX CHAR(48) INIT('PL1.TEMPQ.*');
DCL DYNAMIC_QUEUE_NAME CHAR(48) INIT(' ');

/***********************************************************/
/* LOCAL COPY OF OBJECT DESCRIPTOR */
/***********************************************************/
DCL LMQOD LIKE MQOD;

/***********************************************************/
/* SET UP OBJECT DESCRIPTOR FOR OPEN OF REPLY QUEUE */
/***********************************************************/
LMQOD.OBJECTTYPE = MQOT_Q;
LMQOD.OBJECTNAME = MODEL_QUEUE_NAME;
LMQOD.DYNAMICQNNAME = DYNAMIC_NAME_PREFIX;
OPTIONS = MQOO_INPUT_EXCLUSIVE;
CALL MQOPEN (HCONN, LMQOD, OPTIONS, HOBJ, COMPCODE,
```
Opening an existing queue

This example demonstrates how to use the MQOPEN call to open an existing queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);
:
/***********************************************************/
/* WORKING STORAGE DECLARATIONS */
/***********************************************************/
DCL COMPCODE     BINARY FIXED (31);
DCL REASON       BINARY FIXED (31);
DCL HCONN        BINARY FIXED (31);
DCL HOBJ         BINARY FIXED (31);
DCL OPTIONS      BINARY FIXED (31);
:
DCL QUEUE_NAME   CHAR(48) INIT('PL1.LOCAL.QUEUE');
:
/***********************************************************/
/* LOCAL COPY OF OBJECT DESCRIPTOR */
/***********************************************************/
DCL 1 LMQOD     LIKE MQOD;
:
/***********************************************************/
/* SET UP OBJECT DESCRIPTOR FOR OPEN OF REPLY QUEUE */
/***********************************************************/
LMQOD.OBJECTTYPE = MQOT_Q;
LMQOD.OBJECTNAME = QUEUE_NAME;
OPTIONS = MQOO_INPUT_EXCLUSIVE;
CALL MQOPEN (HCONN,
LMQOD,
OPTIONS,
HOBJ,
COMPCODE,
REASON);
/***********************************************************/
/* TEST THE COMPLETION CODE OF THE OPEN CALL. */
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE */
/* SHOWING THE COMPLETION CODE AND THE REASON CODE. */
/* IF THE CALL HAS SUCCEEDED THEN EXTRACT THE NAME OF */
/* THE NEWLY CREATED DYNAMIC QUEUE FROM THE OBJECT */
/* DESCRIPTOR. */
/***********************************************************/
IF COMPCODE ¬= MQCC_OK
  THEN DO;
    :
    CALL ERROR_ROUTINE;
  END;
ELSE
  DYNAMIC_QUEUE_NAME = LMQOD_OBJECTNAME;
```

Opening an existing queue

This example demonstrates how to use the MQOPEN call to open an existing queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);
:
/***********************************************************/
/* WORKING STORAGE DECLARATIONS */
/***********************************************************/
DCL COMPCODE     BINARY FIXED (31);
DCL REASON       BINARY FIXED (31);
DCL HCONN        BINARY FIXED (31);
DCL HOBJ         BINARY FIXED (31);
DCL OPTIONS      BINARY FIXED (31);
:
DCL QUEUE_NAME   CHAR(48) INIT('PL1.LOCAL.QUEUE');
:
/***********************************************************/
/* LOCAL COPY OF OBJECT DESCRIPTOR */
/***********************************************************/
DCL 1 LMQOD     LIKE MQOD;
:
/***********************************************************/
/* SET UP OBJECT DESCRIPTOR FOR OPEN OF REPLY QUEUE */
/***********************************************************/
LMQOD.OBJECTTYPE = MQOT_Q;
LMQOD.OBJECTNAME = QUEUE_NAME;
OPTIONS = MQOO_INPUT_EXCLUSIVE;
CALL MQOPEN (HCONN,
LMQOD,
OPTIONS,
HOBJ,
COMPCODE,
REASON);
/***********************************************************/
/* TEST THE COMPLETION CODE OF THE OPEN CALL. */
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE */
/* SHOWING THE COMPLETION CODE AND THE REASON CODE. */
/***********************************************************/
IF COMPCODE ¬= MQCC_OK
  THEN DO;
    :
    CALL ERROR_ROUTINE;
  END;
ELSE
  DYNAMIC_QUEUE_NAME = LMQOD_OBJECTNAME;
```
Closing a queue

This example demonstrates how to use the MQCLOSE call. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);
;
/*********************************************************/
/* WORKING STORAGE DECLARATIONS */
/*********************************************************/
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);
DCL HOBJ BINARY FIXED (31);
DCL OPTIONS BINARY FIXED (31);
;
/*********************************************************/
/* SET CLOSE OPTIONS */
/*********************************************************/
OPTIONS=MQCO_NONE;

/*********************************************************/
/* CLOSE QUEUE */
/*********************************************************/
CALL MQCLOSE (HCONN, /* CONNECTION HANDLE */
              HOBJ, /* OBJECT HANDLE */
              OPTIONS, /* CLOSE OPTIONS */
              COMPCODE, /* COMPLETION CODE */
              REASON); /* REASON CODE */

/*********************************************************/
/* TEST THE COMPLETION CODE OF THE CLOSE CALL. */
/*********************************************************/
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE */
/*********************************************************/
IF COMPCODE ¬= MQCC_OK
  THEN DO;
    :
    CALL ERROR_ROUTINE;
END;
```

Putting a message using MQPUT

This example demonstrates how to use the MQPUT call using context. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);
;
/*********************************************************/
/* WORKING STORAGE DECLARATIONS */
/*********************************************************/
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
```
CALL MQPUT (HCONN,
    HOBJ,
    LMQMD,
    LMQPMO,
    BUFFLEN,
    BUFFER,
    COMPCODE,
    REASON);

IF COMPCODE ~= MQCC_OK
    THEN DO;

    CALL ERROR_ROUTINE;
END;
Putting a message using MQPUT1

This example demonstrates how to use the MQPUT1 call. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
%INCLUDE SYSLIB(CMQEPP);
%INCLUDE SYSLIB(CMQP);
/
/*********************************************************/
/* WORKING STORAGE DECLARATIONS */
/*********************************************************/
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);
DCL OPTIONS BINARY FIXED (31);
DCL BUFFLEN BINARY FIXED (31);
DCL BUFFER CHAR(80);...
DCL REPLY_TO_QUEUE CHAR(48) INIT('PL1.REPLY.QUEUE');
DCL QUEUE_NAME CHAR(48) INIT('PL1.LOCAL.QUEUE');
DCL PL1_TEST_MESSAGE CHAR(80) INIT('***** THIS IS ANOTHER TEST MESSAGE *****');...
/*********************************************************/
/* LOCAL COPY OF OBJECT DESCRIPTOR, MESSAGE DESCRIPTOR */
/*********************************************************/
DCL 1 LMQOD LIKE MQOD;
DCL 1 LMQMD LIKE MQMD;
DCL 1 LMQPMO LIKE MQPMO;...
/*********************************************************/
/* SET UP OBJECT DESCRIPTOR AS REQUIRED. */
/*********************************************************/
LMQOD.OBJECTTYPE = MQOT_Q;
LMQOD.OBJECTNAME = QUEUE_NAME;
/*********************************************************/
/* SET UP MESSAGE DESCRIPTOR AS REQUIRED. */
/*********************************************************/
LMQMD.MSGTYPE = MQMT_REQUEST;
LMQMD.PRIORITY = 5;
LMQMD.PERSISTENCE = MQPER_PERSISTENT;
LMQMD.REPLYTOQ = REPLY_TO_QUEUE;
LMQMD.REPLYTOQMGR = '';
LMQMD.MSGID = MQMI_NONE;
LMQMD.CORRELID = MQCI_NONE;
/*********************************************************/
/* SET UP PUT MESSAGE OPTIONS AS REQUIRED */
/*********************************************************/
LMQPMO.OPTIONS = MQPMO_NO_SYNCPOINT;
/*********************************************************/
/* SET UP LENGTH OF MESSAGE BUFFER AND THE MESSAGE */
/*********************************************************/
BUFFLEN = LENGTH(BUFFER);
BUFFER = PL1_TEST_MESSAGE;
CALL MQPUT1 (HCONN,
LMQOD,
LMQMD,
LMQPMO,
BUFFLEN,
BUFFER,
```
PL/I: Putting using MQPUT1

```pli
    COMPCODE,
    REASON);

    /***************************************************************************/
    /* TEST THE COMPLETION CODE OF THE PUT1 CALL. */
    /* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE SHOWING */
    /* THE COMPLETION CODE AND THE REASON CODE. */
    /***************************************************************************/
    IF COMPCODE ¬= MQCC_OK
    THEN DO;
      ...
    CALL ERROR_ROUTINE;
    END;

Getting a message

This example demonstrates how to use the MQGET call to remove a message from
a queue. This extract is not taken from the sample applications supplied with
WebSphere MQ.

```
Getting a message using the wait option

This example demonstrates how to use the MQGET call with the wait option and accepting truncated messages. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
/* CALL MQGET (HCONN,
   HOBJ,
   LMQMD,
   LMQGMO,
   BUFFERLEN,
   BUFFER,
   DATALEN,
   COMPCODE,
   REASON); */

/*********************************************************/
/* TEST THE COMPLETION CODE OF THE GET CALL. */
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE */
/* SHOWING THE COMPLETION CODE AND THE REASON CODE. */
/*********************************************************/
IF COMPCODE ~= MQCC_OK
THEN DO;
  
  CALL ERROR_ROUTINE;
END;
```

Getting a message using the wait option

This example demonstrates how to use the MQGET call with the wait option and accepting truncated messages. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
/* CALL MQGET (HCONN,
   HOBJ,
   LMQMD,
   LMQGMO,
   BUFFERLEN,
   BUFFER,
   DATALEN,
   COMPCODE,
   REASON); */

/*********************************************************/
/* TEST THE COMPLETION CODE OF THE GET CALL. */
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE */
/* SHOWING THE COMPLETION CODE AND THE REASON CODE. */
/*********************************************************/
IF COMPCODE ~= MQCC_OK
THEN DO;
  
  CALL ERROR_ROUTINE;
END;
```
PL/I: Getting using the wait option

/* WAIT INTERVAL SET TO ONE MINUTE. */
/**********************************************************************************/
LMQGMO.OPTIONS = MQGMO_WAIT +
MQGMO_ACCEPT_TRUNCATED_MSG +
MQGMO_NO_SYNCPOINT;
LMQGMO.WAITINTERVAL=60000;
/**********************************************************************************/
/* SET UP LENGTH OF MESSAGE BUFFER. */
/**********************************************************************************/
BUFFLEN = LENGTH(BUFFER);
/**********************************************************************************/
/* HCONN WAS SET BY PREVIOUS MQCONN REQUEST. */
/* HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST. */
/**********************************************************************************/
CALL MQGET (HCONN,
HOBJ,
LMQMD,
LMQGMO,
BUFFLEN,
BUFFER,
DATALEN,
COMPCODE,
REASON);
/**********************************************************************************/
/* TEST THE COMPLETION CODE OF THE GET CALL. */
/* TAKE APPROPRIATE ACTION BASED ON COMPLETION CODE AND */
/* REASON CODE. */
/**********************************************************************************/
SELECT(COMPCODE);
  WHEN (MQCC_OK) DO; /* GET WAS SUCCESSFUL */
  :
END;
  WHEN (MQCC_WARNING) DO;
    IF REASON = MQRC_TRUNCATED_MSG_ACCEPTED
        THEN DO; /* GET WAS SUCCESSFUL */
      :
END;
    ELSE DO;
      CALL ERROR_ROUTINE;
    END;
  END;
  WHEN (MQCC_FAILED) DO;
    CALL ERROR_ROUTINE;
END;
  OTHERWISE;
END;
Getting a message using signaling

Signaling is available only with WebSphere MQ for z/OS.

This example demonstrates how to use the MQGET call with signaling. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);

/*********************************************************
/* WORKING STORAGE DECLARATIONS */
/*********************************************************/
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);
DCL HOBJ BINARY FIXED (31);
DCL DATALEN BINARY FIXED (31);
DCL BUFFLEN BINARY FIXED (31);
DCL BUFFER CHAR(80);

...}
DCL ECB_FIXED FIXED BIN(31);
DCL 1 ECB_OVERLAY BASED(ADDR(ECB_FIXED)),
3 ECB_WAIT BIT,
3 ECB_POSTED BIT,
3 ECB_FLAG3_8 BIT(6),
3 ECB_CODE PIC'999';

...}
DCL LMQMD LIKE MQMD;
DCL 1 LMQGMO LIKE MQGMO;

...}
LMQMD.MSGID = MQMI_NONE;
LMQMD.CORRELID = MQCI_NONE;

...}
LMQGMO.OPTIONS = MQGMO_SET_SIGNAL + MQGMO_NO_SYNCPOINT;
LMQGMO.WAITINTERVAL=60000;
LMQGMO.SIGNAL1 = ADDR(ECB_FIXED);

BUFFLEN = LENGTH(BUFFER);```
CALL GET_MSG;

/***********************************************************/
/* TEST THE COMPLETION CODE OF THE GET CALL. */
/* TAKE APPROPRIATE ACTION BASED ON COMPLETION CODE AND */
/* REASON CODE. */
/**************************************************************/
SELECT;
WHEN ((COMPCODE = MQCC_OK) &
  (REASON = MQCC_NONE)) DO
  ...
  CALL MSG_ROUTINE;
  ...
END;
WHEN ((COMPCODE = MQCC_WARNING) &
  (REASON = MQRC_SIGNAL_REQUEST_ACCEPTED)) DO;
  ...
  CALL DO_WORK;
  ...
END;
WHEN ((COMPCODE = MQCC_FAILED) &
  (REASON = MQRC_SIGNAL_OUTSTANDING)) DO;
  ...
  CALL DO_WORK;
  ...
END;
OTHERWISE DO; /* FAILURE CASE */
/***********************************************************/
/* ISSUE AN ERROR MESSAGE SHOWING THE COMPLETION CODE */
/* AND THE REASON CODE. */
/**************************************************************/
  CALL ERROR_ROUTINE;
  ...
END;
END;

DO_WORK: PROC;
...
IF ECB_POSTED
  THEN DO;
    SELECT(ECB_CODE);
      WHEN(MQEC_MSG_ARRIVED) DO;
        ...
        CALL GET_MSG;
        ...
      END;
      WHEN(MQEC_WAIT_INTERVAL_EXPIRED) DO;
        ...
        CALL NO_MSG;
  END;
Inquiring about the attributes of an object

This example demonstrates how to use the MQINQ call to inquire about the attributes of a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```pli
%INCLUDE SYSLIB(CMQP);
%INCLUDE SYSLIB(CMQEPP);

/*********************************************************/
/* WORKING STORAGE DECLARATIONS */
/*********************************************************/
DCL COMPCODE BINARY FIXED (31);
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);

CALL MQINQ (HCONN, COMPCODE, REASON);
END INQ_MSG;
```

Appendix E. PL/I examples  587
PL/I: Inquiring about object attributes

```
DCL HOBJ BINARY FIXED (31);
DCL OPTIONS BINARY FIXED (31);
DCL SELECTORCOUNT BINARY FIXED (31);
DCL INTATTRCOUNT BINARY FIXED (31);
DCL 1 SELECTOR_TABLE,
     3 SELECTORS(5) BINARY FIXED (31);
DCL 1 INTATTR_TABLE,
     3 INTATTRS(5) BINARY FIXED (31);
DCL CHARATTRLENGTH BINARY FIXED (31);
DCL CHARATTRS CHAR(100);

: /* SET VARIABLES FOR INQUIRE CALL */
: /* INQUIRE ON THE CURRENT QUEUE DEPTH */
: /***************************************************************************/

SELECTORS(01) = MQIA_CURRENT_Q_DEPTH;
SELECTORCOUNT = 1;
INTATTRCOUNT = 1;
CHARATTRLENGTH = 0;
: /***************************************************************************/

CALL MQINQ (HCONN,
           HOBJ,
           SELECTORCOUNT,
           SELECTORS,
           INTATTRCOUNT,
           INTATTRS,
           CHARATTRLENGTH,
           CHARATTRS,
           COMPCODE,
           REASON);
: /***************************************************************************/

```

Setting the attributes of a queue

This example demonstrates how to use the MQSET call to change the attributes of a queue. This extract is not taken from the sample applications supplied with WebSphere MQ.

```
DCL REASON BINARY FIXED (31);
DCL HCONN BINARY FIXED (31);
DCL HOBJ  BINARY FIXED (31);
DCL OPTIONS BINARY FIXED (31);
DCL SELECTORCOUNT BINARY FIXED (31);
DCL INTATTCOUNT BINARY FIXED (31);
DCL 1 SELECTOR_TABLE,
     3 SELECTORS(5) BINARY FIXED (31);
DCL 1 INTATTR_TABLE,
     3 INTATTRS(5) BINARY FIXED (31);
DCL CHARATTRLENGTH BINARY FIXED (31);
DCL CHARATTRS CHAR(100);

;left

/***********************************************************/
/* SET VARIABLES FOR SET CALL                              */
/* SET GET AND PUT INHIBITED                                */
/***********************************************************/
SELECTORS(01) = MQIA_INHIBIT_GET;
SELECTORS(02) = MQIA_INHIBIT_PUT;
INTATTRS(01) = MQQA_GET_INHIBITED;
INTATTRS(02) = MQQA_PUT_INHIBITED;
SELECTORCOUNT = 2;
INTATTCOUNT  = 2;
CHARATTRLENGTH = 0;
/***********************************************************/
/* HCONN WAS SET BY PREVIOUS MQCONN REQUEST.               */
/* HOBJ WAS SET BY PREVIOUS MQOPEN REQUEST.                */
/***********************************************************/
CALL MQSET (HCONN,
           HOBJ,
           SELECTORCOUNT,
           SELECTORS,
           INTATTCOUNT,
           INTATTRS,
           CHARATTRLENGTH,
           CHARATTRS,
           COMPCODE,
           REASON);
/***********************************************************/
/* TEST THE COMPLETION CODE OF THE SET CALL.               */
/* IF THE CALL HAS FAILED ISSUE AN ERROR MESSAGE SHOWING */
/* THE COMPLETION CODE AND THE REASON CODE.                */
/***********************************************************/
IF COMPCODE ¬= MQCC_OK
   THEN DO;
  ...
   CALL ERROR_ROUTINE;
   END;
Appendix F. WebSphere MQ data definition files

WebSphere MQ provides data definition files to assist you with the writing of your applications. Data definition files are also known as:

<table>
<thead>
<tr>
<th>Language</th>
<th>Data definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Include files or header files</td>
</tr>
<tr>
<td>Visual Basic</td>
<td>Module files</td>
</tr>
<tr>
<td>COBOL</td>
<td>Copy files</td>
</tr>
<tr>
<td>Assembler</td>
<td>Macros</td>
</tr>
<tr>
<td>PL/I</td>
<td>Include files</td>
</tr>
</tbody>
</table>

See Appendix A, “Language compilers and assemblers”, on page 521 for the compilers that are supported and suitable for use with these data definition files.

The data definition files to assist with the writing of channel exits are described in WebSphere MQ Intercommunication.

The data definition files to assist with the writing of installable services exits are described in WebSphere MQ System Administration Guide.

For data definition files supported on C++, see WebSphere MQ Using C++.

For data definition files supported on RPG, see WebSphere MQ for iSeries V5.3 Application Programming Reference (ILE RPG).

The names of the data definition files have the prefix CMQ, and a suffix that is determined by the programming language:

<table>
<thead>
<tr>
<th>Suffix</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Assembler language</td>
</tr>
<tr>
<td>b</td>
<td>Visual Basic</td>
</tr>
<tr>
<td>c</td>
<td>C</td>
</tr>
<tr>
<td>l</td>
<td>COBOL (without initialized values)</td>
</tr>
<tr>
<td>p</td>
<td>PL/I</td>
</tr>
<tr>
<td>v</td>
<td>COBOL (with default values set)</td>
</tr>
</tbody>
</table>

Installation library

The name thlqual is the high-level qualifier of the installation library on z/OS.

This chapter introduces WebSphere MQ data definition files, under these headings:

- “C language include files” on page 592
- “Visual Basic module files” on page 592
- “COBOL copy files” on page 593
- “System/390 assembler-language macros” on page 595
- “PL/I include files” on page 597
C language include files

The WebSphere MQ C include files are listed in Table 70. They are installed in the following directories or libraries:

<table>
<thead>
<tr>
<th>Platform</th>
<th>Installation directory or library</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIX</td>
<td>/usr/mqm/inc/</td>
</tr>
<tr>
<td>OS/400</td>
<td>QMQM/H</td>
</tr>
<tr>
<td>Compaq OpenVMS Alpha</td>
<td>/mqm/inc/</td>
</tr>
<tr>
<td>Other UNIX platforms</td>
<td>/opt/mqm/inc/</td>
</tr>
</tbody>
</table>
| OS/2                              | \
| Windows systems                   | \\Program Files\\IBM\\WebSphere MQ\\Tools\\c\\include |
| z/OS                              | thqual.SCSQC370                               |
| Compaq NonStop Kernel             | $volume.zmqslib                               |
| VSE/ESA                           | PRD2.MQ SERIES                               |

Note: For UNIX platforms (not including Compaq OpenVMS Alpha), the include files are symbolically linked into /usr/include.

For more information on the structure of directories, see WebSphere MQ System Administration Guide for WebSphere MQ for AIX, iSeries, HP-UX, OS/2, Solaris, and Windows systems; for other platforms, see the appropriate System Management Guide.

Table 70. C include files for WebSphere MQ

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;cmqc.h&gt;</td>
<td>Call prototypes, data types, structures, return codes, and constants</td>
</tr>
<tr>
<td>&lt;cmqcf.h&gt;</td>
<td>Definitions for programmable commands</td>
</tr>
<tr>
<td>&lt;cmqxc.h&gt;</td>
<td>Definitions for channel exits and data-conversion exits</td>
</tr>
<tr>
<td>&lt;cmqzc.h&gt;</td>
<td>Definitions for installable services exits</td>
</tr>
</tbody>
</table>

Notes: The files are protected against multiple declaration, so you can include them many times.
1. MQSeries for VSE/ESA does not provide this include file.
2. WebSphere MQ for z/OS does not provide this include file.
3. On Compaq NonStop Kernel filenames cannot contain a period (.) so the header filenames are <cmqch> and so on.

Visual Basic module files

WebSphere MQ for Windows provides four Visual Basic module files. They are listed in Table 71 and installed in

\Program Files\IBM\WebSphere MQ\Tools\Samples\VB\Include

Table 71. Visual Basic module files for WebSphere MQ for Windows

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMQB.BAS</td>
<td>Call declarations, data types, and named constants for the main MQI.</td>
</tr>
<tr>
<td>CMQBB.BAS</td>
<td>Call declarations, data types, and named constants for MQAI support.</td>
</tr>
</tbody>
</table>
### Visual Basic module files

Table 71. Visual Basic module files for WebSphere MQ for Windows (continued)

<table>
<thead>
<tr>
<th>File name</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMQCFB.BAS</td>
<td>Call declarations, data types, and named constants for PCF support.</td>
</tr>
<tr>
<td>CMQXB.BAS</td>
<td>Call declarations, data types, and named constants for the channel exits.</td>
</tr>
<tr>
<td>CMQPSB.BAS</td>
<td>Named constants for publish/subscribe.</td>
</tr>
</tbody>
</table>

### COBOL copy files

For COBOL, WebSphere MQ provides separate copy files containing the named constants, and two copy files for each of the structures. There are two copy files for each structure because each is provided both with and without initial values:

- In the WORKING-STORAGE SECTION of a COBOL program, use the files that initialize the structure fields to default values. These structures are defined in the copy files that have names suffixed with the letter “V” (values).
- In the LINKAGE SECTION of a COBOL program, use the structures without initial values. These structures are defined in copy files that have names suffixed with the letter “L” (linkage).

Copy files containing data and interface definitions for WebSphere MQ for iSeries are provided for ILE COBOL programs using prototyped calls to the MQI. The files exist in QMQM/QCBLLESRC with member names that have a suffix of “L” (for structures without initial values) or a suffix of “V” (for structures with initial values).

The WebSphere MQ interfaces for OPM COBOL have been created to maintain compatibility with previous releases, but do not provide support for new function. Consequently, the copy files provided for OPM COBOL programs are at the MQSeries for AS/400 Version 4 Release 2.1 level.

The WebSphere MQ COBOL copy files are listed in Table 72 on page 594. They are installed in the following directories:

<table>
<thead>
<tr>
<th>Platform</th>
<th>Installation directory or library</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIX</td>
<td>/usr/mqm/inc/</td>
</tr>
<tr>
<td>Compaq OpenVMS Alpha</td>
<td>/mqm/inc/</td>
</tr>
<tr>
<td>Other UNIX platforms</td>
<td>/opt/mqm/inc/</td>
</tr>
<tr>
<td>OS/2</td>
<td>\mqm\tools\cobol\copybook (for Micro Focus COBOL) \mqm\tools\cobol\copybook\VAcobol (for IBM VisualAge COBOL)</td>
</tr>
<tr>
<td>Windows</td>
<td>\Program Files\IBM\WebSphere \MQ\Tools\cobol\copybook (for Micro Focus COBOL) \Program Files\IBM\WebSphere \MQ\Tools\cobol\copybook\VAcobol (for IBM VisualAge COBOL)</td>
</tr>
<tr>
<td>z/OS</td>
<td>thlqual.SCSQCOBC</td>
</tr>
<tr>
<td>Compaq NonStop Kernel</td>
<td>$volume.zmqslib</td>
</tr>
<tr>
<td>VSE/ESA</td>
<td>PRD2.MQSERIES</td>
</tr>
</tbody>
</table>
COBOL copy files

Notes:

1. For OS/400, they are supplied in the library QMQM:
   a. For OPM, they are supplied as members of the file QLBLSRC.
   b. For ILE, they are supplied as members of the file QCBLLESRC.
2. For Compaq NonStop Kernel, all the sections are contained in one ENSCRIBE file CMCPCOBOL.

Table 72. COBOL copy files

<table>
<thead>
<tr>
<th>File name (with initial values)</th>
<th>File name (without initial values)</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMQBOV (not OS/400)</td>
<td>CMQBOL (not OS/400)</td>
<td>Begin options structure (MQBO)</td>
</tr>
<tr>
<td>CMQCFV (z/OS only)</td>
<td>not applicable</td>
<td>Additional named constants for events and PCF commands</td>
</tr>
<tr>
<td>CMQCIHV</td>
<td>CMQCILH</td>
<td>CICS information header structure</td>
</tr>
<tr>
<td>CMQCNV</td>
<td>CMQCNL</td>
<td>Connect options structure (MQCN)</td>
</tr>
<tr>
<td>CMQDHV</td>
<td>CMQDHL</td>
<td>Distribution header structure (MQDH)</td>
</tr>
<tr>
<td>CMQDLHV</td>
<td>CMQDLHL</td>
<td>Dead-letter (undelivered-message) header structure (MQDLH)</td>
</tr>
<tr>
<td>CMQDXPV</td>
<td>CMQDXPL</td>
<td>Data-conversion exit parameter structure (MQDXP)</td>
</tr>
<tr>
<td>CMQGMOV</td>
<td>CMQGMOL</td>
<td>Get-message options structure (MQGMO)</td>
</tr>
<tr>
<td>CMQIIHV</td>
<td>CMQIIL</td>
<td>IMS header structure (MQII)</td>
</tr>
<tr>
<td>CMQMDEV</td>
<td>CMQMED</td>
<td>Message descriptor extension structure (MQMDE)</td>
</tr>
<tr>
<td>CMQMDV</td>
<td>CMQMDL</td>
<td>Message descriptor structure (MQMD)</td>
</tr>
<tr>
<td>CMQODV</td>
<td>CMQODL</td>
<td>Object descriptor structure (MQOD)</td>
</tr>
<tr>
<td>CMQORV</td>
<td>CMQORL</td>
<td>Object record structure (MQOR)</td>
</tr>
<tr>
<td>CMQPMOV</td>
<td>CMQPMOL</td>
<td>Put-message options structure (MQPMO)</td>
</tr>
<tr>
<td>CMQRFHV</td>
<td>CMQRFHL</td>
<td>Rules and formatting header structure</td>
</tr>
<tr>
<td>CMQRFHV2V</td>
<td>CMQRFHL2</td>
<td>Rules and formatting header 2 structure</td>
</tr>
<tr>
<td>CMQRPV</td>
<td>CMQRPL</td>
<td>Response record structure (MQRR)</td>
</tr>
<tr>
<td>CMQTMV</td>
<td>CMQTMCL</td>
<td>Trigger-message structure (character format)</td>
</tr>
<tr>
<td>CMQTMV2V</td>
<td>CMQTMCL2</td>
<td>Trigger-message structure (character format) (MQTM)</td>
</tr>
<tr>
<td>CMQV</td>
<td>not applicable</td>
<td>Named constants for the MQI</td>
</tr>
<tr>
<td>CMQWIHV</td>
<td>CMQWIHL</td>
<td>Work-information header structure</td>
</tr>
<tr>
<td>CMQXQHV</td>
<td>CMQXQHL</td>
<td>Transmission-queue header structure (MQXQH)</td>
</tr>
<tr>
<td>CMQXV</td>
<td>not applicable</td>
<td>Named constants for exits</td>
</tr>
</tbody>
</table>

Include in your program only those files you need. Do this with one or more COPY statements after a level-01 declaration. This means you can include multiple versions of the structures in a program if necessary. However, note that CMQV is a large file.
Here is an example of COBOL code for including the CMQMDV copy file:

01 MQM-MESSAGE-DESCRIPTOR.
   COPY CMQMDV.

Each structure declaration begins with a level-01 item; this means you can declare several instances of the structure by coding the level-01 declaration followed by a COPY statement to copy in the remainder of the structure declaration. To refer to the appropriate instance, use the IN keyword.

Here is an example of COBOL code for including two instances of CMQMDV:

* Declare two instances of MQMD
01 MY-CMQMD.
   COPY CMQMDV.
01 MY-OTHER-CMQMD.
   COPY CMQMDV.
*
* Set MSGTYPE field in MY-OTHER-CMQMD
   MOVE MQMT-REQUEST TO MQMD-MSGTYPE IN MY-OTHER-CMQMD.

The structures should be aligned on 4-byte boundaries. If you use the COPY statement to include a structure following an item that is not the level-01 item, try to ensure that the structure is a multiple of 4-bytes from the start of the level-01 item. If you do not do this, you may get a reduction in the performance of your application.

The structures are described in WebSphere MQ Application Programming Reference. The descriptions of the fields in the structures show the names of fields without a prefix. In COBOL programs you must prefix the field names with the name of the structure followed by a hyphen, as shown in the COBOL declarations. The fields in the structure copy files are prefixed this way.

The field names in the declarations in the structure copy files are in uppercase. You can use mixed case or lowercase instead. For example, the field StrucId of the MQGMO structure is shown as MQGMO-STRUCID in the COBOL declaration and in the copy file.

The V-suffix structures are declared with initial values for all of the fields, so you need to set only those fields where the value required is different from the initial value.

**System/390 assembler-language macros**

WebSphere MQ for z/OS provides two assembler-language macros containing the named constants, and one macro to generate each structure. They are listed in Table 73 and installed in thqual.SCSQMACS.

<table>
<thead>
<tr>
<th>Macro</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMQA</td>
<td>Values of the return codes for the API calls</td>
</tr>
<tr>
<td>CMQMDV</td>
<td>Constants for filling in the option fields</td>
</tr>
<tr>
<td>CMQCFCA</td>
<td>Constants for each object attribute, used by the MQINQ and MQSET calls</td>
</tr>
<tr>
<td>CMQCFA</td>
<td>Additional named constants for events and PCF commands</td>
</tr>
<tr>
<td>CMQCHIA</td>
<td>CICS information-header structure</td>
</tr>
<tr>
<td>CMQDLHA</td>
<td>Definition of the MQDLH structure</td>
</tr>
<tr>
<td>CMQDXPA</td>
<td>Definition of the MQDXP structure</td>
</tr>
</tbody>
</table>

Table 73. System/390 assembler-language macros
### System/390 assembler-language macros

<table>
<thead>
<tr>
<th>Macro</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMQGMOA</td>
<td>Definition of the MQGMO structure</td>
</tr>
<tr>
<td>CMQIIHA</td>
<td>Definition of the MQIIH structure</td>
</tr>
<tr>
<td>CMQMIDA</td>
<td>Definition of the MQMD structure</td>
</tr>
<tr>
<td>CMQODA</td>
<td>Definition of the MQOD structure</td>
</tr>
<tr>
<td>CMQPMOA</td>
<td>Definition of the MQPMO structure</td>
</tr>
<tr>
<td>CMQRFHA</td>
<td>Definition of the MQRFH structure</td>
</tr>
<tr>
<td>CMQRFH2</td>
<td>Definition of the MQRFH2 structure</td>
</tr>
<tr>
<td>CMQTMA</td>
<td>Definition of the MQTM structure</td>
</tr>
<tr>
<td>CMQTMC2A</td>
<td>Definition of the MQTMC2 structure</td>
</tr>
<tr>
<td>CMQWIHA</td>
<td>Work-information header structure</td>
</tr>
<tr>
<td>CMQXA</td>
<td>Constants for exits</td>
</tr>
<tr>
<td>CMQXPA</td>
<td>Definition of the MQXP structure</td>
</tr>
<tr>
<td>CMQXQHA</td>
<td>Definition of the MQXQH structure</td>
</tr>
</tbody>
</table>

These macros are called using code like this:

```
MY_MQMD CMQMDA EXPIRY=0,MSGTYPE=MQMT_DATAGRAM
```
PL/I include files

WebSphere MQ for z/OS, OS/2 Warp, and Windows systems provide include files that contain all the definitions you need when you write WebSphere MQ applications in PL/I. They are listed in Table 74. They are installed in the following directories:

**Platform**

**Installation directory or library**

<table>
<thead>
<tr>
<th>OS/2</th>
<th>mqm\tools\pli\include</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows systems</td>
<td>\Program Files\IBM\WebSphere MQ\Tools\PLI\Include</td>
</tr>
<tr>
<td>z/OS</td>
<td>th1qual.SCSQPLIC</td>
</tr>
<tr>
<td>VSE/ESA</td>
<td>PRD2.MQSERIES</td>
</tr>
</tbody>
</table>

**Table 74. PL/I include files**

<table>
<thead>
<tr>
<th>Include file</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMQCFP[1]</td>
<td>Definitions for programmable commands</td>
</tr>
<tr>
<td>CMQEPP</td>
<td>Entry point definitions for the API calls.</td>
</tr>
<tr>
<td>CMQP</td>
<td>Definitions of all the constants and return codes, data types and structures, and constants to initialize the structures.</td>
</tr>
<tr>
<td>CMQXF[1]</td>
<td>Definitions for channel exits and data-conversion exits on z/OS. Named constants related to PCF on OS/2 Warp, and Windows systems.</td>
</tr>
</tbody>
</table>

**Note:**

1. MQSeries for VSE/ESA does not provide this include file.

Include these files in your program if you are going to link the WebSphere MQ stub to your program (see “Preparing your program to run” on page 383). Include only CMQP if you intend to link the WebSphere MQ calls dynamically (see “Dynamically calling the WebSphere MQ stub” on page 387). Dynamic linking can be performed for batch and IMS programs only.
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<thead>
<tr>
<th>Trademark</th>
<th>Trademark</th>
<th>Trademark</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD/Cycle</td>
<td>AIX</td>
<td>AS/400</td>
</tr>
<tr>
<td>C/370</td>
<td>C/400</td>
<td>CICS</td>
</tr>
<tr>
<td>CICS/ESA</td>
<td>COBOL/400</td>
<td>Common User Access</td>
</tr>
<tr>
<td>DB2</td>
<td>Encina</td>
<td>FFST</td>
</tr>
<tr>
<td>IBM</td>
<td>IMS</td>
<td>IMS/ESA</td>
</tr>
<tr>
<td>Integrated Language</td>
<td>iSeries</td>
<td>Language Environment</td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MQSeries</td>
<td>MVS</td>
<td>MVS/ESA</td>
</tr>
<tr>
<td>OpenEdition</td>
<td>OS/2</td>
<td>OS/390</td>
</tr>
<tr>
<td>OS/400</td>
<td>RACF</td>
<td>SAA</td>
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<td>SupportPac</td>
<td>System/390</td>
<td>TXSeries</td>
</tr>
<tr>
<td>VisualAge</td>
<td>VM/ESA</td>
<td>VSE/ESA</td>
</tr>
<tr>
<td>WebSphere</td>
<td>z/OS</td>
<td>zSeries</td>
</tr>
</tbody>
</table>

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assembler language (continued) using the MQI 76
attributes
  DefInputOpenOption 101
  DefPriority 28
  HardenGetBackout 31, 51
  IndexType 132
  inquiring about 171
  MaxMsgLength 109, 124
  MaxPriority 28
  MsgDeliverySequence 31, 124
  ProcessName 197
  queue manager 35
  queues 39
  selectors 171
  setting 171
  Shareability 101
  TrigData 197
  TriggerControl 202
  TriggerData 192
  TriggerDepth 203
  TriggerInterval 204
  TriggerMsgPriority 202
  TriggerType 202
audit trail using message context 32
authentication information
  See AUTHINFO object
AUTHINFO object
attributes 45
authority checking
  alternate user authority on MQOPEN 102
  by MQCLOSE 94
  by MQDISC 94
  by MQOPEN 95
automatically starting an application
  an example 437
  how triggering works 191
  introduction 15
B
backing out changes 31, 175
backout, skipping 142
BackoutCount field 31, 51
base queue 40
Basic
  compilers supported 521
  Basic Mapping Support with the CICS 3270 bridge 285
batch for WebSphere MQ for z/OS adapter 261
building an application 384
calling the stub dynamically 387
restrictions 80
support for 260
benefits of message queuing 8
binding
  FASTPATH 90, 93
  STANDARD 90, 93
BMS with the CICS 3270 bridge 285
bridge request queue
  setting options with the CICS bridge 302
BRMQ
  inbound structure with the CICS 3270 bridge 282
  outbound structure with the CICS 3270 bridge 282
browse cursor 100, 147
browsing (sample for WebSphere MQ for z/OS) 487
browsing messages 147
  using index 148
  browsing messages in logical order 150
  Buffer parameter 109
  BufferLength parameter 123
building applications 355
building Tuxedo applications 463
building your application
  batch with WebSphere MQ for z/OS 384
  CICS and WebSphere MQ for z/OS 385
  IMS 386
  on AIX 331
  on Compaq NonStop Kernel 339
  on Compaq OpenVMS Alpha 343
  on HP-UX 351
  on NCR UNIX SVR4 MP-RAS, R3.0 337
  on OS/2 357
  on OS/400 361
  on Solaris 369
  on Windows systems 375
  on z/OS 385
built-in formats 27
C
C language
  compilers supported 521
  examples
    MQCLOSE 529
    MQCONN 526
    MQDISC 526
    MQGET 532
    MQGET with signaling 534
    MQGET with wait option 533
    MQINQ 536
    MQOPEN for dynamic queue 527
    MQOPEN for existing queue 528
    MQPUT 529
    MQPUT1 530
    MQSET 537
    include files 592
    support for 73
  C language include files 355
    <cmqc.h> 592
    <cmqcf.h> 592
    <cmqcx.h> 592
    <cmqcz.h> 592
    header files 592
    include files 592
C++
  support for 72
  C++ language
    compilers supported 521
    C++ programs 355
C++ sample programs 405
call interface 63
calling dynamically with WebSphere MQ for z/OS 387
CAM (credit application manager) 505
CCSID (Coded Character Set Identifier)
  same as queue manager 26
CEDF (CICS Execution Diagnostic Facility) 78, 265
CEMT I TASK
  example with the CICS 3270 bridge 284
CETR (CICS Trace Control transaction) 392
CF (coupling facility) 6, 36
channel
  dataconversion exit 153
  channel queue 39
CICS
  adapter 262
  API-crossing exit 267
  assembler language applications 76
calling the stub dynamically with WebSphere MQ for z/OS 387
COBOL applications 334, 377, 378
CSQCAPX 267
debugging programs 392
Execution Diagnostic Facility 78
on OS/400 363
preparing C programs 335, 372
sample transaction for MQSeries for SINIX and DC/OSx 367
sample transaction for WebSphere MQ for AIX 335, 354
sample transaction for WebSphere MQ for Solaris 372
storage protection facility 269
trace 392
Trace Control transaction 392
WebSphere MQ for z/OS support 260
with MQSeries for OS/2 Warp 358
with MQSeries for SINIX and DC/OSx 367
with WebSphere MQ for AIX 334
with WebSphere MQ for HP-UX 353
with WebSphere MQ for Solaris 371
with WebSphere MQ for Windows 376
with WebSphere MQ for z/OS 385
CICS 3270 bridge
  3270 legacy applications 296
  Application Data Structure (ADS) 287, 291
  application programming 283
  Basic Mapping Support (BMS) 285
  CEMT I TASK example 284
  inbound BRMQ structure 282
  inbound message structure 282
  interpreting RECEIVE MAP vectors 291
  interpreting SEND MAP vectors 287
  managing units of work 285
  message structure 281
  optimized emulation example 298
  outbound BRMQ structure 282
  outbound message structure 282
<table>
<thead>
<tr>
<th><strong>CICS 3270 bridge (continued)</strong></th>
<th><strong>transactions 280</strong> transactions in the distributed environment 295 transactions with start data 295 unoptimized emulation example 297 using vectors 281</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CICS adapter</strong></td>
<td>** abreends 264** QLOP abend 264 trace points 264 using CEDF 265</td>
</tr>
<tr>
<td><strong>CICS bridge</strong></td>
<td>**Application Data Structure (ADS) 277 Application Data Structure terminology 308 applications on z/OS 277 COMMAREA data 277 debugging applications 306 distributed programming 295 DPL programs 277 error handling 304 legacy applications 277 managing MsgId and CorrelId 302 setting bridge request queue options 302 setting MQCRH fields 300 setting MQMD fields 299 unit of work 302 using DPL programs 278</td>
</tr>
<tr>
<td><strong>CICS DPL bridge</strong></td>
<td><strong>application programming 279 COMMAREA data 278 managing units of work 280 message structure 278 transactions in the distributed environment 296</strong></td>
</tr>
<tr>
<td><strong>CICS Execution Diagnostic Facility (CEDF) 265</strong></td>
<td><strong>CICS for OS/2 user exit 15 184 CICS sample transaction 455 CKQC transaction 87, 392 CKTI transaction 206, 213 client (WebSphere MQ) LU 6.2 link library 353 triggering support 191 WebSphere MQ clients and servers what it is 6 cluster what it is 5 cluster queue MQOPEN option 100 overview 38 clusters (message affinities) WebSphere MQ techniques 15</strong></td>
</tr>
<tr>
<td><strong>COBOL (continued)</strong></td>
<td><strong>examples (continued)</strong> MQINQ 555 MQOPEN for dynamic queue 543 MQOPEN for existing queue 544 MQPUT 546 MQPUT1 548 LITLINK directive 358, 366, 378 on AIX 333 on HP-UX 352 on OS/2 358 on OS/400 362 on S/390 or DC/OSx 366 on Solaris 370 on Windows systems 377 support for 75 using named constants 75 Coded Character Set Identifier (CCSID) same as queue manager 26 coded character sets 28 CodedCharSetId (CCSID) 27 message data 26 COMMAREA data with the CICS DPL bridge 278 commit single-phase 176 two-phase 176 committing changes 175 communication connectionless 6 time-independent 7 compilers supported 521 compiling for MQSeries for AT&amp;T GIS UNIX 337 for MQSeries for Compaq OpenVMS Alpha 343 for MQSeries for OS/2 Warp 357 for MQSeries for S/390 365 for WebSphere MQ for AIX 332 for WebSphere MQ for HP-UX 351 for WebSphere MQ for iSeries 361 for WebSphere MQ for Solaris 369 for WebSphere MQ for Windows 375 for WebSphere MQ for z/OS 383 compiling C programs 355 completion code 71 configuring for API exits 216 confirmation of arrival (COA) report 21 confirmation of delivery (COD) report 22 connecting to a queue manager 88, 90 connection handle returned from MQCONN 89 returned from MQCONNX 90 scope of 89, 93 shared 92 thread independent 92 using with MQGET 120 what it is 71 connection tag 273 connectionless communication 6 constants in COBOL 75 context default 110 context (continued) identity 33 message 32 MQOPEN options 101 MQPUT options 110 origin 33 context (Credit Check sample application) 511 Context field 107 convert characters call 156 convert message data MQGET 121, 145 copy files how to use them 593 copying messages 147 correlation identifier 31 CorrelId managing with the CICS bridge 302 CorrelId field 31, 131 coupling facility (CF) 6, 36 creating conversion-exit code 156 credit application manager (CAM) 505 credit check sample (WebSphere MQ for z/OS) 501 crtmqcvx 156 CSQ4BA1 sample 487 CSQ4CA1 sample 487 CSQ4VBA1 sample 487 CSQ4AC1 sample 493 CSQ4CB5 sample 509 CSQ4CC1 sample 493 CSQ4CG1 sample 489 CSQ4CVB1 sample 505 CSQ4CVB2 sample 505 CSQ4CVB3 sample 508 CSQ4CVB4 sample 508 CSQ4CVB5 sample 509 CSQ4CVC1 sample 493 CSQ4CD1 sample 498 CSQ4CD2 sample 499 CSQ4CD3 sample 499 CSQ4CD4 sample 500 CSQ4CD5 sample 501 CSQ4ICB3 sample 513 CSQ4TC1 sample 498 CSQ4TC2 sample 499 CSQ4TC3 sample 500 CSQ4TC4 sample 500 CSQ4TC5 sample 501 CSQ4TVD1 sample 498 CSQ4TVD2 sample 499 CSQ4TVD4 sample 500 CSQ4TVD5 sample 501 CSQ4CAP sample 267 CSQ4TRMN transaction 206, 213 CSQ4CVRX sample 156 cursor, browse 100, 147 CVTMQMDTA 156</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td><strong>data application 19 message 19, 109 data conversion amqsvfc0 sample program 445 AMQSVFC4 sample program 445 amqsvfx sample program 445</strong></td>
</tr>
</tbody>
</table>
data conversion (continued)
application 27
convert characters call 156
convert WebSphere MQ Data Type command 156
create WebSphere MQ conversion-exit command 156
IMS bridge 320
interface 153
message 145
MQGET 121, 145
MQXCNVC call 64
UNIX environment 165
z/OS considerations 155

data conversion interface (DCI) 153
data definition files 65
copy files 591
header files 591
include files 591
macros 591
data in a message 19, 109
data types
elementary 65
structures 65
data-conversion exit 153, 155
amqsvfc0 sample program 445
AMQSVFC4 sample program 445
amqsvfxc sample program 445
convert characters call 156
convert WebSphere MQ Data Type command 156
convert WebSphere MQ conversion-exit command 156
IMS bridge 320
invoking 154
MQXCNVC call 64
skeleton 156
UNIX environment 165
writing
Compaq NonStop Kernel systems 163
Compaq OpenVMS Alpha 164
OS/2 160
OS/400 159
UNIX systems 164
Windows NT 169
z/OS 162
datagram 20
DataLength parameter 123
date and time of messages 34
DCE sample exits 405
dead-letter (undelivered message) queue
handler 54
brief description 54
sample 467
overview 44
sample to deal with messages on it 467
use within WebSphere MQ for z/OS sample 510
using 53
dead-letter queue
shared 274
DeadLetterQName field 197
debugging applications
with the CICS bridge 306
debugging programs 391
default context 110
defining alias for queue manager 97
DefInputOpenOption attribute 101
DefPriority attribute 28
design considerations
performance hints and tips 16
disconnecting from a queue manager 94
distributed programming
CICS bridge 295
distribution lists 113
identifying 114
opening 114
putting messages to 116
using the MQPMR structure 117
DPL programs 277
dynamic linking of MQI calls for
WebSphere MQ for z/OS 387
dynamic queue
closing temporary queue 103
creating 102
overview 41
permanent queue properties 42
temporary queue properties 42
when to use 42
dynamic queues, shared queues 273
dynamic XA resource management structure 183
DynamicQName field 102

E
EBDIC newline character conversion 146
ECB (event control block) 141
emulation
example with the CICS 3270 bridge 297, 298
Encina sample transaction 466
Encoding field 26
environment variable
MQ_CONNET_TYPE 93
environments for WebSphere MQ for z/OS 259
error handling
with the CICS bridge 304
errors
defead-letter (undelivered message) queue 53
dealing with failure of a call 49
incorrect message data 51
report message 52
system interruptions 50
undelivered message queue 53
event control block 141
event queue 39
event-driven processing 8
examples
assembler language
MQCLOSE 564
MQCONN 560
MQDISC 561
MQGET 567
MQGET with signaling 570
MQGET with wait option 569
MQINQ 572
MQOPEN for dynamic queue 561
MQOPEN for existing queue 563
exception report 21
exclusive access to a queue 100
Execution Diagnostic Facility 78
execution key of CICS programs 269
exit programs 267
data conversion 155
expiry report 21
external syncpoint coordination 182
interfaces 183
restrictions 184
X/Open XA interface 183
EXTSHM environment variable 331

F
FASTPATH binding 90
environment variable 93
Fastpath UNIX applications 83
feedback codes, IMS bridge 317
Feedback field 23
flexes
AlternateUserld 102
H
handle
scope of connection handle 89, 93, 96
scope of object handle 96
using 71
using object handle 95
HardenGetBackout attribute 31, 51
Hconn
shared 92
thread independent 92
heap size
for OS/2 MQI client 338
WebSphere MQ for Windows 376
inquiring about attributes (continued)
WebSphere MQ for iSeries sample program 441
WebSphere MQ for UNIX sample program 441
WebSphere MQ for Windows sample program 441
WebSphere MQ for z/OS sample 493
installable services
in multithreaded environment 83
interfaces to external syncpoint managers 183
internal syncpoint coordination 181
intra group queuing agent 43
intra-group queuing (IGQ)
what it is 6
invoking data-conversion exit 154
J
Java programs
triggering on WebSphere MQ for iSeries 209
JCL (Job Control Language)
batch 384
CICS and WebSphere MQ for z/OS 385
IMS 386
L
languages 72
languages supported 521
large messages
reference messages 133
segmented messages 133
LDAP (lightweight directory access protocol) 395
legacy applications
with the CICS 3270 bridge 296
with the CICS bridge 277
libraries
MQI for MQSeries for Compaq NonStop Kernel 340
libraries to use
with MQSeries for AT&T GIS UNIX 337
with MQSeries for Compaq OpenVMS Alpha 343
with MQSeries for OS/2 Warp 357
with MQSeries for SINIX and DC/OSx 368
with WebSphere MQ for AIX 332
with WebSphere MQ for HP-UX 352
with WebSphere MQ for Solaris 370
with WebSphere MQ for Windows 375
library files 65
libs.a 333
libsnastubs.a 353
lightweight directory access protocol (LDAP) 395
linking
for MQSeries for AT&T GIS UNIX 337
linking (continued)
  for MQSeries for Compaq OpenVMS
  Alpha 343
  for MQSeries for OS/2 Warp 357
  for MQSeries for SINIX and
  DC/OSs 365
  for WebSphere MQ for AIX 332
  for WebSphere MQ for HP-UX 351
  for WebSphere MQ for iSeries 361
  for WebSphere MQ for Solaris 369
  for WebSphere MQ for Windows 375
  for WebSphere MQ for z/OS 383
  linking in the MQI client environment
  when using LU 6.2 353
  linking libraries 356
  LLZZ data segment, IMS bridge 320
  local queue 37
  looking at a message 147
  macros, assembler language 595
  mail manager sample application
  (WebSphere MQ for z/OS) 494
  MatchOptions field
  MQGMO structure 122
  maximum message length
  increasing 134
  maximum message size, shared
  queues 273
  MaxMsgLength attribute 109, 124
  MaxPriority attribute 28
  MCA (message channel agent), definition
  of 4
  message
  backed out 31
  browsing 147
    using index 148
  browsing and removing 149
  browsing in logical order 150
  browsing when message length
  unknown 149
  channel agent definition 4
  confirm arrival 21
  confirm delivery 22
  context
    MQOPEN options 101
    MQPUT options 110
    types 32
  control information 20
  copying 147
  creating 19
  data 19, 109
  data conversion
    considerations 27
    MQGET 145
  data format 26
  datagram 20
  definition 4
  descriptor
    MQMD structure 20
    when using MQGET 120
    when using MQPUT 106
  design 13
  exception 21
  expiry 21
  getting 119
  message (continued)
  getting a particular 131
  greater than 4 MB 133
  groups 28
  identifier 31
  logical ordering 124
  looking at 147
  maximum size 109
  negative action notification 22
  notification of arrival 140
  order of retrieval from a queue 124
  originator information 33
  persistence 30
  persistence and triggers 209
  physical ordering 124
  positive action notification 22
  priority 28, 124
  priority and triggers 209
  problem delivering 53
  putting 105
  putting one 111
  reference 137
  removing after browsing 149
  reply 21
  reply, IMS bridge 319
  report 21, 52
  retry sending 53
  return to sender 53
  sample to deal with those on
  dead-letter queue 467
  segmentation 134
  segmented 29
  selecting from a queue 31
  signaling 140
  size 109
  structure 19
  trigger 192, 209
  trigger after queue manager
  restart 209
  trigger format 210
  type for status information 21
  type when no reply required 20
  types 20
  undeliverable, IMS bridge 316
  undelivered 53
  undelivered, sample to handle 467
  use of types 20
  waiting for 139
  message affinities (clusters)
  WebSphere MQ techniques 15
  message channel agent (MCA), definition
  of 4
  message context (Credit Check sample
  application) 511
  message data conversion, MQGET 121,
  145
  message handler sample (WebSphere MQ
  for z/OS) 514
  Message Queue Interface (continued)
    using System/390 assembler 76
  message queue, definition of 4
  message queuing 3
  benefits of 8
  features 6
  message segmentation, IMS bridge 320
  message structure
    for the CICS DPL bridge 278
    inbound with the CICS 3270
    bridge 282
    outbound with the CICS 3270
    bridge 282
  messages
    mapping to IMS transaction
      types 316
    retrieving in correct order 272
  migrating applications to use shared
  queues 274
  model queue 41, 102
  MQ_CONNECT_TYPE 93
  MQ_MSG_HEADER_LENGTH 110
  MQ_*_DEFAULT values
    with WebSphere MQ for AIX 74
  MQACH structure 226
  MQAXC structure 224
  MQAXP structure 218
  MQCA_* values 171
  MQCH
    setting fields with the CICS
    bridge 300
  MQCLOSE
    authority checking 94
    call parameters 104
    closing a queue 103
  MQCLOSE, using the call
    Assembler example 564
    C language example 529
    COBOL example 546
    PL/1 example 579
  MQCMIT 178
  MQCONN
    call parameters 88
    scope of 89
  MQCONN, using the call
    Assembler example 560
    C language example 526
    COBOL example 542
    PL/1 example 576
  MQCONNX 90
  environment variable 93
  options
    FASTPATH binding 90
    shared connection 92
    STANDARD binding 92
    thread independent connection 92
    scope of 89
  MQCONNXAny call
    use in Visual Basic 80
  MQDHH 109
  MQDISC
    authority checking 94
    when to use 94
  MQDISC, using the call
    Assembler example 561
    C language example 526
    COBOL example 542
MQDISC, using the call (continued)
PL/I example 576
MQDLH 53, 109
MQGET
backing out changes 175
buffer size 123
call parameters 119
committing changes 175
data conversion 145
increase speed of 132
message data conversion 121
message options 120
order of message retrieval 124
to get a specific message 131
triggered queues 205
unknown message length 149
using MQGMO 120
using MQMD 120
waiting for messages 139
with TM/MP 188
when it fails 152
when to use 119
MQGET, using the call
Assembler example 567
C language example 532
COBOL 549
PL/I example 582
MQGET, using the call with signaling
Assembler example 570
C language example 534
COBOL example 552
PL/I example 585
MQGET, using the call with the wait option
Assembler example 569
C language example 533
COBOL example 551
PL/I example 583
MQGMO 120
MQGMO_*
ACCEPT_TRUNCATED_MSG 123
MQGMO_BROWSE_*
FIRST 147
MSG_UNDER_CURSOR 149
NEXT 147
MQGMO_CONVERT 145
MQGMO_MARK_SKIP_BACKOUT 51
explanation 142
MQGMO_MSG_UNDER_CURSOR 149
MQGMO_WAIT 139
MQI
libraries
for MQSeries for Compaq NonStop Kernel 340
MQI (Message Queue Interface)
calls 63
client library files 65
data definition files 65
dealing with failure of a call 49
elementary data types 65
IMS applications 311
library files 65
overview 15
structures 65
stub programs 65
using System/390 assembler 76
MQI client
LU 6.2 link library 353
MQIA_* values 172
MQIH 315
MQINQ
call parameters 172
use of selectors 171
when it fails 173
MQINQ using the call
C language example 536
COBOL example 555
PL/I example 587
MQINQ, using the MQINQ and MQSET calls
Assembler example 572
MQMD
overview 20
setting fields with the CICS bridge 299
versions 20
when using MQGET 120
when using MQPUT 106
MQMT_* values 20
MQQD 96
MQQQO_* values 100
MQOPEN
browse cursor 147
call parameters 96
MQQQO_* values 100
object handle 95
using MQQD 96
using options parameter 100
MQOPEN, using the call to create a dynamic queue
Assembler example 561
C language example 527
COBOL example 543
PL/I example 577
MQOPEN, using the call to open an existing queue
Assembler example 563
C language example 528
COBOL example 544
PL/I example 578
MQPMO 106
MQPUT
backing out changes 175
call parameters 105
committing changes 175
context information 110
if it fails 118
quiescing queue manager 107
syncpointing 107
using MQPMO 106
MQPUT, using the call
Assembler example 564
C language example 529
COBOL example 546
PL/I example 579
MQPUT1
call parameters 111
if it fails 118
performance 105
MQPUT1, using the call
Assembler example 566
C language example 530
COBOL example 548
MQPUT1, using the call (continued)
PL/I example 581
MQRC_*
SECOND_MARK_NOT_ALLOWED 143
MQRMIXASwitch 183
MQRMIXASwitchDynamic 183
MQSeries for AT&T GIS UNIX
amqisetx 443
amqmsetx 443
amqsseta 443
building your application 337
C compiler 337
compilers supported 521
flags when compiling 337
key features 10
link libraries 337
sample programs 405
set sample 443
syncpoints 180
triggering using samples 437
TUXEDO samples 455
ubbingstcc.cfg example 459
MQSeries for Compaq NonStop Kernel application
FASTPATH binding 341
guardian 340
running 342
STANDARD binding 341
building your application 339
compilers supported 521
compiling and binding applications 340
FASTPATH binding 341
Java Transaction Services 340
MQI libraries 340
notification of message arrival 140
program design considerations 339
running applications 342
sample programs 405
STANDARD binding 341
supported compilers 339
syncpoint considerations 187
threads in applications 340
TM/MP
using MQGET wait interval 188
triggering applications 212
using signaling 140
MQSeries for Compaq OpenVMS Alpha
building your application 343
C compiler 343
compilers supported 521
flags when compiling 343
link libraries 343
sample programs 405
triggering an application 211
MQSeries for Compaq Tru64 UNIX
applications, building in C 345
building applications in C 345, 346
in C++ 347, 348
in COBOL 349
in Java 350
C language include files
<cmqc.h> 345, 346
<cmqcfc.h> 345, 346
Index 609
MQSeries for Compaq Tru64 UNIX
(Ccontinued)
C language include files
<cmqxc.h> 345, 346
<cmqzc.h> 345, 346
C programs, compiling 347
C++ language include files
<cmqc.h> 347, 348
<imqi.hpp> 347, 348
<imqtype.h> 347, 348
compiling C programs 347, 348
compiling C++ programs 347
compiling COBOL programs 349
compiling Java programs 350
linking libraries
in C 346, 347
in C++ 348, 349
in COBOL 350
MQSeries for DIGITAL UNIX (Compaq Tru64 UNIX)
compilers supported 521
sample programs 405
MQSeries for OS/2 Warp
building your application 357
CICS support 358
compilers supported 521
key features 10
sample programs 405
scope of MQCONN and MQCONNX 89
synpoints 180
Transaction Server support 358, 360
triggering using samples 437
MQSeries for SINIX and DC/OSx
build TUXEDO server environment 458, 459
building your application 365
CICS support 367
compilers supported 521
flags when compiling 365
link libraries 368
sample programs 405
MQSeries for VSE/ESA
building your application 373
compilers supported 521
sample programs 405
MQSET
attribute list 173
call parameters 173
use of selectors 171
MQSET, using the call
C language example 537
COBOL example 556
PL/1 example 588
MQSET, using the MQINQ and MQSET calls
Assembler example 572
MQTM 210
MQTM (trigger message) 208
MQTMC (trigger message, character) 208
MQTMC2 (trigger message, character) 208
MQTRANSACTIONLIFE
refresh TM/MP transaction 188
MQXCNVC data-conversion call 64
MQXEP call 230
MQXQH 109
MsgDeliverySequence attribute 31, 124
MsgId
managing with the CICS bridge 302
MsgId field 131
MsgToken field
MQGMO structure 123
N
name resolution 47, 97
namelist
attributes 44
opening 95
rules for naming 46
sample application 508
naming of WebSphere MQ objects 46
negative action notification (NAN) report 22
notification of message arrival 140
object
AUTHINFO
attributes 45
closing 103
creating 12
descriptor 96
handle 71
introduction 12
naming 46
opening 95
process definition 196
attributes 45
queue 37
queue manager 35
rules for naming 46
storage class 45
using handle 95
what it is 35
object-oriented programming (OOP) 325
OOP (object-oriented programming) 325
opening a WebSphere MQ object 95
opening distribution lists
identifying distribution lists 114
identifying Object Records 114
the MQOD structure 114
the MQOR structure 114
Options field
MQGMO structure 121
MQPMO structure 107
Options parameter (MQOPEN call) 100
order of message retrieval 124
origin context 33
OTMA sense codes 317
P
parameters
Buffer 109
BufferLength 123
DataLength 123
Options 100
performance
design hints and tips 16
MQGET and buffer size 123
MQGET for a particular message 132
MQPUT1 105
persistent messages 30
permanent dynamic queue, properties 42
Persistence field 30
PL/1
CMQEP E 597
CMQP 597
compilers supported 521
examples
MQCLOSE 579
MQCONN 576
MQDISC 576
MQGET 582
MQGET with signaling 585
MQGET with wait option 583
MQINQ 587
MQOPEN for dynamic queue 577
MQOPEN for existing queue 578
MQPUT 579
MQPUT1 581
MQSET 588
include files 597
on AIX 334
on OS/2 360
on Windows NT 379
support for 79
planning a WebSphere MQ application 11
platform support
list of 16
positive action notification (PAN) report 22
print message (sample for WebSphere MQ for z/OS) 489
Priority field 28
priority in messages 28
problem delivering a message, overview 31
problem determination
abend codes issued by the CICS adapter 264
trace points in CICS adapter 264
using CEDF with the CICS adapter 265
problem determination, use of report message 52
process definition object
attributes 45
example to create one 196
opening 95
rules for naming 46
triggering prerequisite 196
what it is 192
ProcessName 208
ProcessName attribute 197
programming languages 72
put (sample for WebSphere MQ for z/OS) 482
put-message options 106
PutAppName field 33
PutAppType field 33
PutDate field 33
Index 611

PutMsgRecFields field 108
PutMsgRecOffset field 108
PutMsgRecPtr field 108
PutTime field 33
putting messages 105
putting messages to a distribution list
the MQPMR structure 117
Q
QLOP abend on WebSphere MQ for z/OS 479
QLOP abend, CICS adapter 264
QMQM library 592
QSG (queue-sharing group) 10
what it is 6, 36
queue alias 38, 40
application attributes 39
authority check on MQOPEN 95
base 40
channel 39
closing 95, 103
cluster 38
creating 37
dead-letter 44, 53
dead-letter on WebSphere MQ for z/OS 510
definition 4
dynamic
permanent 42
temporary 42
dynamic, creation of 102
event 39
exclusive access 100
handle 95
initiation 44, 193
introduction to 37
local definition 37
model 41, 102
name resolution 47
name resolution when remote 103
object handle 95
opening 95
order of messages 31
remote
definition 37
putting messages 110
using 40
using local definition 97
using MQOPEN 103
reply-to 32
resolving name 97
rules for naming 46
selecting messages 31
shared 38
shared access 100
system admin command 44
system command 39
system command input 44
system default 39, 44
transmission 38, 43
triggered 204
undelivered message 44, 53
queue attributes for WebSphere MQ for z/OS
sample application 493
queue manager
alias definition 97
attributes 35
authority checking 94
connecting using MQCONN 88
connecting using MQCONNX 90, 93
definition 5
disconnecting 94
location of default 88
number per system 5
reply-to 32
restart and trigger messages 209
scope of MQCONN and MQCONNX 89
workload management 36
queue-sharing group (QSG) 10
what it is 6, 36
queue-sharing groups
application programming 272
queueing definition 3
features 6
quiescing connection
MQGET 121
quiescing queue manager
how applications should react 50
MQCONN 89
MQOPEN 102
MQPUT 107
R
reason codes 71
RECEIVE MAP vectors
interpreting with the CICS 3270
bridge 291
recoverable resource manager services (RRS)
batch adapter 261
what it is 179
recovery 8, 261
RecsPresent field 107
reenterable assembler-language programs 78
reference messages 137
remote queue
definition 37
using 40
using local definition of 97
using MQOPEN 103
reply message 21
reply messages, IMS bridge 319
reply-to 32
reply-to queue 32
reply-to queue manager 32
ReplyToQ field 32
ReplyToQMgr field 32
report
confirmation of arrival (COA) 21
confirmation of delivery (COD) 22
exception 21
expiry 21
negative action notification (NAN) 22
positive action notification (PAN) 22
Report field 21
report message
creating 52
options 22
type of 21
reports
application-generated 24
request of 24
segmented messages 23
WebSphere MQ-generated 24
request message 21
resolution of queue names 47, 97
ResolvedQMgrName field 107
ResolvedQName field
MQGMO structure 122
MQPMO structure 107
resource manager, XA compliant name 183
ResponseRecOffset field 108
ResponseRecPtr field 108
restrictions in z/OS batch 80
retry sending message 53
return codes 71
ReturnedLength field
MQGMO structure 123
RPG language
compilers supported 521
on OS/400 363
support for 78
RPG sample programs 405
RRS (recoverable resource manager services)
batch adapter 261
what it is 179
runmqcmd monitor 207
runmqtrm monitor
error detection 213
how to run 207
running a program automatically
an example 437
how triggering works 191
S
sample applications
API-crossing exit for z/OS 267
sample applications for WebSphere MQ for z/OS
browse 487
credit check 501
features of MQI demonstrated 471
going 485
logging on to CICS 478
mail manager 494
message handler 514
preparing in batch 475
preparing in CICS Transaction Server for z/OS 478
preparing in IMS 481
preparing in TSO 477
print message 489
put 482
queue attributes 493
sample programs
building C versions 415
building C++ versions 417
building COBOL versions 418
sample programs (continued)
building TAL versions 420
building versions on OSS 420
C++ 405
DCE exits 405
preparing and running
Compaq NonStop Kernel 415
Compaq OpenVMS Alpha systems 413
OS/2 and Windows systems 414
OS/400 413
UNIX systems 413
RPG 405
sample programs for MQSeries for OS/2
Warp, Windows systems, and UNIX systems
sample programs for MQSeries for OS/2
Warp, Windows systems, and UNIX systems (continued)
SegmentStatus field
MQGMO structure 123
selection of messages from queues 31
selector for attributes 171
SEND MAP vectors
interpreting with the CICS 3270 bridge 287
send message, retry on failure 53
sense codes, IMS 317
serialized applications 272
server application (IMS) 312
server environment
TUXEDO 455
setting attributes 171
setting attributes on WebSphere MQ for z/OS 493
Shareability attribute 101
shared access to a queue 100
shared queue 10
overview 38
what it is 6, 36
shared queues
application programming 272
dead-letter queue 274
initiation queue 274
SYSTEM.* queues 274
signal handling on UNIX products 81
before version 5.2 82
additional considerations 83
asynchronous signals 82
fastpath applications 83
MQI function calls 83
non-threaded applications 82
synchronous signals 82
threaded applications 82
from version 5.2 84
additional considerations
(threaded) 85
fastpath applications 85
installable services 86
MQI function calls 85
synchronous signals 84
threaded applications 84
unthreaded applications 84
user exits 86
Signal1 field 122, 141
Signal2 field
MQGMO structure 122
signaling 14, 140
single-phase commit 176
size of messages 109
skeloton data-conversion exit 156
skipping backout 142
SQL on OS/400 364
SSL authentication information
See AUTHINFO object
stack size
for OS/2 MQI client 358
WebSphere MQ for Windows 376
STANDARD binding 90
environment variable 93
starting applications automatically
an example 437
how triggering works 191
introduction 15
static XA resource management
structure 183
scope, handles 89, 93, 96
security 8
Security Services Programming Interface (SSPI)
extit for WebSphere MQ for Windows 380
Segmentation field
MQGMO structure 123
segmented messages 29
reports 23
segmented messages, IMS bridge 320
Signal1 field
MQGMO structure 123
sense codes, IMS 317
serialized applications 272
server application (IMS) 312
server environment
TUXEDO 455
setting attributes 171
setting attributes on WebSphere MQ for z/OS 493
Shareability attribute 101
shared access to a queue 100
shared queue 10
overview 38
what it is 6, 36
shared queues
application programming 272
dead-letter queue 274
initiation queue 274
SYSTEM.* queues 274
signal handling on UNIX products 81
before version 5.2 82
additional considerations 83
asynchronous signals 82
fastpath applications 83
MQI function calls 83
non-threaded applications 82
synchronous signals 82
threaded applications 82
from version 5.2 84
additional considerations
(threaded) 85
fastpath applications 85
installable services 86
MQI function calls 85
synchronous signals 84
threaded applications 84
unthreaded applications 84
user exits 86
Signal1 field 122, 141
Signal2 field
MQGMO structure 122
signaling 14, 140
single-phase commit 176
size of messages 109
skeloton data-conversion exit 156
skipping backout 142
SQL on OS/400 364
SSL authentication information
See AUTHINFO object
stack size
for OS/2 MQI client 358
WebSphere MQ for Windows 376
STANDARD binding 90
environment variable 93
starting applications automatically
an example 437
how triggering works 191
introduction 15
static XA resource management
structure 183
store-and-forward 7
Strucl field
MQGMO structure 121
MQPM0 structure 106
structures 65
in COBOL copy files 593
stub program for WebSphere MQ for z/OS 384
CICS 385
CSQBSTUB 384
calling dynamically 387
CSQCSTUB 385
calling dynamically 387
CSQOSTUB 386
IMS 386
stub programs 65
syncpoint
calls by platform 63
considerations 176
external coordination 182
external manager interfaces 183
IMS applications 311
in CICS for iSeries applications 180
in Compaq NonStop Kernel applications 187
in the Credit Check sample application 511
internal coordination 181
MQBACK 179
MQCMIT 178
overview 8
single-phase commit 176
two-phase commit 176
with MQSeries for OS/2 Warp 180
with WebSphere MQ for AIX 180
with WebSphere MQ for HP-UX 180
with WebSphere MQ for iSeries 180, 185
with WebSphere MQ for Windows 180
with WebSphere MQ for z/OS 260
with WebSphere MQ on UNIX systems 180
X/Open XA interface 183
sysplex 6, 36
system command queue 39
system command queues 44
system default queue 39, 44
system interruptions 50
SYSTEM.* queues, shared 274

T
TAL
compilers supported 521
support for 80
techniques with WebSphere MQ 14
temporary dynamic queue closing 103
properties 42
testing WebSphere MQ applications 17
threads, maximum no. 89
time and date of messages 34
time-independent communication 7
TMI (trigger monitor interface) 208
trace entries for CICS adapter 392
trace points in CICS adapter 264
Transaction Server
with MQSeries for OS/2 Warp 358, 360
with WebSphere MQ for Windows 376
transactions
with CICS 3270 bridge 280
transactions in the distributed environment
CICS 3270 bridge 295
CICS DPL bridge 296
transactions with start data
CICS 3270 bridge 295
translation of data 146
transmission queue 38, 43
TrigData attribute 197
trigger
event 192
conditions for 198
controlling 202
feedback code 213
following queue manager restart 209
message
definition 192
MQTM format 210
object attribute changes 210
persistence and priority 209
properties 209
without application messages 199
monitor
for WebSphere MQ for iSeries 209
what it is 193
writing your own 208
monitor, provided
amqtmlcm 206
AMQSERV4 206
AMQSTRG0 206
AMQSTRG4 206
AMQSTRG4 sample program 446
by platform 206
CKTI 206
CSQOTRMN 206
runmqtm 206
runmqtrm 206
process definition 192
server
AMQSERV4 sample program 447
of 203
type
trigger monitor interface (TMI) 208
TriggerControl attribute 202
TriggerData attribute 192
TriggerDepth attribute 203
triggering
an application on Compaq OpenVMS Alpha 211
application design 204
application queue 191
applications from MQSeries for Compaq NonStop Kernel 212
example of type DEPTH 203
example of type EVERY 203
example of type FIRST 203, 204
getting messages 205
how it works 194
how it works with the samples 437
IMS bridge 322
triggering (continued)
introduction 15, 191
Java applications on WebSphere MQ for iSeries 209
points to note 194
prerequisites 196
process definition attributes 45
sample program
for WebSphere MQ for iSeries 439
sample trigger monitor for MQSeries for OS/2 Warp 446
sample trigger monitor for WebSphere MQ for Windows 446
sample trigger monitor for WebSphere MQ on UNIX systems 446
sequence of events 194
setting conditions 202
what it is 191
when it does not work 213
with the request sample on MQSeries for OS/2 Warp 437
with the request sample on WebSphere MQ for Windows 437
with the request sample on WebSphere MQ on UNIX systems 437
with units of work 204
without application messages 199
triggering for WebSphere MQ for z/OS sample application 505
TriggerInterval attribute 204
TriggerMsgPriority attribute 202
TriggerType attribute 202
trusted applications 90, 93
Tuxedo
WebSphere MQ and XA support 189
Tuxedo applications, building 463
TUXEDO sample makefile for WebSphere MQ for Windows 462
TUXEDO sample programs
amqstgxx 455
amqstgpx 455
amqstgx 455
building server environment 455
TUXEDO ubbstxcn.cfg example for WebSphere MQ for Windows 461
TUXEDO ubbstxcx.cfg example for WebSphere MQ on UNIX systems 459
two-phase commit 176

U
ubbstxcn.cfg example for WebSphere MQ for Windows 461
ubbstxcx.cfg example for WebSphere MQ on UNIX systems 459
undelivered message queue, using 53
undelivered messages, IMS bridge 316
unit of work
message persistence 30
syncpoint 175
triggering 204
with the CICS bridge 302
units of work
managing with CICS DPL bridge 280
managing with the CICS 3270 bridge 285

Index 613
UNIX products
Fastpath applications 83
installable services 83
MQI function calls 83
SIGALRM 83
signal handling 81
signals during MQI calls 83
threaded client applications 84
user exits 83
use of message types 20
user exits 267
user exits, in multithreaded environment 83
user-defined formats 27
UserIdentifier field 33
Valid syntax
creating conversion-exit code 157
input data set 157
vectors
using with CICS 3270 bridge 281
Version field 107
MQGMO structure 121
MQPMO structure 107
Visual Basic
amqcnodb.vbp sample 80
MQCNOCOD structure 80
MQCONNAny call 80
on Windows NT 379
support for 80
Visual Basic language
module files 592
Visual Basic module files
CMQB.BAS 592
CMQB3.BAS 592
CMQB4.BAS 592
CMQBB.BAS 592
CMQCFB.BAS 592
CMQXB.BAS 592
module files 592
Waiting for messages 14, 139
WaitInterval field 122, 139
WebSphere MQ applications
planning 11
testing 17
WebSphere MQ client
connection to queue manager 89
using triggering 192
what it is 6
WebSphere MQ data conversion interface 153
WebSphere MQ for AIX
amqisetx 443
amqmssetx 443
amqseta 443
amqzsc 188
amqzsc21 188
amqzscn 188
WebSphere MQ for AIX (continued)
build TUXEDO server environment 453
building your application 331
CICS support 334
compilers supported 521
key features 10
sample programs 405
scope of MQCONN and MQCONNX 89
set sample 443
syncpoints 180
triggering using samples 437
TUXEDO samples 455
ubbstxcx.cfg example 459
XA switch load module 188
WebSphere MQ for HP-UX
amqisetx 443
amqmssetx 443
amqseta 443
amqzsc 188
build TUXEDO server environment 457
building your application 351
CICS support 353
compilers supported 521
sample programs 405
scope of MQCONN and MQCONNX 89
set sample 443
syncpoints 180
triggering using samples 437
TUXEDO samples 455
ubbstxcx.cfg example 459
XA switch load module 188
WebSphere MQ for iSeries
AMQZSTUB 361
building your application 361
compilers supported 521
compiling 361
CRTC MOD 361
disconnecting from queue manager 94
key features 10
linking 361
sample program
using triggering 439
SQL programming considerations 364
syncpoint considerations with CICS for iSeries 180
syncpoints 180, 185
trigger monitors 209
triggering Java applications 209
WebSphere MQ for Linux
compilers supported 521
WebSphere MQ for Solaris
build TUXEDO server environment 456, 459
building your application 369
C compiler 369
CICS support 371
compilers supported 521
link libraries 370
sample programs 405
WebSphere MQ for Windows
amqspin.dll 469
WebSphere MQ for Windows (continued)
amqspin.c 470
authentication
Kerberos 380
NTLM 380
build TUXEDO server environment 460
building your application 375
channel-exit program 380
CICS support 376
compilers supported 521
collection client, security exit 380
collection client, security exit 380
Kerberos
authentication 380
key features 10
NTLM authentication 380
object code, security exit 469
principal, security exit 380, 383
sample programs 405
sample security exit 380
scope of MQCONN and MQCONNX 89
security exit
object code 469
sample 380
source code 470
Security Services Programming Interface (SSPI) 380
servicePrincipalName, security exit 383
source code, security exit 470
syncpoints 180
Transaction Server support 376
triggering using samples 437
TUXEDO sample makefile 462
TUXEDO samples 455
ubbstxcn.cfg example 461
WebSphere MQ for z/OS
building your application 383
CMQA 595
CMQDLHA 595
CMQDXPA 595
CMQEP 597
CMQGMOA 595
CMQIIHA 595
CMQMDA 595
CMQODA 595
CMQP 597
CMQPMOA 595
CMQTM 595
CMQTMC2A 595
CMQXA 595
CMQPXA 595
CMQXQHA 595
compilers and assemblers supported 521
CSQBSTUB 384
CSQCSSTUB 385
CSQGSTUB 386
key features 9
requesting no backout of MQGET 142
using signaling 140
WebSphere MQ object
branching 103
creating 12
WebSphere MQ object (continued)
introduction 12
namelist 44
naming 46
opening 95
process definition
attributes 45
create 196
queue 37
queue manager 35
rules for naming 46
storage class 45
what it is 35
WebSphere MQ on UNIX systems
key features 10
sample programs 405
syncpoints 180
triggering using samples 437
TXEDO 455
ubbstcex.cfg example 459
WebSphere MQ Workflow 271
Windows 95 and Windows 98 clients
compilers supported 521
WLM (workload manager) 271
Workflow 271
workload management
queue manager 36
workload manager (WLM) 271
writing applications 321
writing exit programs
data conversion
Compaq NonStop Kernel
systems 163
Compaq OpenVMS Alpha 164
MQSeries for OS/2 Warp 160
UNIX systems 164
WebSphere MQ for iSeries 159
WebSphere MQ for z/OS 162
Windows NT 169

X
X/Open XA interface support 183
XA resource manager
name 183
XA support
switch load module 188
WebSphere MQ with Tuxedo 189
XA transaction manager samples 448

Z
z/OS
batch restrictions 80
OpenEdition 266
support for 260
WLM (workload manager) 271
workload manager (WLM) 271
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