
**Information technology — Message
Handling Systems (MHS): MHS routing**

*Technologies de l'information — Systèmes de messagerie (MHS): Routage
MHS*

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CONTENTS

	<i>Page</i>
1 Scope	1
2 Normative references	1
2.1 Presentation references	1
2.2 Directory references	1
2.3 Message Handling references	2
2.4 Country Code references	2
2.5 Additional references	2
3 Definitions	2
3.1 MHS-routing definitions	2
3.2 MHS definitions	3
3.3 Directory definitions	3
4 Abbreviations	3
5 Conventions	3
5.1 Conventions for routing model specification	3
5.2 General font conventions	4
5.3 Font conventions for ASN.1 definitions	4
5.4 Rules for ASN.1 definitions	4
6 MHS-routing Overview	4
6.1 Operational characteristics	4
6.2 Components of the model	5
6.2.1 Routing-collective	6
6.2.2 Routing-MTA	6
6.2.3 Connection-group	7
6.2.4 OR-address-subtree	8
6.2.5 Routing-advice	9
6.2.6 Local use tables	10
6.3 Routing decision overview	10
6.4 Directory organization	11
6.5 Authentication principles	11
7 Routing-collective-subtree	12
7.1 Object classes	12
7.1.1 Routing Collective object class	12
7.1.2 Routing MTA object class	12
7.1.3 Connection Group object class	12
7.1.4 MTA Information object class	12
7.2 Attribute types	13
7.2.1 Routing Collective attribute types	13
7.2.2 Routing MTA attribute types	13
7.2.3 Connection Group attribute types	14
7.2.4 MTA Information attribute types	16
7.3 Name forms	17
8 OR-address-subtree	17
8.1 OR-address Element object class	17
8.2 OR-address Element attribute types	17
8.2.1 Routing Advice	17
8.2.2 Expression Matches	19
8.2.3 Next Level Complete	20
8.2.4 Recipient MD Assigned Alternate Recipient	20

8.3	OR-address Element subclasses	20
8.3.1	OR-address Subtree Base object class	20
8.3.2	Common OR-address object classes.....	20
8.3.3	Mnemonic OR-address object classes	21
8.3.4	Terminal OR-address object classes.....	21
8.3.5	Numeric OR-address object classes.....	22
8.3.6	Postal OR-address object classes.....	22
8.4	OR-address Element Names	22
8.4.1	Common OR-address Element Names	22
8.4.2	Mnemonic OR-address Element Names.....	22
8.4.3	Terminal OR-address Element Names	23
8.4.4	Numeric OR-address Element Names	23
8.4.5	Postal OR-address Element Names	23
8.5	Generation of OR-address-element attributes	24
8.6	OR-address-subtree name forms	24
9	Procedures	25
9.1	Routing-MTA procedures	25
9.1.1	Amendment to the Front-end procedure.....	26
9.1.2	Routing-decision procedure.....	26
9.1.3	OR-address-subtree-read procedure	29
9.1.4	Local-delivery-evaluation procedure.....	31
9.1.5	Routing-knowledge-acquisition procedure.....	31
9.1.6	MTA-bind-in procedure	35
9.1.7	MTA-bind-out procedure	37
9.1.8	Trace verification step.....	38
9.2	Administrative procedures.....	39
9.2.1	Routing-MTA configuration.....	39
9.2.2	OR-address-subtree construction.....	39
10	Conformance	41
10.1	Routing-MTA conformance	41
10.2	Administrative DUA conformance	41
10.3	DSA conformance	41
Annex A	– Reference Definition of Object Identifiers	42
Annex B	– Reference Definition of MHS-routing Directory Objects.....	44
Annex C	– Reference Definition of MHS-routing OR-address-subtree.....	47
Annex D	– OR-address-subtree structure.....	54
D.1	Common OR-address elements	55
D.1.1	MHS Country	55
D.1.2	MHS ADMD	55
D.1.3	MHS PRMD	55
D.2	Mnemonic OR-address elements.....	55
D.2.1	MHS Organization	55
D.2.2	MHS Organizational Unit.....	55
D.2.3	MHS Common Name	56
D.2.4	MHS Surname	56
D.2.5	MHS Given Name	56
D.2.6	MHS Initials	56
D.2.7	MHS Generation Qualifier	57
D.3	Terminal OR-address elements	57
D.3.1	MHS Network Address	57
D.3.2	MHS Terminal Identifier.....	57
D.3.3	MHS Terminal Type.....	57
D.4	Numeric OR-address elements	58
D.5	Postal OR-address elements	58
D.5.1	MHS PDS Name	58
D.5.2	MHS Physical Delivery Country.....	58
D.5.3	MHS Postal Code	58

Annex E – Example of extension to the OR-address-subtree schema for MHS Network Address	59
E.1 Network address subfield object classes.....	59
E.2 Network address subfield Element Names	59
E.3 Network address subfield name forms	59
E.4 Network address subfield structure rules.....	60
Annex F – MHS-routing example applications.....	61
F.1 Simple PRMD	61
F.2 Large PRMD with autonomous departments	61
F.3 Internal use by ADMDs.....	62
F.4 'Public access' in a community	62
Annex G – Routing knowledge acquisition example.....	64
Annex H – Profile and Connection-group Identifiers	65
H.1 Common Profiles.....	65
H.2 ISP profiles	65
H.3 Common profile connection-groups.....	66
Annex I – Glossary of terms	67
Index	68

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO/IEC 10021 may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 10021-10 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.412.

This second edition cancels and replaces the first edition (ISO/IEC 10021-10:1998), which has been technically revised.

ISO/IEC 10021 consists of the following parts, under the general title *Information technology — Message Handling Systems (MHS)*:

- *Part 1: System and Service Overview* [ISO/IEC 10021-10:1999](https://standards.iteh.ai/catalog/standards/sist/ce26ecdc-7f0d-4867-a3fa-a713a2878e70/iso-iec-10021-10-1999)
- *Part 2: Overall architecture* <https://standards.iteh.ai/catalog/standards/sist/ce26ecdc-7f0d-4867-a3fa-a713a2878e70/iso-iec-10021-10-1999>
- *Part 3: Abstract Service Definition Conventions*
- *Part 4: Message transfer system: Abstract service definition and procedures*
- *Part 5: Message store: Abstract service definition*
- *Part 6: Protocol specifications*
- *Part 7: Interpersonal messaging system*
- *Part 8: Electronic Data Interchange Messaging Service*
- *Part 9: Electronic Data Interchange Messaging System*
- *Part 10: MHS routing*
- *Part 11: Guide for Messaging Systems Managers*

Annexes A to D form a normative part of this part of ISO/IEC 10021. Annexes E to I are for information only.

Introduction

This Recommendation | International Standard is one of a series of Recommendations | International Standards defining Message Handling in a distributed open systems environment.

Message Handling provides for the exchange of messages between users on a store-and-forward basis. A message submitted by one user (the originator) is transferred through the message-transfer-system (MTS) and delivered to one or more other users (the recipients).

This Recommendation | International Standard defines a method for routing messages through the Message Handling System (MHS).

This Recommendation | International Standard has been produced by joint ITU-T – ISO/IEC agreement. The corresponding documents are ITU-T Rec. X.412 and ISO/IEC 10021-10.

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INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

**INFORMATION TECHNOLOGY –
MESSAGE HANDLING SYSTEMS (MHS):
MHS ROUTING**

1 Scope

This Recommendation | International Standard specifies the means by which messages are routed through the MHS, and supplements the procedures defined in 14.3 of ITU-T Rec. X.411 | ISO/IEC 10021-4.

Other Recommendations | parts of ISO/IEC 10021 define other aspects of the MHS. ITU-T Rec. F.400/X.400 | ISO/IEC 10021-1 defines the user-oriented services provided by the MHS. ITU-T Rec. X.402 | ISO/IEC 10021-2 provides an architectural overview of the MHS. ITU-T Rec. X.411 | ISO/IEC 10021-4 defines the abstract-service of the Message Transfer System.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendation and Standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunications Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Presentation references

This Recommendation | International Standard cites the following Presentation specifications:

- ITU-T Recommendation X.680 (1997) | ISO/IEC 8824-1: 1998, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- ITU-T Recommendation X.681 (1997) | ISO/IEC 8824-2: 1998, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*

2.2 Directory references

This Recommendation | International Standard cites the following Directory specifications:

- ITU-T Recommendation X.500 (1997) | ISO/IEC 9594-1: 1998, *Information technology – Open Systems Interconnection – The Directory: Overview of concepts, models, and services.*
- ITU-T Recommendation X.501 (1997) | ISO/IEC 9594-2: 1998, *Information technology – Open Systems Interconnection – The Directory: Models.*
- ITU-T Recommendation X.520 (1997) | ISO/IEC 9594-6: 1998, *Information technology – Open Systems Interconnection – The Directory: Selected attribute types.*
- ITU-T Recommendation X.521 (1997) | ISO/IEC 9594-7: 1998, *Information technology – Open Systems Interconnection – The Directory: Selected object classes.*

2.3 Message Handling references

This Recommendation | International Standard cites the following Message Handling System specifications:

- ITU-T Recommendation F.400/X.400 (1999), *Message handling services: Message handling system and service overview*.
- ISO/IEC 10021-1: 1999, *Information technology – Message Handling Systems (MHS) – Part 1: System and service overview*.
- ITU-T Recommendation X.402 (1999) | ISO/IEC 10021-2: 1999, *Information technology – Message Handling Systems (MHS): Overall architecture*.
- ITU-T Recommendation X.411 (1999) | ISO/IEC 10021-4: 1999, *Information technology – Message Handling Systems (MHS): Message transfer system: Abstract service definition and procedures*.

2.4 Country Code references

This Recommendation | International Standard cites the following Country Code specifications:

- ISO 3166-1: 1997, *Codes for the representation of names of countries and their subdivisions – Part 1: Country codes*.
- ITU-T Recommendation X.121 (1996), *International number plan for public data networks*.

2.5 Additional references

This Recommendation | International Standard cites the following specification:

- ISO/IEC 9945-2: 1993, *Information technology – Portable Operating System Interface (POSIX) – Part 2: Shell and Utilities*.

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3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

[ISO/IEC 10021-10:1999](https://standards.iteh.ai/catalog/standards/sist/ce26ecdc-7f0d-4867-a3fa-ISO/IEC-10021-10:1999)

3.1 MHS-routing definitions

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The following terms are defined in clauses 6 and 7 of this Recommendation | International Standard:

- connection-group
- entry-connection-group
- enumerated connection-group
- indirect-exit-connection-group
- key-routing-collective
- local-exit-connection-group
- local-use-tables
- MHS-routing
- next-MTA
- OR-address-element
- OR-address-subtree
- routing-advice
- routing-collective
- routing-collective-subtree
- routing-MTA
- transit-exit-connection-group
- unenumerated connection-group

A glossary of these terms appears in annex I.

3.2 MHS definitions

The following terms are defined in ITU-T Rec. X.402 | ISO/IEC 10021-2:

- Administration Management Domain (ADMD)
- Management Domain (MD)
- Message Handling System (MHS)
- Message Transfer Agent (MTA)
- Message Transfer System (MTS)
- Originator/recipient Address (OR-address)
- Private Management Domain (PRMD)
- Reliable Transfer Service Element (RTSE)

For the purposes of this Recommendation | International Standard, the term *message*, where used unqualified, refers generically to a *message*, *probe*, or *report*.

3.3 Directory definitions

The following terms are defined in ITU-T Rec. X.501 | ISO/IEC 9594-2:

- Directory Information Tree (DIT)
- Directory System Agent (DSA)
- Directory User Agent (DUA)
- Relative Distinguished Name (RDN)

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4 Abbreviations

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The abbreviations used in this Recommendation | International Standard are defined in ITU-T Rec. X.402 | ISO/IEC 10021-2, and ITU-T Rec. X.501 | ISO/IEC 9594-2 (see 3.2 and 3.3), except for the following.

- ACSE Association Control Service Element (ITU-T Rec. X.217 | ISO/IEC 8649)
- APS Asynchronous Protocol Specification (ITU-T Rec.X.445)
- IP Internet Protocol
- LAN Local Area Network
- PSAP Presentation Service Access Point (ITU-T Rec. X.650 | ISO/IEC 7498-3)
- WAN Wide Area Network
- X.25 A packet-switched network conforming to ITU-T Rec. X.25

5 Conventions

This Recommendation | International Standard uses the descriptive conventions listed below.

5.1 Conventions for routing model specification

This Recommendation | International Standard uses the following ASN.1-based descriptive conventions for the indicated purposes:

- a) To define the data types and values for MHS-routing, ASN.1 itself.
- b) To define the Directory entries for MHS-routing, the OBJECT-CLASS, ATTRIBUTE, NAME-FORM, STRUCTURE-RULE, and MATCHING-RULE information object classes of ITU-T Rec. X.501 | ISO/IEC 9594-2.

Whenever this Recommendation | International Standard describes a class of data structure having components, each component is categorized as one of the following **grades**:

- a) **Mandatory (M)**: A mandatory component shall be present in every instance of the class.
- b) **Optional (O)**: An optional component may be present in an instance of the class at the discretion of the object (e.g. user) supplying that instance.
- c) **Conditional (C)**: A conditional component shall be present in an instance of the class as specified by this Recommendation | International Standard.

5.2 General font conventions

Throughout this Recommendation | International Standard, terms are rendered in **bold** when defined. Terms that are proper nouns are capitalized, generic terms are not. Multi-word generic terms are hyphenated. Italic font is used for ASN.1 identifiers defined in other Recommendations | International Standards.

5.3 Font conventions for ASN.1 definitions

Throughout this Recommendation | International Standard, ASN.1 definitions appear in fixed-pitch font (of this type) to highlight the difference between normal text and ASN.1 definitions. The font used for ASN.1 definitions is smaller than that used for normal text.

5.4 Rules for ASN.1 definitions

ASN.1 definitions appear both in the body of this Recommendation | International Standard to aid the exposition, and again, formally, in annexes for reference. If a difference is found between the ASN.1 used in the exposition and that formally defined in the corresponding annex, a specification error is indicated.

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6 MHS-routing Overview

The purpose of a Message Handling System (MHS) is to enable users to exchange messages on a store-and-forward basis. A message submitted on behalf of one user, the originator, is conveyed by the Message Transfer System (MTS) and subsequently delivered to the agents of one or more additional users, the recipients. The MTS comprises a collection of Message Transfer Agents (MTAs), which are highly distributed, and a message may traverse a number of MTAs on the journey from its originator to its recipient.

In MHS, the originator does not specify a path through the MTS to reach a recipient, but simply specifies a recipient OR-name (from which the OR-address is obtained). It is the responsibility of each MTA to determine the next MTA to which the message should be transferred to progress its journey to its recipient. Routing is thus the process of selecting, given an OR-address, the MTA to which the message should next be transferred.

Other Recommendations | International Standards specify the services provided by MHS, and the protocols used to transfer messages within the MTS. The means by which an MTA determines an appropriate route that will convey a message to its recipient is the subject of this Recommendation | International Standard. The various mechanisms defined herein which enable MTAs to make this determination constitute MHS-routing.

The path taken between an originator and recipient may vary on different occasions, since there will in general be a number of possible paths between them, and factors such as congestion and availability may influence route selection.

MTAs acquire routing information by accessing Directory entries whose maintenance is the responsibility of an MHS administrator. These entries model the various properties of the MHS that are relevant to routing. However, MHS-routing does not depend on the provision of a fully interconnected Directory.

6.1 Operational characteristics

MHS-routing has the following operational characteristics:

- a) In MHS-routing, the OR-address name-space is decoupled from the constraints of hardware organization (e.g. the assignment of users to particular machines, or the ability of groups of machines to interconnect). This is in contrast with routing strategies that use OR-address pattern-matching methods to make routing decisions, which constrain an MHS administrator's choice in the allocation of OR-addresses to users, and require users to change their OR-addresses whenever their MTA changes.

OR-addresses are intended to reflect the organizational hierarchy, and to use only as many levels of OR-address element as is required to achieve this. However, many organizations have staff distributed over multiple locations (where staff will necessarily use a local MTA), or have multiple messaging systems in use (e.g. mainframe-based, integrated office automation systems, and PC LAN email systems) where staff in any one department are arbitrarily allocated to different systems. Separating the OR-address hierarchy from the physical topology allows for the assignment to users of addresses which are compact and related to their organizational role, regardless of their physical location.

- b) MHS-routing supports the range of connection densities possible among MTAs. One extreme is where all MTAs are connected to a common network and any MTA can connect to any other (e.g. a public wide-area network). At the other extreme an administrator specifies precisely which MTA pairs are able to communicate, as if the MTAs were connected by individual cables, regardless of the actual connection method.

Some MHS installations restrict the topology (e.g. by performing all routing through a central switch MTA), because of the management cost in maintaining routing information, even when all the MTAs concerned are connected to a LAN or WAN and could, in principle, exchange messages directly. However, moving to the fully connected possibility may be undesirable for some organizations, due to concerns of security and cost optimization.

- c) MHS-routing permits varying degrees of autonomy and segregation in the management of an MHS system. Many organizations will have the overall MHS managed by a central IT unit, with the management of individual system components devolved to local administrators. Often, the MHS management hierarchy will be different from the organizational hierarchy. Typically, the MHS management reflects geographical locality, while the users are organized into geographically dispersed business units. In MHS-routing, this practice is accommodated by the use of two separate hierarchies for these two aspects of MHS organization.

- d) MHS-routing accommodates a range of routing problem sizes, from an organization managing two or three MTAs, up to a PRMD operating hundreds or thousands of MTAs. An organization might organize only its internal connectivity, using ADMDs or specific bilateral agreements for all external connectivity, or it might join a more open community which publishes routing information in the Directory and allows for the open exchange of messages across a common network infrastructure.

- e) MHS-routing does not constrain the choice of routing policies available to an organization. It provides a framework for the management of relevant routing information such that a range of routing strategies may be implemented.

- f) MHS-routing provides a balanced trade-off in terms of cost/efficiency. Any scheme which relies on access to the Directory is likely to be slower to execute than one based purely on local tables held in the MTA. However, the Directory-based approach should provide the MTA with a better quality of information and so improve overall efficiency by the determination of optimal routes. For example, in a large PRMD it may often be infeasible to provide each MTA with customised tables listing every address in the domain, and consequently messages will take multiple hops towards their destination, passing through central MTAs that hold the tables. When Directory-based MHS-routing is used, the processing required at the originating MTA is greater, but is likely to identify a direct route and so enable transfer of the message in a single step.

The use of MHS-routing also leads to a more scalable architecture, allowing for medium-capacity MTAs to be distributed throughout the network rather than depending on a small number of MTAs to perform central message switching. This scalable approach reduces the risks associated with a single point of failure on the network.

6.2 Components of the model

The different types of information stored in the Directory represent the modelling objects used to represent the MHS. Use of Directory access-control is not required for the operation of MHS-routing, but it may be employed where it is required to limit visibility to browsers of the Directory. Equally, information may be stored in a private DIT that has no connection to the outside world - there is no assumption that a fully interconnected Directory is available. However some routing policies, particularly those of an unrestricted nature, would benefit from a fully interconnected Directory.

6.2.1 Routing-collective

A **routing-collective** is a collection of one or more MTAs, under common management, which has collective responsibility for a portion of the OR-address name-space, and is capable of routing a message to any MTA managed within the collective. Therefore a routing-collective represents the management structure of some part of the MHS in the context of routing. By grouping together MTAs under common management control, the routing-collective provides abstraction (the internal structure of the routing-collective may be concealed from external MTAs) and is useful in limiting the scope of the information that MTAs need to hold.

The smallest instance of a routing-collective is a single MTA, and indeed each MTA is itself defined as a routing-collective. The largest instance of a routing-collective will typically be a Management Domain. While a routing-collective which comprises several PRMDs is not precluded, it is unusual for such PRMDs to be under genuinely common management control; the more typical case of loose confederations of PRMDs may be handled by other mechanisms.

Routing-collectives are structured in a hierarchical manner, with the number of levels chosen to suit the organization in question. Small MDs, or MDs of a very uniform nature under the complete control of a central IT management unit, will require only a two-level hierarchy. The MD is one routing-collective and contains all the MTAs (each of which is itself a routing-collective). More complex MDs will normally require a third level of routing-collective perhaps to group together all of the MTAs at a given location, or all those belonging to each department.

Each complete hierarchy of routing-collectives is represented by a DIT subtree, the **routing-collective-subtree**, which models their hierarchical relationships. All routing-collectives within a routing-collective subtree co-operate with one another in performing MHS-routing.

Each routing-collective has an entry in the Directory that indicates the connection-groups (see 6.2.3) by which a message may be transferred into the routing-collective, and those by which a message may be transferred out of the routing-collective.

6.2.2 Routing-MTA

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A **routing-MTA** is an MTA that participates in MHS-routing as defined in this Recommendation | International Standard. By definition, a routing-MTA is the smallest instance of a routing-collective and occupies the lowest level in the routing-collective hierarchy, i.e. it appears as a leaf of the routing-collective subtree.

The routing-MTA is provided, by local configuration, with its routing-MTA Directory name (a routing-collective name) and credentials which enable it to read that Directory entry. All other information necessary for MHS-routing may be acquired from the Directory. As an implementation choice, this information may be retrieved at initialisation, or may be retrieved dynamically as required. For the purposes of exposition, the former approach is assumed. The caching of information acquired from the Directory may be necessary for efficient implementation, but is beyond the scope of this Recommendation | International Standard.

NOTE 1 – Implementors should be aware that out-of-date cached information can lead to routing loops and sub-optimal route choices. While procedures are specified to resolve routing loops, cache refreshing should also be performed at regular intervals.

A routing-MTA Directory entry indicates the one or more OR-address-subtrees which the routing-MTA's administrator has chosen to reflect the routing policy of this MTA, and also indicates the Directory name of the MHS Message Transfer Agent entry for this MTA (see A.1.3 of ITU-T Rec. X.402 | ISO/IEC 10021-2).

In order to fulfil its function, a routing-MTA must acquaint itself with knowledge of the other routing-collectives in its routing-collective-subtree. The minimum knowledge required for a routing-MTA to achieve this is discovered by collecting information from a specific subset of the routing-collectives in its routing-collective-subtree. These **key-routing-collectives** are defined as follows:

- the siblings of the routing-collective;
- the siblings of each of the routing-collective's superior routing-collectives.

NOTE 2 – While knowledge of a routing-collective's key-routing-collectives is required for the operation of MHS-routing, this information is not recorded explicitly in any Directory entry since it differs for every routing-collective, and may readily be discovered by inspection.

The reason for this definition of key-routing-collectives may be understood as follows. By the definition of routing-collective, a routing-MTA must be able to route a message to any of the other MTAs in each routing-collective of which it is a member; the practical effect is that the routing-MTA must be able to act on routing information that instructs it to transfer a message to one of the routing-collectives in the same routing-collective-subtree. Hence a simplistic definition of key-routing-collectives would include all of the routing-collectives in this tree. However, this gives more information than is strictly required. Plainly, the routing-MTA does not need to consider itself as a destination; similarly, an

instruction to transfer the message to one of the routing-MTA's superior routing-collectives is meaningless (since the message has already arrived in that routing-collective), so these are not considered as key-routing-collectives. One of the purposes of having more than one level of routing-collective hierarchy is that a routing-MTA does not need to be aware of the internal structure of routing-collectives in distant parts of the routing-collective-subtree. Hence if one routing-collective is considered to be a key-routing-collective, its subordinates do not need to be. Excluding these unnecessary elements leaves the definition which has been adopted.

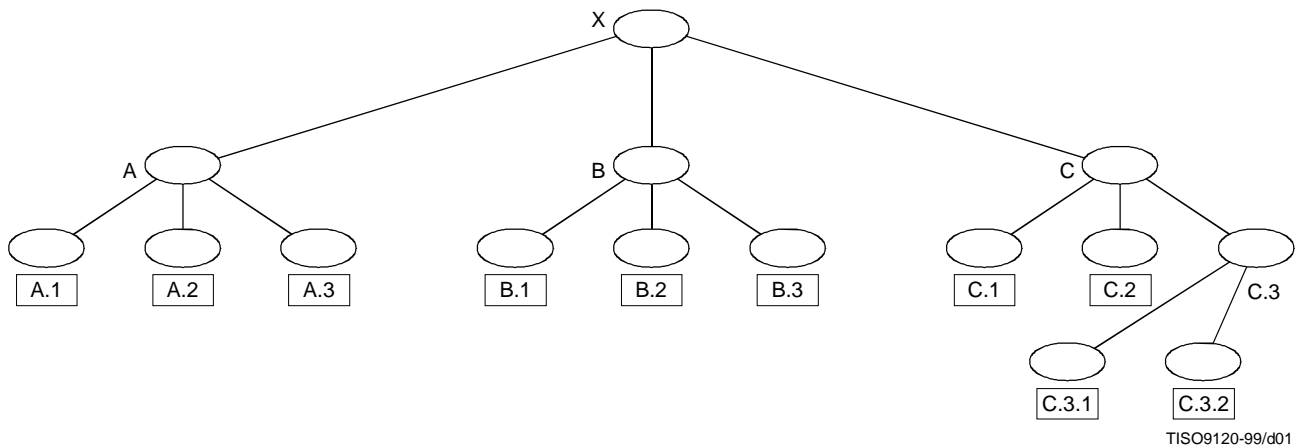


Figure 1 – Example of a routing-collective-subtree

Figure 1 illustrates the hierarchical relationships in a routing-collective-subtree. The routing-collective at the base of the subtree, X, has three immediate subordinate routing-collectives, A, B, and C. In turn, A, B, and C each contain three immediate subordinate routing-collectives. In the case of A and B, these routing-collectives are also routing-MTAs. In the case of C, C.1 and C.2 are routing-MTAs, while C.3 is a routing-collective containing two routing-MTAs. The names of the routing-MTAs are enclosed in boxes. For the routing-MTA B.3, the key-routing-collectives are B.1, B.2, A, and C.

6.2.3 Connection-group

A **connection-group** is a group of connections over which messages may be directly exchanged between members of a set of MTAs, using a specific MHS transfer protocol over a common network. It therefore represents the topology of the MHS, i.e., how the MTAs are physically interconnected. All MTAs in a connection-group have a network technology and a message transfer Application Context in common, and have administrative approval to interwork.

A connection-group is represented by specifying its member MTAs. A connection may be created between every pair of these MTAs. The Directory entry that represents a connection-group may also indicate the specific message transfer protocol used.

The simplest type of connection-group has just two members: this represents a conventional pair of MTAs that have been configured to communicate with one another. Larger sets may be constructed for convenience. If a number of MTAs are connected to a LAN or WAN, such that connections are permitted between any pair of them, they may all be assigned to a single connection-group, rather than to multiple groups that represent all the individual connections possible.

Connection-groups are of two types, enumerated and unenumerated. An **enumerated connection-group** is identified by Directory name, and has an associated list of member MTAs, as described above. An **unenumerated connection-group** is also identified by Directory name, and is typically associated with a network infrastructure such as a public or private wide-area network (e.g. X.25 or IP). Its membership is defined by self-declaration. The administrator who makes a local decision to configure an MTA into such a group is implicitly declaring that the MTA will accept connections from any other MTA on the same network, without prior agreement between MTA administrators.

Each routing-collective classifies the connection-groups available to it as follows:

- a) an **entry-connection-group** is one that may be used to transfer messages into the routing-collective.
- b) an **exit-connection-group** is one that may be used to transfer messages out of the routing-collective.

Two types of exit-connection-groups are distinguished: a **transit-exit-connection-group** is one that may be used to transfer a message out of the routing-collective, regardless of origin; a **local-exit-connection-group** is one that may be used to transfer a message out of the routing-collective, but is available only for messages originated, or redirected, or DL-expanded within the routing-collective.