

[MS-MQBR-Diff]:

Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm

Intellectual Property Rights Notice for Open Specifications Documentation

- **Technical Documentation.** Microsoft publishes Open Specifications documentation (“this documentation”) for protocols, file formats, data portability, computer languages, and standards support. Additionally, overview documents cover inter-protocol relationships and interactions.
- **Copyrights.** This documentation is covered by Microsoft copyrights. Regardless of any other terms that are contained in the terms of use for the Microsoft website that hosts this documentation, you can make copies of it in order to develop implementations of the technologies that are described in this documentation and can distribute portions of it in your implementations that use these technologies or in your documentation as necessary to properly document the implementation. You can also distribute in your implementation, with or without modification, any schemas, IDLs, or code samples that are included in the documentation. This permission also applies to any documents that are referenced in the Open Specifications documentation.
- **No Trade Secrets.** Microsoft does not claim any trade secret rights in this documentation.
- **Patents.** Microsoft has patents that might cover your implementations of the technologies described in the Open Specifications documentation. Neither this notice nor Microsoft's delivery of this documentation grants any licenses under those patents or any other Microsoft patents. However, a given Open Specifications document might be covered by the Microsoft [Open Specifications Promise](#) or the [Microsoft Community Promise](#). If you would prefer a written license, or if the technologies described in this documentation are not covered by the Open Specifications Promise or Community Promise, as applicable, patent licenses are available by contacting iplg@microsoft.com.
- **License Programs.** To see all of the protocols in scope under a specific license program and the associated patents, visit the [Patent Map](#).
- **Trademarks.** The names of companies and products contained in this documentation might be covered by trademarks or similar intellectual property rights. This notice does not grant any licenses under those rights. For a list of Microsoft trademarks, visit www.microsoft.com/trademarks.
- **Fictitious Names.** The example companies, organizations, products, domain names, email addresses, logos, people, places, and events that are depicted in this documentation are fictitious. No association with any real company, organization, product, domain name, email address, logo, person, place, or event is intended or should be inferred.

Reservation of Rights. All other rights are reserved, and this notice does not grant any rights other than as specifically described above, whether by implication, estoppel, or otherwise.

Tools. The Open Specifications documentation does not require the use of Microsoft programming tools or programming environments in order for you to develop an implementation. If you have access to Microsoft programming tools and environments, you are free to take advantage of them. Certain Open Specifications documents are intended for use in conjunction with publicly available standards specifications and network programming art and, as such, assume that the reader either is familiar with the aforementioned material or has immediate access to it.

Support. For questions and support, please contact dochelp@microsoft.com.

Revision Summary

Date	Revision History	Revision Class	Comments
7/20/2007	0.1	Major	MCPP Milestone 5 Initial Availability
9/28/2007	1.0	Major	Updated and revised the technical content.
10/23/2007	1.0.1	Editorial	Changed language and formatting in the technical content.
11/30/2007	2.0	Major	Updated and revised the technical content.
1/25/2008	2.0.1	Editorial	Changed language and formatting in the technical content.
3/14/2008	2.1	Minor	Clarified the meaning of the technical content.
5/16/2008	2.1.1	Editorial	Changed language and formatting in the technical content.
6/20/2008	2.1.2	Editorial	Changed language and formatting in the technical content.
7/25/2008	2.1.3	Editorial	Changed language and formatting in the technical content.
8/29/2008	3.0	Major	Updated and revised the technical content.
10/24/2008	3.0.1	Editorial	Changed language and formatting in the technical content.
12/5/2008	3.0.2	Editorial	Changed language and formatting in the technical content.
1/16/2009	3.0.3	Editorial	Changed language and formatting in the technical content.
2/27/2009	3.0.4	Editorial	Changed language and formatting in the technical content.
4/10/2009	3.0.5	Editorial	Changed language and formatting in the technical content.
5/22/2009	4.0	Major	Updated and revised the technical content.
7/2/2009	4.1	Minor	Clarified the meaning of the technical content.
8/14/2009	4.1.1	Editorial	Changed language and formatting in the technical content.
9/25/2009	4.2	Minor	Clarified the meaning of the technical content.
11/6/2009	5.0	Major	Updated and revised the technical content.
12/18/2009	5.0.1	Editorial	Changed language and formatting in the technical content.
1/29/2010	5.1	Minor	Clarified the meaning of the technical content.
3/12/2010	5.1.1	Editorial	Changed language and formatting in the technical content.
4/23/2010	5.1.2	Editorial	Changed language and formatting in the technical content.
6/4/2010	5.1.3	Editorial	Changed language and formatting in the technical content.
7/16/2010	6.0	Major	Updated and revised the technical content.
8/27/2010	7.0	Major	Updated and revised the technical content.
10/8/2010	7.0	None	No changes to the meaning, language, or formatting of the technical content.
11/19/2010	7.0	None	No changes to the meaning, language, or formatting of the technical content.

Date	Revision History	Revision Class	Comments
1/7/2011	7.0	None	No changes to the meaning, language, or formatting of the technical content.
2/11/2011	8.0	Major	Updated and revised the technical content.
3/25/2011	9.0	Major	Updated and revised the technical content.
5/6/2011	10.0	Major	Updated and revised the technical content.
6/17/2011	10.1	Minor	Clarified the meaning of the technical content.
9/23/2011	10.1	None	No changes to the meaning, language, or formatting of the technical content.
12/16/2011	10.1	None	No changes to the meaning, language, or formatting of the technical content.
3/30/2012	10.1	None	No changes to the meaning, language, or formatting of the technical content.
7/12/2012	10.2	Minor	Clarified the meaning of the technical content.
10/25/2012	11.0	Major	Updated and revised the technical content.
1/31/2013	11.0	None	No changes to the meaning, language, or formatting of the technical content.
8/8/2013	12.0	Major	Updated and revised the technical content.
11/14/2013	12.0	None	No changes to the meaning, language, or formatting of the technical content.
2/13/2014	12.0	None	No changes to the meaning, language, or formatting of the technical content.
5/15/2014	12.0	None	No changes to the meaning, language, or formatting of the technical content.
6/30/2015	13.0	Major	Significantly changed the technical content.
10/16/2015	13.0	None	No changes to the meaning, language, or formatting of the technical content.
7/14/2016	13.0	None	No changes to the meaning, language, or formatting of the technical content.
6/1/2017	13.0	None	No changes to the meaning, language, or formatting of the technical content.
9/15/2017	14.0	Major	Significantly changed the technical content.
9/12/2018	15.0	Major	Significantly changed the technical content.

Table of Contents

1	Introduction	6
1.1	Glossary	6
1.2	References	7
1.2.1	Normative References	7
1.2.2	Informative References	8
1.3	Overview	8
1.3.1	Direct Connection	8
1.3.2	Intra-Site Routing	8
1.3.3	Inter-Site Routing	9
1.4	Relationship to Other Protocols	10
1.5	Prerequisites/Preconditions	11
1.6	Applicability Statement	11
1.7	Versioning and Capability Negotiation	11
1.8	Vendor-Extensible Fields	11
1.9	Standards Assignments	11
2	Messages	12
2.1	Transport	12
2.2	Message Syntax	12
2.3	Directory Service Schema Elements	12
3	Protocol Details	13
3.1	Algorithm Details	13
3.1.1	Abstract Data Model	13
3.1.1.1	Shared Data Elements	14
3.1.1.2	Routing Table	14
3.1.2	Timers	14
3.1.2.1	QueueManager Query Timer	14
3.1.3	Initialization	14
3.1.3.1	RoutingTable Initialization	14
3.1.4	Higher-Layer Triggered Events	15
3.1.5	Message Processing Events and Sequencing Rules	15
3.1.5.1	GetNextHops	15
3.1.5.2	GetNextHopsForRouter	16
3.1.5.3	GetNextHopsForSiteGate	17
3.1.5.4	GetQueueManager	17
3.1.5.5	GetRoutingServer	18
3.1.5.6	GetSiteGate	19
3.1.5.7	GetSiteGateForSite	19
3.1.5.8	IsSiteGate	20
3.1.5.9	GetDirectoryData	20
3.1.6	Timer Events	21
3.1.6.1	QueueManager Query Timer Event	21
3.1.7	Other Local Events	21
4	Protocol Examples	22
5	Security	23
5.1	Security Considerations for Implementers	23
5.2	Index of Security Parameters	23
6	(Updated Section) Appendix A: Product Behavior	24
7	Change Tracking	25
8	Index	26

1 Introduction

The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm is used by Message Queuing (also known as MSMQ) to determine the next hop when routing a message.

The document describes intra-site routing, inter-site routing and direct connection between source and destination MSMQ queue managers where it is possible, as described in section 1.3.

For more information on MSMQ, see [MSDN-MSMQ].

Sections 1.5, 1.8, 1.9, 2, and 3 of this specification are normative. All other sections and examples in this specification are informative.

1.1 Glossary

This document uses the following terms:

administrator: A user who has complete and unrestricted access to the computer or domain.

connected network: A network of computers in which any two computers can communicate directly through a common transport protocol (for example, TCP/IP or SPX/IPX). A computer can belong to multiple connected networks.

directory: The database that stores information about objects such as users, groups, computers, printers, and the directory service that makes this information available to users and applications.

enterprise: A unit of administration of a network of MSMQ queue managers. An enterprise consists of an MSMQ Directory Service, one or more connected networks, and one or more MSMQ sites.

format name: A name that is used to reference a queue when making calls to API functions.

in-routing server: An MSMQ routing server that receives all messages on behalf of a particular client and forwards those messages to that client.

inter-site routing: The process of routing a message between different MSMQ sites within an enterprise.

intra-site routing: The process of routing a message within a single MSMQ site.

message: A data structure representing a unit of data transfer between distributed applications. A message has message properties, which may include message header properties, a message body property, and message trailer properties.

message packet: A byte buffer that is the physical representation of the message in the queue manager and on the wire.

Microsoft Message Queuing (MSMQ): A communications service that provides asynchronous and reliable message passing between distributed applications. In Message Queuing, applications send messages to queues and consume messages from queues. The queues provide persistence of the messages, enabling the sending and receiving applications to operate asynchronously from one another.

MSMQ queue manager: An MSMQ service hosted on a machine that provides queued messaging services. Queue managers manage queues deployed on the local computer and provide asynchronous transfer of messages to queues located on other computers. A queue manager is identified by a globally unique identifier (GUID).

MSMQ routing link: A communication link between two sites. A routing link is represented by a routing link object in the directory service. Routing links can have associated link costs. Routing links with their associated costs can be used to compute lowest-cost routing paths for store-and-forward messaging.

MSMQ routing server: A role played by an MSMQ queue manager. An MSMQ routing server implements store and forward messaging. A routing server can provide connectivity between different connected networks within a site or can provide session concentration between sites.

MSMQ site: A network of computers, typically physically collocated, that have high connectivity as measured in terms of latency (low) and throughput (high). A site is represented by a site object in the directory service. An MSMQ site maps one-to-one with an Active Directory site when Active Directory provides directory services to MSMQ.

MSMQ site gate: An MSMQ routing server through which all intersite messaging traffic flows.

out-routing server: An MSMQ routing server that receives all messages sent by a particular client and routes those messages on behalf of that client.

queue: An object that holds messages passed between applications or messages passed between Message Queuing and applications. In general, applications can send messages to queues and read messages from queues.

routing link cost: A value that models the relative cost of direct communication between two MSMQ sites.

routing table: A table maintained by each MSMQ site gate for inter-site routing. For each MSMQ site in an enterprise, the table specifies the MSMQ site to which a message should be forwarded in order to minimize the total routing link cost for that message.

server: A computer on which the remote procedure call (RPC) server is executing.

MAY, SHOULD, MUST, SHOULD NOT, MUST NOT: These terms (in all caps) are used as defined in [RFC2119]. All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2 References

Links to a document in the Microsoft Open Specifications library point to the correct section in the most recently published version of the referenced document. However, because individual documents in the library are not updated at the same time, the section numbers in the documents may not match. You can confirm the correct section numbering by checking the Errata.

1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dohelp@microsoft.com. We will assist you in finding the relevant information.

[MS-ADTS] Microsoft Corporation, "Active Directory Technical Specification".

[MS-DTYP] Microsoft Corporation, "Windows Data Types".

[MS-MQDMPR] Microsoft Corporation, "Message Queuing (MSMQ): Common Data Model and Processing Rules".

[MS-MQDSSM] Microsoft Corporation, "Message Queuing (MSMQ): Directory Service Schema Mapping".

[MS-MQQB] Microsoft Corporation, "Message Queuing (MSMQ): Message Queuing Binary Protocol".

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, <http://www.rfc-editor.org/rfc/rfc2119.txt>

1.2.2 Informative References

[MS-MQDS] Microsoft Corporation, "Message Queuing (MSMQ): Directory Service Protocol".

[MS-MQOD] Microsoft Corporation, "Message Queuing Protocols Overview".

[MSDN-MSMQ] Microsoft Corporation, "Message Queuing (MSMQ)", <http://msdn.microsoft.com/en-us/library/ms711472.aspx>

1.3 Overview

The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm describes message routing within an enterprise network.

Message queuing clients transfer messages either by direct connection with the destination or by sending them to an MSMQ Routing Server. <1> If a direct connection is not possible or the client is configured to use a routing service, MSMQ routing servers can temporarily store messages and subsequently forward them to the destination MSMQ queue manager or to another MSMQ routing server.

Message routing occurs when at least one of the following conditions exists.

- The source MSMQ queue manager and the destination MSMQ queue manager belong to different MSMQ sites.
- The source MSMQ queue manager and the destination MSMQ queue manager do not share a connected network.
- The source MSMQ queue manager is configured to use an out-routing server. Every outgoing message from the source MSMQ queue manager is routed through the configured out-routing server.
- The destination MSMQ queue manager is configured to use an in-routing server. Every incoming message to the destination MSMQ queue manager is routed through the configured in-routing server.

More information on queuing messages is specified in [MS-MQQB].

1.3.1 Direct Connection

A direct connection between two MSMQ queue managers that share a connected network is possible when the source MSMQ queue manager is not configured to use one or more out-routing server(s), and the destination MSMQ queue manager is not configured to use one or more in-routing server(s). A MSMQ queue manager can belong to more than one connected network.

1.3.2 Intra-Site Routing

If a source MSMQ queue manager is configured to use an out-routing server, every outgoing message is routed through that out-routing server. Similarly, if a destination MSMQ queue manager is configured to use an in-routing server, every incoming message is routed through that in-routing server. Using in-routing and out-routing servers to route messages within an MSMQ site can reduce network bandwidth consumption by providing session concentration.

An MSMQ routing server can also be used to exchange messages between two MSMQ queue managers within an MSMQ site that do not share a common connected network.

An MSMQ routing server can also be used to exchange messages between two MSMQ queue managers within an MSMQ site when direct connection between those MSMQ queue managers fails.

1.3.3 Inter-Site Routing

Administrators can model the physical topology of an enterprise as properties in the directory. The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm uses this model to make routing decisions.

MSMQ sites represent a grouping of MSMQ queue managers in the enterprise network according to physical location. MSMQ queue managers in one MSMQ site use MSMQ site gates within the same MSMQ site to route messages to MSMQ queue managers in other MSMQ sites. An MSMQ site gate can route a message to another MSMQ site by sending that message to another MSMQ site gate.

Routing inter-site traffic only through MSMQ site gates often results in session concentration, which can reduce network bandwidth consumption between physically distant nodes.

If an enterprise network has more than one MSMQ site, an administrator creates MSMQ routing links to allow messages to be routed between those MSMQ sites. MSMQ routing links identify neighboring MSMQ sites whose MSMQ site gates can communicate directly. Each MSMQ routing link includes a routing link cost that represents how expensive it is to transfer messages directly between the two sites.

A message can be transferred through multiple MSMQ sites on the way to the destination MSMQ site. Each MSMQ site gate along the way uses a routing table to find the next hop in a least-cost path to the destination MSMQ site.

To build the routing table, MSMQ site gates consider the enterprise as a graph with vertices as MSMQ sites and bidirectional nonnegative edge weights as the routing link costs. An MSMQ site gate builds a least-cost spanning tree using its MSMQ site as the root and uses this tree to populate its routing table.

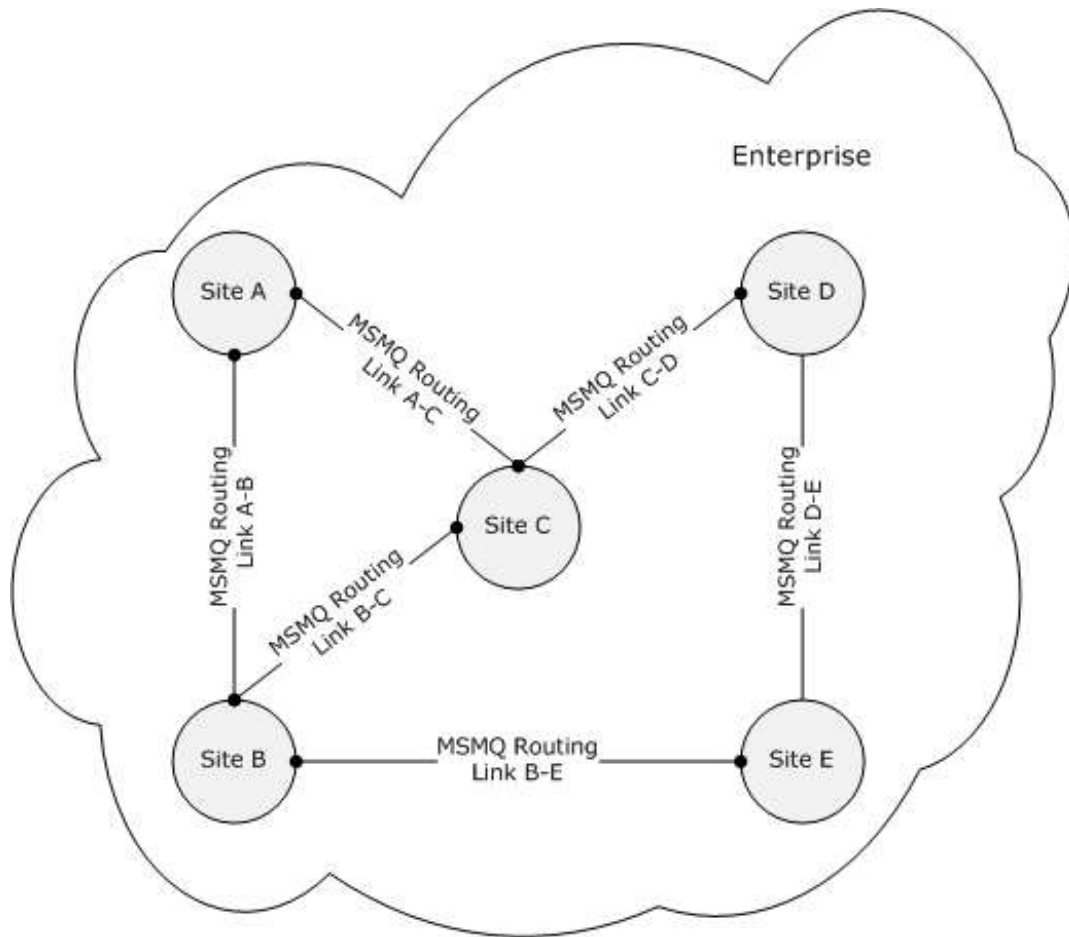


Figure 1: Enterprise as a set of MSMQ sites and MSMQ routing links

Routing link cost provides a mechanism for administrators to enforce one route over another in cases where multiple routes exist.

As described in section 3.1.6.1, each MSMQ queue manager that runs MSMQ within an enterprise periodically queries the directory to determine whether it acts as an MSMQ site gate, and to build a routing table if the querying MSMQ queue manager is an MSMQ site gate.

1.4 Relationship to Other Protocols

The Message Queuing (MSMQ): Binary Reliable Messaging Protocol, as specified in [MS-MQQB], relies upon the Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm to determine the next hop when messages are sent using public and private format names.

The algorithm uses shared state and processing rules defined in Message Queuing (MSMQ): Common Data Model and Processing Rules.

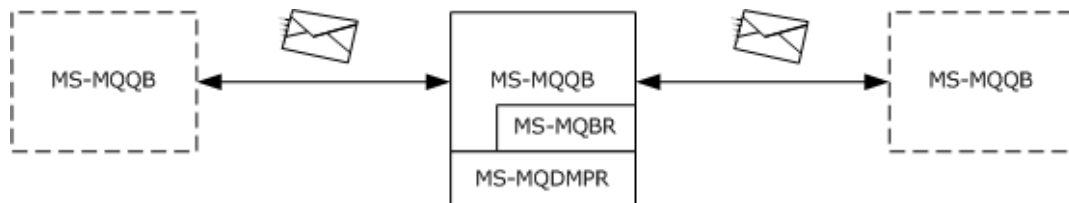


Figure 2: MS-MQBB uses the MS-MQBR algorithm when message routing is required

1.5 Prerequisites/Preconditions

If an enterprise has more than one MSMQ site, each MSMQ site has one or more MSMQ site gates assigned to it.

The following are the requirements for an MSMQ queue manager to be an MSMQ site gate:

- The MSMQ queue manager has to belong to the MSMQ site for which it is an MSMQ site gate.
- The MSMQ queue manager has to be able to connect directly to each MSMQ site gate in each neighboring MSMQ site.

MSMQ routing servers within an MSMQ site have to be able to communicate on all connected networks used by the MSMQ queue managers within that MSMQ site.

1.6 Applicability Statement

The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm is applicable when a public or private format name message has to be routed within an enterprise.

1.7 Versioning and Capability Negotiation

None.

1.8 Vendor-Extensible Fields

None.

1.9 Standards Assignments

None.

2 Messages

2.1 Transport

None.

2.2 Message Syntax

None.

2.3 Directory Service Schema Elements

This algorithm uses abstract data model (ADM) elements specified in section 3.1.1. A subset of these elements can be published in a directory. This algorithm SHOULD<2> access the directory using the algorithm specified in [MS-MQDSSM] and using LDAP [MS-ADTS]. The Directory Service schema elements for ADM elements published in the directory are defined in [MS-MQDSSM] section 2.4.<3>

3 Protocol Details

3.1 Algorithm Details

This section describes a conceptual model of possible data organization that an implementation maintains to implement in this algorithm. The described organization is provided to facilitate the explanation of how the algorithm behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

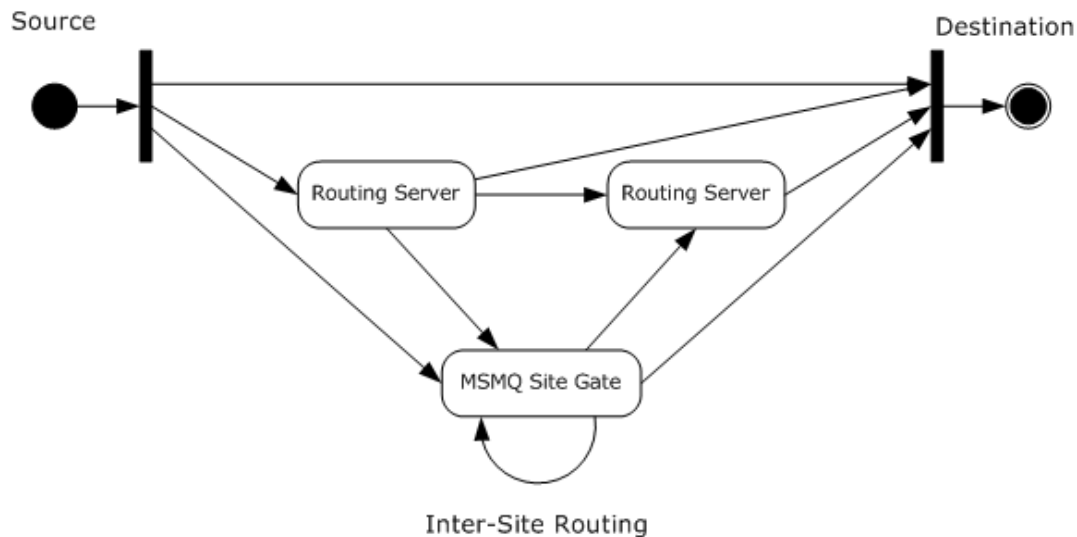


Figure 3: Message Routing

This diagram represents all possible paths that a message can take through an MSMQ enterprise. Each box represents a class of MSMQ queue manager participating in message transfer. Each arrow represents a transfer of a message from an MSMQ queue manager in the class at the tail of the arrow to an MSMQ queue manager in the class at the head of the arrow. In this diagram, the only arrow that represents a message transfer between MSMQ queue managers in different MSMQ sites is the inter-site routing arrow between two MSMQ site gates. All other arrows represent message transfer between MSMQ queue managers within the same MSMQ site.

The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm determines the path that a message traverses between MSMQ queue managers. The path computed by this algorithm is agnostic of message or queue priorities.

3.1.1 Abstract Data Model

The abstract data model for the Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm comprises elements that are private to this algorithm and others that are shared between multiple MSMQ protocols that are co-located at a common MSMQ queue manager. The shared abstract data model is defined in [MS-MQDMPR] section 3.1.1, and the relationship between Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm and other protocols that share a common MSMQ queue manager is described in [MS-MQOD].

Section 3.1.1.1 details the elements from the shared data model that are manipulated by this algorithm, and section 3.1.1.2 details the data model element that is private to Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm.

3.1.1.1 Shared Data Elements

This algorithm manipulates the following abstract data model elements from the shared abstract data model defined in [MS-MQDMPR] section 3.1.1.

DirectoryObject: As defined in [MS-MQDMPR] section 3.1.1.

QueueManager: As defined in [MS-MQDMPR] section 3.1.1.1.

Site: As defined in [MS-MQDMPR] section 3.1.1.7.

RoutingLink: As defined in [MS-MQDMPR] section 3.1.1.8.

3.1.1.2 Routing Table

The RoutingTable contains records of mappings from the unique identifier of the destination Site to the unique identifier of the next-hop Site on the least-cost path to the destination Site.

DestinationSiteID: Site.Identifier that is the unique identifier of the destination Site.

NextHopSiteID: Site.Identifier that is the unique identifier of the next-hop Site.

3.1.2 Timers

The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm SHOULD maintain the following timer.

3.1.2.1 QueueManager Query Timer

This timer regulates the amount of time that the protocol waits before updating the information in the RoutingTable. This timer fires the QueueManager Query Timer Event, as described in section 3.1.6.1.

3.1.3 Initialization

The QueueManager Query Timer SHOULD be started and SHOULD be initialized internally to 3,600 seconds.

3.1.3.1 RoutingTable Initialization

If IsSiteGate returns 0 when called with the **QueueManager.Identifier** initializing its RoutingTable, the RoutingTable is initialized to be empty.

To create a collection of **Sites** that belong to the enterprise, the GetDirectoryData (section 3.1.5.9) method MUST be called, where the *DataElementType* parameter is the string "Site", and the *FilterArray* parameter has no elements.

To create a collection of **RoutingLinks** that belong to the enterprise, the GetDirectoryData method MUST be called, where the *DataElementType* parameter is the string "RoutingLink", and the *FilterArray* parameter has no elements.

If the collection of **Sites** or the collection of **RoutingLinks** is empty when initializing the RoutingTable, the RoutingTable is initialized to be empty.

Otherwise, to populate the RoutingTable, consider an enterprise as a connected, nonnegative, weighted, directed graph **E** with vertices **S** and directed edges **L**, as follows:

E = (S, L).

Each vertex in **S** represents a **Site**. Each edge in **L** represents one direction of a **RoutingLink** between two **Sites**. That is, for any two **Sites** **x** and **y**, the directed edge (**x**, **y**) exists if and only if a **RoutingLink** exists where **x** is equal to the **RoutingLink.Site1Identifier** and **y** is equal to the **RoutingLink.Site2Identifier** or where **x** is equal to the **RoutingLink.Site2Identifier** and **y** is equal to the **RoutingLink.Site1Identifier**.

Associated with each edge (**x**, **y**) is a weight that is equal to the **RoutingLink.ActualCost** value of the corresponding **RoutingLink**.

The cost of a path between two vertices from **S** in graph **E** is a sum of costs of all of the edges in that path. The least-cost path between any two vertices from **S** in graph **E** is the path with the lowest cost.

Given such a mapping of an enterprise to a directed graph, discovering the least-cost path between two **Sites** corresponds exactly to finding the least-cost path through a directed graph. Dijkstra's algorithm SHOULD be used to find least-cost paths (as described in [RFC1]) to each destination site by finding a spanning tree that covers the graph. The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm populates the **RoutingTable** with a row for each site in the enterprise. To initialize the row for a given site **S**, the **DestinationSiteId** property contains the **Site.Identifier** of **S**, and the **NextHopSiteId** contains the **Site.Identifier** of the next-hop site on the path in the spanning tree from the current site to **S**.

When for a given pair of source and destination vertices there are two or more routes with equal cost, the algorithm selects one of them.

3.1.4 Higher-Layer Triggered Events

None.

3.1.5 Message Processing Events and Sequencing Rules

This section describes how the Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm uses **QueueManager**, **Site**, **RoutingLink** (section 3.1.1 of [MS-MQDMPR]), and **RoutingTable** (section 3.1.1.2) data elements to determine the next hop for a message.

3.1.5.1 GetNextHops

GetNextHops defines the algorithm that a **QueueManager** ADM element uses to determine the next possible hops for a message to get from the current **QueueManager** ADM element (identified by the *SourceID* parameter) to the ultimate destination (identified by the *DestinationID* parameter). The return value is the list of identifiers of the **QueueManager** ADM elements that can be used as the possible next hop.

```
GetNextHops(SourceID of type GUID, DestinationID of type GUID)

;SourceID      - QueueManager.Identifier that identifies the source
;DestinationID - QueueManager.Identifier that identifies the destination

INIT NextHops of type List of GUID           ;Next hop QueueManager.Identifier
INIT SourceMachine of type QueueManager
INIT DestinationMachine of type QueueManager

SET NextHops to an empty list
SET SourceMachine to result of CALL GetQueueManager(SourceID)
SET DestinationMachine to result of
    CALL GetQueueManager(DestinationID)

IF SourceMachine <> Nothing AND DestinationMachine <> Nothing THEN
    IF SourceMachine.RoutingServer = True THEN
        SET NextHops to result of GetNextHopsForRouter(SourceMachine,
            DestinationMachine)
```

```

ELSE
  IF SourceMachine.OutRoutingServerIdentifierList is not empty THEN
    SET NextHops to SourceMachine.OutRoutingServerIdentifierList
  ELSE
    IF intersection of SourceMachine.SiteIdentifierList AND
      DestinationMachine.SiteIdentifierList is not empty THEN
      IF DestinationMachine.InRoutingServerIdentifierList is not empty THEN
        SET NextHops to Destination.InRoutingServerIdentifierList
      ELSE
        ADD DestinationID to NextHops
      ENDIF
    ELSE
      ADD the result of CALL GetRoutingServer(SourceID) to NextHops
    ENDIF
  ENDIF
ENDIF
ENDIF

IF NextHops = Nothing
  Raise Exception ; Routing Attempt Fails
ENDIF

RETURN with NextHops

```

3.1.5.2 GetNextHopsForRouter

GetNextHopsForRouter defines the algorithm that a **QueueManager** ADM element uses to determine the next hops for a message to get from the source **QueueManager** ADM element (identified by the *SourceMachine* parameter) to the ultimate destination (identified by the *DestinationMachine* parameter), and the source queue manager is an MSMQ Routing Server. The return value is the list of identifiers of the **QueueManager** ADM elements that can be used as the possible next hop. It returns Nothing on failure.

```

GetNextHopsForRouter(SourceMachine of type QueueManager,
                    DestinationMachine of type QueueManager)

INIT NextHops of type List of GUID ;Next hop QueueManager.Identifier
INIT IsSourceSiteGate of type Boolean

SET NextHops to an empty list

SET IsSourceSiteGate to result of
  CALL IsSiteGate(SourceMachine.Identifier)

IF IsSourceSiteGate = 1 THEN
  SET NextHops to result of
    CALL GetNextHopsForSiteGate(SourceMachine, DestinationMachine)
ELSE IF SourceMachine.Identifier is one of
  DestinationMachine.InRoutingServerIdentifierList THEN
  ADD DestinationMachine.Identifier to NextHops
ELSE IF intersection of SourceMachine.SiteIdentifierList AND
  DestinationMachine.SiteIdentifierList is not empty THEN
  IF DestinationMachine.InRoutingServerIdentifierList is not
empty THEN
    SET NextHops to DestinationMachine.InRoutingServerIdentifierList
  ELSE
    ADD DestinationMachine.Identifier to NextHops
  ENDIF
ELSE
  ADD the return of
    CALL GetSiteGate(SourceMachine.Identifier) to NextHops
ENDIF

```


RETURN with NextHops

3.1.5.3 GetNextHopsForSiteGate

GetNextHopsForSiteGate defines the algorithm that a **QueueManager** ADM element uses to determine the next possible hops for a message to get from the source **QueueManager** (identified by the *SourceMachine* parameter) to the ultimate destination (identified by the *DestinationMachine* parameter), and the source queue manager is an MSMQ Site Gate. The return value is the list of identifiers of the **QueueManager** ADM elements that can be used as the possible next hop. It returns Nothing on failure.

```
GetNextHopsForSiteGate(SourceMachine of type QueueManager,
                       DestinationMachine of type QueueManager)

INIT NextHops of type List of GUID           ;Next hop QueueManager.Identifier
SET NextHops to an empty list

IF SourceMachine.Identifier
  is one of DestinationMachine.InRoutingServerIdentifierList
THEN
  ADD DestinationMachine.Identifier to NextHops
ELSE IF intersection of SourceMachine.SiteIdentifierList AND
DestinationMachine.SiteIdentifierList in not empty THEN
  IF DestinationMachine.InRoutingServerIdentifierList is not empty THEN
    SET NextHops to DestinationMachine.InRoutingServerIdentifierList
  ELSE
    ADD DestinationMachine.Identifier to NextHops
  ENDIF
ELSE
  INIT NextSite of type GUID
  INIT Entry of type RECORD of RoutingTable

  SET NextSite to Nothing

  FOREACH Entry FROM RoutingTable DO
    IF Entry.DestinationSiteID in
DestinationMachine.SiteIdentifierList THEN
      SET NextSite = Entry.NextHopSiteID
    ENDIF
  END FOREACH

  IF NextSite <> Nothing THEN

    ADD the return of CALL GetSiteGateForSite(NextSite) to NextHops

  ENDIF

ENDIF

RETURN with NextHops
```

3.1.5.4 GetQueueManager

GetQueueManager returns the **QueueManager** record from the directory identified by the *MachineID* parameter. If no such record is found, it returns Nothing.

```
GetQueueManager(MachineID of type GUID)
```

```

;MachineID - QueueManager.Identifier
;corresponding to the requested QueueManager

INIT Machine of type QueueManager
INIT ArrayQM of type vector of QueueManager
INIT StrMachineID of type string

SET Machine to Nothing

SET StrMachineID to MachineID as string

SET ArrayQM to return of CALL GetDirectoryData ("QueueManager",
        one-element array: "Identifier" EQUALS StrMachineID)
IF ArrayQM <> Nothing THEN
    SET Machine to the first element of ArrayQM
ENDIF

RETURN with Machine

```

3.1.5.5 GetRoutingServer

GetRoutingServer returns the **QueueManager.Identifier** of the MSMQ Routing Server for a given **QueueManager** identified by the input parameter *MachineID*. If there is no MSMQ Routing Server within the Site for the given **QueueManager**, this method returns Nothing.

```

GetRoutingServer(MachineID of type GUID)
;MachineID - QueueManager.Identifier that identifies the QueueManager that
;requested an MSMQ routing server

INIT SourceMachine of type QueueManager
INIT MachineTemp of type QueueManager
INIT Router type of GUID
INIT ArrayQM of type vector of QueueManager

SET SourceMachine to result of CALL GetQueueManager(MachineID)
IF SourceMachine = Nothing THEN
    RETURN with Nothing
ENDIF

SET Router to Nothing

SET ArrayQM to result of CALL GetDirectoryData("QueueManager", Nothing)

IF ArrayQM = Nothing THEN
    RETURN with Router
ENDIF

FOREACH MachineTemp FROM ArrayQM DO
    IF (intersection MachineTemp.SiteIdentifierList AND
        SourceMachine.SiteIdentifierList is not empty) AND
        MachineTemp.RoutingServer = True THEN
        SET Router to MachineTemp.Identifier
        BREAK FOREACH
    ENDIF
END FOREACH

RETURN with Router

```

3.1.5.6 GetSiteGate

GetSiteGate returns the **QueueManager.Identifier** of an MSMQ Site Gate for a given **QueueManager** identified by the *MachineID* parameter. If no MSMQ Site Gate is found within the Site to which the QueueManager belongs, this method returns Nothing.

```
GetSiteGate(MachineID of type GUID)

;MachineID - QueueManager.Identifier that identifies the machine

INIT SourceMachine of type QueueManager
INIT SiteGate of type GUID
INIT SiteTemp of type Site
INIT ArraySite of type vector of Site

SET SourceMachine to result of CALL GetQueueManager(MachineID)
IF SourceMachine = Nothing THEN
    RETURN with Nothing
ENDIF

SET SiteGate to Nothing

SET ArraySite to result of CALL GetDirectoryData("Site", Nothing)

IF ArraySite = Nothing THEN
    RETURN with SiteGate
ENDIF

FOREACH SiteTemp FROM ArraySite DO
    IF SiteTemp.Identifier in
        SourceMachine.SiteIdentifierList THEN
        SET SiteGate to one of SiteTemp.SiteGateCollection
        BREAK FOREACH
    ENDIF
END FOREACH

RETURN with SiteGate
```

3.1.5.7 GetSiteGateForSite

GetSiteGateForSite returns the **QueueManager.Identifier** of the MSMQ site gate for a given MSMQ site identified by the *SiteID* parameter. If no MSMQ site gate is found within the **Site**, this method returns Nothing.

```
GetSiteGateForSite(SiteID of type GUID)

;SiteID - Site.Identifier that identifies Site

INIT SiteGate of type GUID
INIT SiteTemp of type Site
INIT ArraySite of type vector of Site
INIT StrSiteID of type string

SET SiteGate to Nothing
SET StrSiteID to SiteID as string

SET ArraySite to result of GetDirectoryData("Site", one-element array: "Identifier" EQUALS
StrSiteID)

IF ArraySite = Nothing THEN
    RETURN with SiteGate
ENDIF
```

```

SET SiteTemp to one of ArraySite

SET SiteGate to one of SiteTemp.SiteGateCollection

RETURN with SiteGate

```

3.1.5.8 IsSiteGate

IsSiteGate returns 1 if a given **QueueManager** identified by the *MachineID* parameter is an MSMQ Site Gate. Otherwise this method returns 0.

```

IsSiteGate(MachineID of type GUID)

;MachineID - QueueManager.Identifier

INIT Machine of type QueueManager
INIT Site of type Site
INIT ArraySite of type vector of Site

SET Machine to result of CALL GetQueueManager(MachineID)
IF Machine = Nothing THEN
    RETURN with 0
ENDIF

IF Machine.RoutingServer = False THEN
    RETURN with 0
ENDIF

SET ArraySite to result of GetDirectoryData("Site", Nothing)
IF ArraySite = Nothing THEN
    RETURN with 0
ENDIF

FOREACH Site FROM ArraySite DO
    IF (Site.Identifier = in Machine.SiteIdentifierList) THEN
        FOREACH SiteGate in Site.SiteGateCollection DO
            IF (MachineID = SiteGate.Identifier) THEN
                RETURN with 1
            ENDIF
        END FOREACH
    ENDIF
END FOREACH

RETURN with 0

```

3.1.5.9 GetDirectoryData

The **GetDirectoryData** method returns a vector of **DirectoryObject**. It accepts two parameters. The *DataElementType* parameter is a string that specifies the type of the **DirectoryObject**. The *FilterArray* parameter is an array of **attribute-filter expressions**, as specified in [MS-MQDMPR] section 3.1.7.1.20. Each element in the *FilterArray* parameter specifies a query constraint that MUST be satisfied by all **DirectoryObject(s)** corresponding to the object type specified in the *DataElementType* parameter. This method generates Read Directory Begin, Read Directory Next, and Read Directory End events as specified in [MS-MQDMPR] section 3.1.7.1.21, 3.1.7.1.22, and 3.1.7.1.23 respectively, by using the data type HANDLE as specified in [MS-DTYP] section 2.2.16. This method uses the DirectoryOperationResult enumeration as specified in [MS-MQDMPR] section 3.1.1.17, to determine the outcome of these events.

```

GetDirectoryData( DataElementType of type string,
                  FilterArray of type array of string )

;DataElementType - identifies the type of the Directory's data element to be requested
;FilterArray - identifies constraints for reading data from the Directory

INIT Result of type DirectoryOperationResult
INIT DataTemp of type DirectoryObject
INIT RequestedData of type vector of DirectoryObject
INIT Handle of type HANDLE

SET RequestedData to Nothing
SET Handle to Nothing

SET (Result, Handle) to result of RAISE Read Directory Begin event with
(iDirectoryObjectType = DataElementType, iFilter = FilterArray)

IF Result <> DirectoryOperationResult.Success THEN
    RETURN with RequestedData
ENDIF

ReadLoop:

SET (Result, DataTemp) to result of RAISE Read Directory Next event with
(Handle)
IF Result = DirectoryOperationResult.Success THEN
    Add DataTemp to RequestedData
    GOTO ReadLoop

ENDIF
IF Result <> DirectoryOperationResult.EndOfData THEN
    SET RequestedData to Nothing
ENDIF

SET Result to result of RAISE Read Directory End event with (Handle)

RETURN with RequestedData

```

3.1.6 Timer Events

3.1.6.1 QueueManager Query Timer Event

When this timer fires, a **QueueManager** reinitializes its RoutingTable, as specified in section 3.1.3.1.

3.1.7 Other Local Events

None.

4 Protocol Examples

The Message Queuing (MSMQ): Binary Reliable Message Routing Algorithm calculates inter-site routing based on the routing link costs.

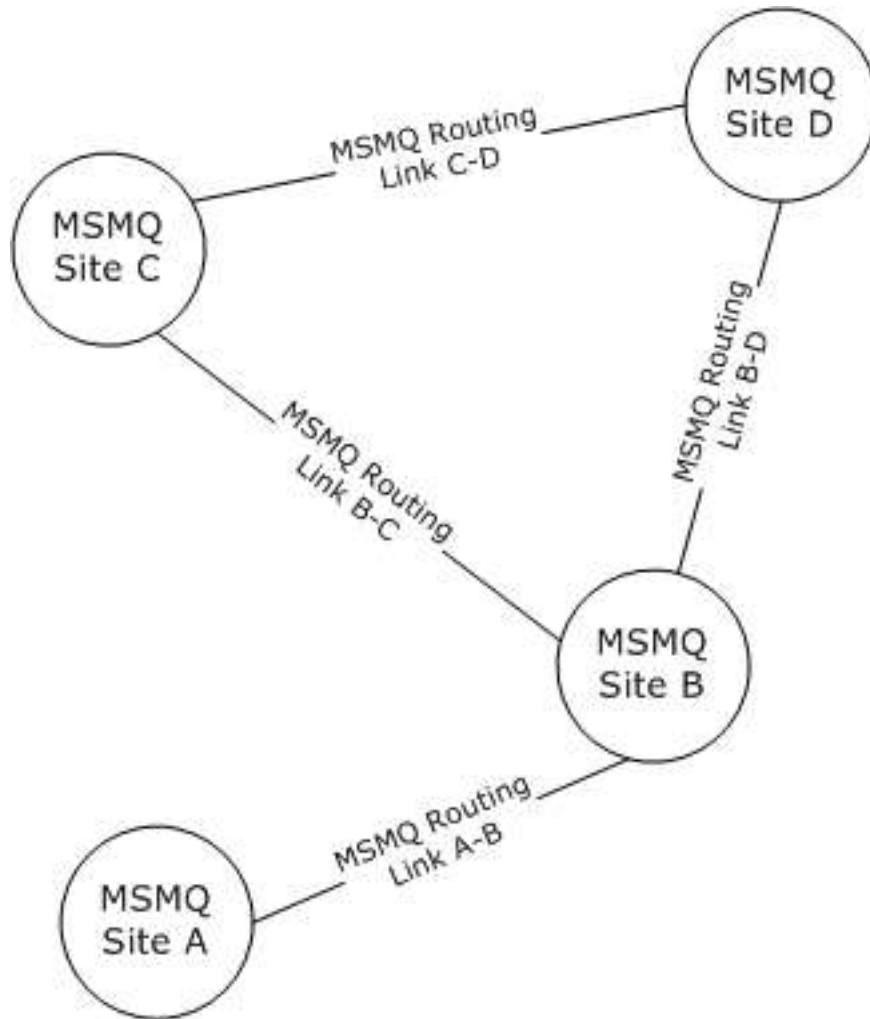


Figure 4: Enterprise example

If the cost associated with the MSMQ routing link A-B is 3 and the cost associated with the other three MSMQ routing links B-C, B-D, and C-D is 1, then messages routed by the Message Queuing (MSMQ): Binary Reliable Messaging Protocol from A to C always travel from A to B and then from B to C. However, if the cost associated with MSMQ routing links A-B and B-C is 3 and the cost associated with MSMQ routing links C-D and B-D is 1, then messages routed from A to C always travel from A to B, from B to D, and then from D to C.

For more details on message packet sequence see [MS-MQQB] section 4.

5 Security

5.1 Security Considerations for Implementers

None.

5.2 Index of Security Parameters

None.

6 (Updated Section) Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include updates to those products.

- Windows NT operating system
- Windows 2000 operating system
- Windows XP operating system
- Windows Server 2003 operating system
- Windows Vista operating system
- Windows Server 2008 operating system
- Windows 7 operating system
- Windows Server 2008 R2 operating system
- Windows 8 operating system
- Windows Server 2012 operating system
- Windows 8.1 operating system
- Windows Server 2012 R2 operating system
- Windows 10 operating system
- Windows Server 2016 operating system
- Windows Server operating system
- Windows Server 2019 operating system

Exceptions, if any, are noted in this section. If an update version, service pack or Knowledge Base (KB) number appears with a product name, the behavior changed in that update. The new behavior also applies to subsequent updates unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms "SHOULD" or "SHOULD NOT" implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term "MAY" implies that the product does not follow the prescription.

<1> Section 1.3: Only server versions of Windows can be configured as MSMQ routing servers.

<2> Section 2.3: For Windows NT and Windows 2000, this protocol uses the Message Queuing (MSMQ): Directory Service Protocol [MS-MQDS].

<3> Section 2.3: For the Message Queuing (MSMQ): Directory Service Protocol [MS-MQDS], the Directory Service schema elements are described in [MS-MQDS] sections 2.2.10 and 3.1.4.21.1 through 3.1.4.21.4.

7 Change Tracking

This section identifies changes that were made to this document since the last release. Changes are classified as Major, Minor, or None.

The revision class **Major** means that the technical content in the document was significantly revised. Major changes affect protocol interoperability or implementation. Examples of major changes are:

- A document revision that incorporates changes to interoperability requirements.
- A document revision that captures changes to protocol functionality.

The revision class **Minor** means that the meaning of the technical content was clarified. Minor changes do not affect protocol interoperability or implementation. Examples of minor changes are updates to clarify ambiguity at the sentence, paragraph, or table level.

The revision class **None** means that no new technical changes were introduced. Minor editorial and formatting changes may have been made, but the relevant technical content is identical to the last released version.

The changes made to this document are listed in the following table. For more information, please contact dochelp@microsoft.com.

Section	Description	Revision class
6 Appendix A: Product Behavior	Added Windows Server 2019 to the list of applicable products.	Major

8 Index

A

- Abstract data model
 - overview 13
 - routing table 14
 - shared data elements 14
- Algorithm
 - abstract data model
 - overview 13
 - routing table 14
 - shared data elements 14
 - higher-layer triggered events 15
 - initialization
 - overview 14
 - RoutingTable 14
 - local events 21
 - message processing 15
 - overview 13
 - sequencing rules 15
 - timer events - QueueManager query 21
 - timers
 - overview 14
 - QueueManager query 14
- Applicability 11

C

- Capability negotiation 11
- Change tracking 25

D

- Data model - abstract
 - overview 13
 - routing table 14
 - shared data elements 14
- Direct connection 8
- Directory service schema elements 12

E

- Elements - directory service schema 12
- Examples - overview 22

F

- Fields - vendor-extensible 11

G

- GetDirectoryData 20
- GetNextHops 15
- GetNextHopsForRouter 16
- GetNextHopsForSiteGate 17
- GetQueueManager 17
- GetRoutingServer 18
- GetSiteGate 19
- GetSiteGateForSite 19
- Glossary 6

H

Higher-layer triggered events 15

I

Implementer - security considerations 23

Index of security parameters 23

Informative references 8

Initialization

- overview 14

- RoutingTable 14

Inter-site routing 9

Intra-site routing 8

Introduction 6

IsSiteGate 20

L

Local events 21

M

Message processing 15

Messages

- Directory Service schema elements 12

- syntax 12

- transport 12

N

Normative references 7

O

Overview (synopsis) 8

P

Parameters - security index 23

Preconditions 11

Prerequisites 11

Product behavior 24

R

References 7

- informative 8

- normative 7

Relationship to other protocols 10

S

Schema elements - directory service 12

Security

- implementer considerations 23

- parameter index 23

Sequencing rules 15

Standards assignments 11

Syntax 12

T

Timer events - QueueManager query 21

Timers

- overview 14
 - QueueManager query 14
- Tracking changes 25
- Transport 12
- Triggered events - higher-layer 15

V

- Vendor-extensible fields 11
- Versioning 11