

ANSI/IEEE Std 802.1D, 1998 Edition

[Incorporates ANSI/IEEE Std 802.1D, 1993 Edition, IEEE P802.1p,
IEEE Std 802.1j-1996, IEEE Std 802.6k-1992,
IEEE Std 802.11c-1998, and IEEE P802.12e]

(Adopted by ISO/IEC and redesignated as
ISO/IEC 15802-3:1998)

**IEEE Standard for Information technology—
Telecommunications and information exchange between systems—
Local and metropolitan area networks—
Common specifications**

Part 3: Media Access Control (MAC) Bridges

Adopted by the ISO/IEC and redesignated as ISO/IEC 15802-3:1998

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ANSI/IEEE Std 802.1D, 1998 Edition

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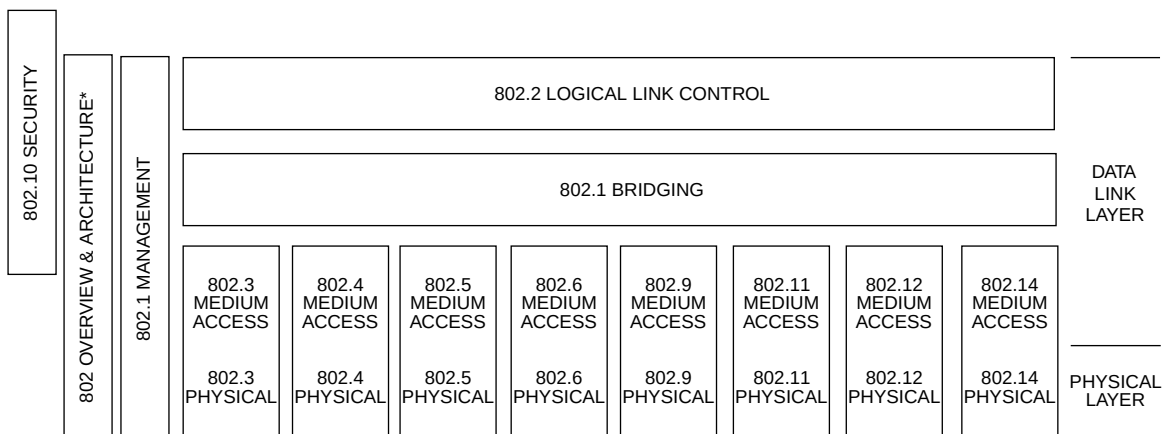
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Introduction to ANSI/IEEE Std 802.1D, 1998 Edition

[This introduction is not part of ANSI/IEEE Std 802.1D, 1998 Edition, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 3: Media Access Control (MAC) Bridges.]

This standard is part of a family of standards for local and metropolitan area networks. The relationship between the standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



* Formerly IEEE Std 802.1A.

This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model (ISO/IEC 7498-1 : 1994). The access standards define seven types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining the technologies noted above are as follows:

- IEEE Std 802 *Overview and Architecture.* This standard provides an overview to the family of IEEE 802 Standards.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] *LAN/MAN Management.* Defines an OSI management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D [ISO/IEC 15802-3] *Media Access Control (MAC) Bridges.* Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/IEEE Std 802.1E [ISO/IEC 15802-4] *System Load Protocol.* Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ANSI/IEEE Std 802.1F *Common Definitions and Procedures for IEEE 802 Management Information*
- ANSI/IEEE Std 802.1G [ISO/IEC 15802-5] *Remote Media Access Control (MAC) bridging.* Specifies extensions for the interconnection, using non-LAN communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.
- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2] *Logical link control*

- ANSI/IEEE Std 802.3 [ISO/IEC 8802-3] *CSMA/CD access method and physical layer specifications*
- ANSI/IEEE Std 802.4 [ISO/IEC 8802-4] *Token passing bus access method and physical layer specifications*
- ANSI/IEEE Std 802.5 [ISO/IEC 8802-5] *Token ring access method and physical layer specifications*
- ANSI/IEEE Std 802.6 [ISO/IEC 8802-6] *Distributed Queue Dual Bus (DQDB) access method and physical layer specifications*
- ANSI/IEEE Std 802.9 [ISO/IEC 8802-9] *Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers*
- ANSI/IEEE Std 802.10 *Interoperable LAN/MAN Security*
- ANSI/IEEE Std 802.11 [ISO/IEC DIS 8802-11] *Wireless LAN Medium Access Control (MAC) and physical layer specifications*
- ANSI/IEEE Std 802.12 [ISO/IEC 8802-12] *Demand-priority access method, physical layer and repeater specifications*

In addition to the family of standards, the following is a recommended practice for a common Physical Layer technology:

- IEEE Std 802.7 *IEEE Recommended Practice for Broadband Local Area Networks*

The following additional working group has authorized standards projects under development:

- IEEE 802.14 *Standard Protocol for Cable-TV Based Broadband Communication Network*

Conformance test methodology

An additional standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the 802 family of standards. Thus the conformance test documents for 802.3 are numbered 1802.3.

ANSI/IEEE Std 802.1D, 1998 Edition

The MAC Bridge standardization activities that resulted in the development of IEEE Std 802.1D-1990 (subsequently republished as ISO/IEC 10038:1993 [IEEE Std 802.1D, 1993 Edition]) specified an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC Service boundary. IEEE Std 802.1D-1990 also introduced the concept of filtering services in Bridged LANs, and mechanisms whereby filtering information in such LANs may be acquired and held in a Filtering Database. This revision of ISO/IEC 10038: 1993 extends this concept of filtering services in order to define additional capabilities in Bridged LANs aimed at the following:

- a) The provision of expedited traffic capabilities, to support the transmission of time-critical information in a LAN environment;
- b) The provision of filtering services that support the dynamic definition and establishment of Groups in a LAN environment, and the filtering of frames by Bridges such that frames addressed to a given

Group are forwarded only on those LAN segments that are required in order to reach the members of that Group.

To this end, this document incorporates a set of changes and additions to ISO/IEC 10038: 1993 that define the following:

- a) The nature of Filtering Services in Bridged LANs;
- b) The concept of Traffic Classes and the effect on the operation of the Forwarding Process of supporting multiple Traffic Classes in Bridges;
- c) The structure of the Filtering Database that is needed in order to support Dynamic Multicast Filtering services;
- d) The registration protocol that is required in order to provide Dynamic Multicast Filtering Services;
- e) The management services and operations that are required in order to support administration of Dynamic Multicast Filtering Services.

Relationship between IEEE Std 802.1D and IEEE P802.1Q

A further IEEE standard under development, IEEE P802.1Q, extends the concepts of filtering services and MAC Bridging in order to provide a set of capabilities that allow MAC Bridges to support the definition and management of Virtual LANs (VLANs).

The capabilities defined in IEEE P802.1Q include the definition of a VLAN frame format that is able to carry VLAN identification and user priority information over LAN technologies, such as CSMA/CD, that have no inherent capability to signal priority information. This information is carried in an additional header field, known as the *Tag Header*, which is inserted immediately following the Destination MAC Address, and Source MAC Address (and Routing Information field, if present) of the original frame. IEEE P802.1Q extends the priority handling aspects of this standard to make use of the ability of the VLAN frame format to carry user priority information end to end across any set of concatenated underlying MACs.

The VLAN Bridging specification contained in IEEE 802.1Q is independent of this standard, in the sense that IEEE 802.1Q makes a separate and distinct statement of the conformance requirements for VLAN Bridges from the conformance requirements for MAC Bridges defined in this standard. However, IEEE 802.1Q makes use of many of the elements of the specification contained in this standard, in particular

- a) The Bridge architecture;
- b) The Internal Sublayer Service, and the specification of its provision by IEEE 802 LAN MACs;
- c) The major features of the operation of the Forwarding Process;
- d) The Spanning Tree Algorithm and Protocol;
- e) The Generic Attribute Registration Protocol (GARP); and
- f) The GARP Multicast Registration Protocol (GMRP).

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IEEE Std 802.11c-1998

IEEE Std 802.11c-1998 adds the necessary information to map the IEEE 802.11 MAC parameters onto ISO/IEC 15802-3 (IEEE Std 802.1D) parameters.

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Abstract: The concept of Media Access Control (MAC) Bridging, introduced in the 1993 edition of this standard, has been expanded to define additional capabilities in Bridged LANs aimed at providing for expedited traffic capabilities, to support the transmission of time-critical information in a LAN environment; and providing filtering services that support the dynamic use of Group MAC Addresses in a LAN environment.

Keywords: local area networks, MAC Bridge management, MAC bridges, media access control (MAC) bridges, multicast address filtering, traffic class expediting

The Institute of Electrical and Electronics Engineers, Inc.
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Print: ISBN 0-7381-0329-2 SH94651
PDF: ISBN 0-7381-1416-2 SS94651

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Part 3: Media Access Control (MAC) Bridges

1. Overview

1.1 Introduction

IEEE 802 Local Area Networks (or LANs; see 3.4) of all types can be connected together using MAC Bridges. Each individual LAN has its own independent MAC. The Bridged LAN created allows the interconnection of stations attached to separate LANs as if they were attached to a single LAN, although they are in fact attached to separate LANs each with its own MAC. A MAC Bridge operates below the MAC Service Boundary, and is transparent to protocols operating above this boundary, in the Logical Link Control (LLC) sublayer or Network Layer (ISO/IEC 7498-1: 1994¹). The presence of one or more MAC Bridges can lead to differences in the Quality of Service provided by the MAC sublayer; it is only because of such differences that MAC Bridge operation is not fully transparent.

A Bridged LAN can provide for

- a) The interconnection of stations attached to LANs of different MAC types;
- b) An effective increase in the physical extent, the number of permissible attachments, or the total performance of a LAN;
- c) Partitioning of the physical LAN for administrative or maintenance reasons.

NOTE—Scope, definitions, references, and conformance requirements relating to the operation of Source-Routing Transparent Bridge operation can be found in Annex C.1.

1.2 Scope

For the purpose of compatible interconnection of data processing equipment using the IEEE 802 MAC Service supported by interconnected IEEE 802 LANs (see 3.4) using different or identical Media Access Control methods, this standard specifies a general method for the operation of MAC Bridges. To this end it

- a) Positions the bridging function within an architectural description of the MAC Sublayer.
- b) Defines the principles of operation of the MAC Bridge in terms of the support and preservation of the MAC Service, and the maintenance of Quality of Service.
- c) Specifies the MAC Internal Sublayer Service provided by individual LANs to the Media Access Method Independent Functions that provide frame relay in the Bridge.
- d) Identifies the functions to be performed by Bridges, and provides an architectural model of the internal operation of a Bridge in terms of Processes and Entities that provide those functions.
- e) Establishes the requirements for a protocol between the Bridges in a Bridged LAN to configure the network, and specifies the distributed computation of a Spanning Tree active topology.
- f) Specifies the encoding of the Bridge Protocol Data Units (BPDUs).
- g) Establishes the requirements for Bridge Management in the Bridged LAN, identifying the managed objects and defining the management operations.

¹Information about references can be found in Clause 2.

- h) Specifies how the management operations are made available to a remote manager using the protocol and architectural description provided by ISO/IEC 15802-2: 1995.
- i) Specifies performance requirements and recommends default values and applicable ranges for the operational parameters of a Bridge.
- j) Specifies the requirements to be satisfied by equipment claiming conformance to this standard.
- k) Specifies criteria for the use of MAC-specific bridging methods.

This standard specifies the operation of MAC Bridges that attach directly to IEEE 802 LANs, as specified in the relevant MAC standards for the MAC technology or technologies implemented.

The specification of Remote Bridges, which interconnect LANs using Wide Area Network (WAN) media for the transmission of frames between Bridges, is outside the scope of this standard.

NOTE—Remote MAC Bridging is specified in ISO/IEC 15802-5: 1997 [ANSI/IEEE Std 802.1G, 1997 Edition].

2. References

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 15802. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 15802 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of ISO and IEC maintain registers of currently valid International Standards.

ANSI X3.159-1989, American National Standards for Information Systems—Programming Language—C.²

IEEE Std 802-1990, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.³

IEEE Std 802.1F-1993, IEEE Standards for Local and Metropolitan Area Networks: Common Definitions and Procedures for IEEE 802 Management Information.

IEEE Std 802.3, 1998 Edition, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

IEEE Std 802.9a-1995, IEEE Standards for Local and Metropolitan Area Networks: Supplement to Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers: Specification of ISLAN 16-T.

IEEE Std 802.11-1997, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications.⁴

IETF INTERNET-DRAFT, Internet Group Management Protocol (IGMP), Version 2, January 20th 1997⁵.

IETF RFC 1493, Decker, Langille, Rijsinghani and McCloughrie, Definitions of Managed Objects for Bridges, July 1993⁶.

ISO 6937-2: 1983, Information processing—Coded character sets for text communication—Part 2: Latin alphabetic and non-alphabetic graphic characters.⁷

ISO/IEC 7498-1: 1994, Information processing systems—Open Systems Interconnection—Basic Reference Model—Part 1: The Basic Model.

²ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

³IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁴A draft International Standard (ISO/IEC DIS 8802-11) is under way for this standard. For information about the status of this DIS, contact the ISO Central Secretariat, 1 rue de Varembé, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse; or the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁵Internet Drafts are retrievable at the IETF Web site, <http://www.ietf.cnri.reston.va.us/home.html>, or call InterNIC at 1-800-444-4345 for information about receiving copies through the mail.

⁶Internet RFCs are retrievable by FTP at [ds.internic.net/rfc/rfcnnnn.txt](ftp://ds.internic.net/rfc/rfcnnnn.txt) (where nnnn is a standard's publication number such as 1493), or call InterNIC at 1-800-444-4345 for information about receiving copies through the mail.

⁷ISO and ISO/IEC documents are available from the ISO Central Secretariat, 1 rue de Varembé, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse; and from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

ISO/IEC 8802-2: 1998 [ANSI/IEEE Std 802.2, 1998 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 2: Logical link control.⁸

ISO/IEC 8802-4: 1990 [ANSI/IEEE Std 802.4-1990], Information processing systems—Local area networks—Part 4: Token-passing bus access method and physical layer specifications.

ISO/IEC 8802-5: 1998 [ANSI/IEEE Std 802.5, 1998 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 5: Token ring access method and physical layer specifications.

ISO/IEC 8802-6: 1994 [ANSI/IEEE Std 802.6, 1994 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 6: Distributed Queue Dual Bus (DQDB) access method and physical layer specifications.

ISO/IEC 8802-9: 1996 [ANSI/IEEE Std 802.9, 1996 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 9: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers.

ISO/IEC 8802-12: 1998 [ANSI/IEEE Std 802.12, 1998 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 12: Demand-Priority access method, physical layer and repeater specifications.

ISO/IEC 8824: 1990, Information technology—Open Systems Interconnection—Specification of Abstract Syntax Notation One (ASN.1) (Provisionally retained edition).

ISO/IEC 8825: 1990, Information technology—Open Systems Interconnection—Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) (Provisionally retained edition).

ISO/IEC 9595: 1998, Information technology—Open Systems Interconnection—Common management information service.

ISO 9314-2: 1989, Information processing systems—Fibre Distributed Data Interface—Part 2: FDDI Token Ring Media Access Control (MAC).

ISO/IEC 9596-1: 1991, Information technology—Open Systems Interconnection—Common management information protocol—Part 1: Specification.

ISO/IEC TR 11802-2: 1997, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Technical reports and guidelines—Part 2: Standard Group MAC addresses.

ISO/IEC 11802-5: 1997 [ANSI/IEEE Std 802.1H, 1997 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Technical reports and guidelines—Part 5: Media Access Control (MAC) Bridging of Ethernet V2.0 in Local Area Networks.

⁸ISO [IEEE] and ISO/IEC [IEEE] documents are available from ISO Central Secretariat, 1 rue de Varembe, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse; and from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

ISO/IEC 15802-1: 1995, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 1: Medium Access Control (MAC) service definition.

ISO/IEC 15802-2: 1995 [ANSI/IEEE Std 802.1B, 1995 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 2: LAN/MAN management.

ISO/IEC 15802-5: 1998 [ANSI/IEEE Std 802.1G, 1998 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 5: Remote Medium Access Control (MAC) bridging.

3. Definitions

For the purposes of this standard, the following terms and definitions apply:

3.1 Bridged Local Area Network

A concatenation of individual IEEE 802 LANs interconnected by MAC Bridges.

3.2 Expedited traffic

Traffic that requires preferential treatment as a consequence of jitter, latency, or throughput constraints, or as a consequence of management policy.

3.3 Group

A Group associates

- a) A group MAC address; and
- b) A set of properties that define membership characteristics; and
- c) A set of properties that define the forwarding/filtering behavior of a Bridge with respect to frames destined for members of that group MAC address;

with a set of end stations that all wish to receive information destined for that group MAC address. Members of such a set of end stations are said to be *Group members*.

A Group is said to *exist* if the properties associated with that Group are visible in an entry in the Filtering Database of a Bridge, or in the GARP state machines that characterize the state of the Group; a Group is said to *have members* if the properties of the Group indicate that members of the Group can be reached through specific Ports of the Bridge.

NOTE—An example of the information that Group members might wish to receive is a multicast video data stream.

3.4 IEEE 802 Local Area Network (LAN)

IEEE 802 LANs (also referred to in the text simply as LANs) are LAN technologies that provide a MAC Service equivalent to the MAC Service defined in ISO/IEC 15802-1. IEEE 802 LANs include IEEE Std 802.3 (CSMA/CD), ISO/IEC 8802-4 (Token Bus), ISO/IEC 8802-5 (Token Ring), ISO/IEC 8802-6 (DQDB), ISO/IEC 8802-9 (IS-LAN), IEEE Std 802.11 (Wireless), ISO/IEC 8802-12 (Demand Priority), and ISO 9314-2 (FDDI) LANs.

NOTE—The connectionless service part of ISO/IEC 8802-6 provides an equivalent MAC Service. This standard covers Bridging of 48-bit addressed ISO/IEC 8802-6 PDUs only. The Bridging of 60-bit addressed ISO/IEC 8802-6 PDUs is outside the scope of this standard.

4. Abbreviations

The following abbreviations are used in this standard:

BPDU	Bridge Protocol Data Unit
CRC	Cyclic Redundancy Check
FCS	Frame Check Sequence
GARP	Generic Attribute Registration Protocol
GARP PDU	GARP Protocol Data Unit
GID	GARP Information Declaration
GIP	GARP Information Propagation
GMRP	GARP Multicast Registration Protocol
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
MAC	Media Access Control

5. Conformance

5.1 Static conformance requirements

A MAC Bridge for which conformance to this standard is claimed shall

- a) Conform to the relevant MAC standards for the MAC technology or technologies implemented at its Ports, as described in 6.5;
- b) Conform to ISO/IEC 8802-2 for the implementation of a class of LLC supporting Type 1 operation as required by 7.3, and 7.1.2;
- c) Relay and filter frames as described in 7.1 and specified in 7.5, 7.6, and 7.7 for support of Basic Filtering Services, and for a single traffic class associated with each outbound Port;
- d) Maintain the information required to make frame-filtering decisions as described in 7.1 and specified in 7.8 and 7.9, for the support of Basic Filtering Services.
- e) Use stated values of the following parameters of the Filtering Database (7.9):
 - 1) Filtering Database Size, the maximum number of entries that can be held in the Filtering Database.
 - 2) Permanent Database Size, the maximum number of entries that can be held in the Permanent Database.
- f) Conform to the provisions for addressing specified in 7.12.
- g) Provide
 - 1) A means of assigning a group MAC Address to identify the Bridge Protocol Entity, if 48-bit Universally Administered Addresses are not used;
 - 2) A distinct Port identifier for each Port of the Bridge, as specified in 8.5, as required by 8.2 for operation of the Spanning Tree Algorithm and Protocol.
- h) Implement the Spanning Tree Algorithm and Protocol described in Clause 8, as specified in 8.7.
- i) Not exceed the values given in 8.10.2 for the following parameters:
 - 1) Maximum bridge transit delay
 - 2) Maximum Message Age increment overestimate
 - 3) Maximum BPDU transmission delay
- j) Use the value given in Table 8-3 for the following parameter:
 - 1) Hold Time
- k) Encode transmitted BPDUs and validate received BPDUs as specified in Clause 9.
- l) Specify a Guaranteed Port Filtering Rate for each Bridge Port, a Guaranteed Bridge Relaying Rate for the Bridge, and the related time intervals TF and TR as specified in Clause 16. Operation of the Bridge within the specified parameters shall not violate any of the other conformance provisions of this standard.

5.2 Options

A MAC Bridge for which conformance to this standard is claimed may

- a) Provide the capability to control the mapping of the priority of forwarded frames as specified in 6.4, 7.5.1, and 7.7.3.
- b) Provide the capability to read and update the Filtering and Permanent Databases as specified in 7.9.
- c) Provide the capability to set the Ageing Time as specified in 7.9. A Bridge that provides this capability shall implement the full range of values specified in Table 7-4.
- d) Implement the optional provisions for addressing Bridge Management as specified in 7.12.4, for associating the Bridge Address with a Bridge Port as specified in 7.12.5, and for preconditioning group addresses in the Permanent Database as specified in 7.9.6.
- e) Provide the capability to assign values to the following parameters to allow configuration of the Spanning Tree active topology:

- 1) Bridge Priority
- 2) Port Priority
- 3) Path Cost for each Port

A Bridge that provides this capability shall implement the range of values specified in 8.10.2 and Table 8-4 and Table 8-5.

- f) Provide the capability to set the values of the following parameters of the Spanning Tree Algorithm and Protocol:
 - 1) Bridge Max Age
 - 2) Bridge Hello Time
 - 3) Bridge Forward DelayA Bridge that provides this capability shall implement the range of values specified in 8.10.2 and Table 8-3.
- g) Support management of the Bridge. Bridges claiming to support management shall support all the management objects and operations defined in Clause 14.
- h) Support the use of a remote management protocol. Bridges claiming to support remote management shall
 - 1) State which remote management protocol standard(s) or specification(s) are supported.
 - 2) State which standard(s) or specification(s) for managed object definitions and encodings are supported for use by the remote management protocol.
- i) Support the ability to disable topology change detection, as described in 8.5.5.10.
- j) Provide multiple traffic classes, as described in 7.7, associated with one or more outbound Ports;
- k) Provide the capability for Static Filtering Entries for individual MAC addresses to specify that forwarding or filtering behavior should be based on dynamic filtering information, as specified in 7.9.1;
- l) Relay and filter frames as described in 7.1 and specified in 7.5, 7.6, 7.7, and 7.9 for support of Extended Filtering Services, and implement the GARP Multicast Registration Protocol (GMRP), as detailed in the conformance requirements defined in 10.4.1;
- m) Provide the ability to manage the priority of relayed frames, as specified in 6.4, 7.5.1, and 7.7.3.

5.3 Protocol Implementation Conformance Statement (PICS) proforma

The supplier of an implementation that is claimed to conform to this standard shall complete a copy of the PICS proforma provided in Annex A and shall provide the information necessary to identify both the supplier and the implementation.

5.4 Recommendations

5.4.1 Management

Support of the managed objects and management operations specified in Clause 14 is highly recommended.

5.5 MAC-specific bridging methods

MAC-specific bridging methods may exist. Use of a MAC-specific bridging method and the method specified in this standard on the same LAN shall

- a) Not prevent communication between stations in a Bridged LAN.
- b) Preserve the MAC Service.
- c) Preserve the characteristics of each bridging method within its own domain.
- d) Provide for the ability of both bridging techniques to coexist simultaneously on a LAN without adverse interaction.

6. Support of the MAC Service

MAC Bridges interconnect the separate IEEE 802 LANs that comprise a Bridged LAN by relaying and filtering frames between the separate MACs of the Bridged LAN. The position of the bridging function within the MAC Sublayer is shown in Figure 6-1.

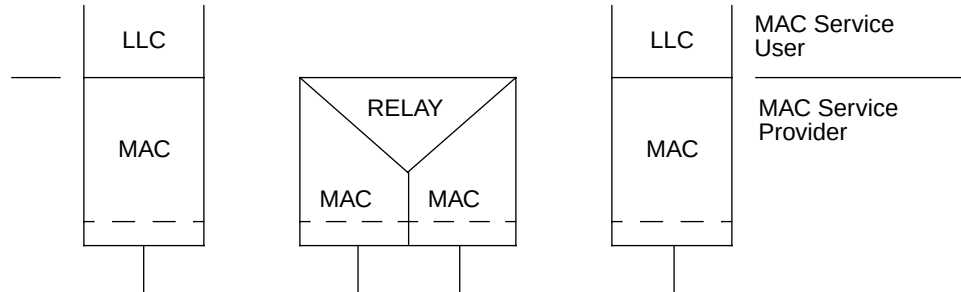


Figure 6-1—Internal organization of the MAC Sublayer

This clause discusses the following aspects of service provision in Bridged LANs:

- a) Provision of the MAC Service to end stations;
- b) Preservation of the MAC Service;
- c) Maintenance of Quality of Service;
- d) Provision of the internal sublayer service within the MAC Bridge;
- e) Support of the Internal Sublayer Service by specific MAC procedures;
- f) Filtering services.

6.1 Support of the MAC Service

The MAC Service provided to end stations attached to a Bridged LAN is the (unconfirmed) connectionless-mode MAC Service defined in ISO/IEC 15802-1. The MAC Service is defined as an abstraction of the features common to a number of specific MAC Services; it describes the transfer of user data between source and destination end stations, via MA-UNITDATA request primitives and corresponding MA-UNITDATA indication primitives issued at MAC Service access points. Each MA-UNITDATA request and indication primitive has four parameters: Destination Address, Source Address, MAC Service data unit (MSDU), and Priority.

The style of Bridge operation maximizes the availability of the MAC Service to end stations and assists in the maintenance of the Bridged LAN. It is therefore desirable that Bridges be capable of being configured in the Bridged LAN:

- a) So as to provide redundant paths between end stations to enable the Bridged LAN to continue to provide the Service in the event of component failure (of Bridge or LAN).
- b) So that the paths supported between end stations are predictable and configurable given the availability of Bridged LAN components.

6.2 Preservation of the MAC Service

The MAC Service offered by a Bridged LAN consisting of LANs interconnected by MAC Bridges is similar to that offered by a single LAN (6.3). In consequence,

- a) A Bridge is not directly addressed by communicating end stations, except as an end station for management purposes: frames transmitted between end stations carry the MAC Address of the peer-end station in their Destination Address field, not the MAC Address, if any, of the Bridge.
- b) All MAC Addresses must be unique within the Bridged LAN.
- c) The MAC Addresses of end stations are not restricted by the topology and configuration of the Bridged LAN.

6.3 Quality of service maintenance

The MAC Sublayer provides the MAC Service to end stations attached to a LAN or a Bridged LAN. The quality of the MAC Service supported by a Bridge should not be significantly inferior to that provided by a single LAN. The Quality of Service parameters to be considered are those that relate to

- a) Service availability
- b) Frame loss
- c) Frame misordering
- d) Frame duplication
- e) The transit delay experienced by frames
- f) Frame lifetime
- g) The undetected frame error rate
- h) Maximum service data unit size supported
- i) User priority
- j) Throughput

6.3.1 Service availability

Service availability is measured as that fraction of some total time during which the MAC Service is provided. The operation of a Bridge can increase or lower the service availability.

The service availability can be increased by automatic reconfiguration of the Bridged LAN in order to avoid the use of a failed component (e.g., repeater, cable, or connector) in the data path. The service availability can be lowered by failure of a Bridge itself, through denial of service by the Bridge, or through frame filtering by the Bridge.

A Bridge may deny service and discard frames (6.3.2) in order to preserve other aspects of the MAC Service (6.3.3 and 6.3.4) when automatic reconfiguration takes place. Service may be denied to end stations that do not benefit from the reconfiguration; hence, the service availability is lowered for those end stations. Bridges may filter frames in order to localize traffic in the Bridged LAN. Should an end station move, it may then be unable to receive frames from other end stations until the filtering information held by the Bridges is updated.

To maximize the service availability, no loss of service or delay in service provision should be caused by Bridges, except as a consequence of a failure, removal, or insertion of a Bridged LAN component, or as a consequence of the movement of an end station. These are regarded as extraordinary events. The operation of any additional protocol necessary to maintain the quality of the MAC Service is thus limited to the configuration of the Bridged LAN, and is independent of individual instances of service provision.

NOTE—This is true only in circumstances where admission control mechanisms are not present, i.e., where the Bridges provide a “best effort” service. The specification and applicability of admission control mechanisms in Bridges is outside the scope of this standard.

6.3.2 Frame loss

The MAC Service does not guarantee the delivery of Service Data Units. Frames transmitted by a source station arrive, uncorrupted, at the destination station with high probability. The operation of a Bridge introduces minimal additional frame loss.

A frame transmitted by a source station can fail to reach its destination station as a result of

- a) Frame corruption during physical layer transmission or reception.
- b) Frame discard by a Bridge because
 - 1) It is unable to transmit the frame within some maximum period of time and, hence, must discard the frame to prevent the maximum frame lifetime (6.3.6) from being exceeded.
 - 2) It is unable to continue to store the frame due to exhaustion of internal buffering capacity as frames continue to arrive at a rate in excess of that at which they can be transmitted.
 - 3) The size of the service data unit carried by the frame exceeds the maximum supported by the MAC procedures employed on the LAN to which the frame is to be relayed.
 - 4) Changes in the connected topology of the Bridged LAN necessitate frame discard for a limited period of time to maintain other aspects of Quality of Service.

6.3.3 Frame misordering

The MAC Service does not permit the reordering of frames with a given user priority for a given combination of destination address and source address. MA_UNITDATA.indication service primitives corresponding to MA_UNITDATA.request primitives, with the same requested priority and for the same combination of destination and source addresses, are received in the same order as the request primitives were processed.

NOTE—The operation of the Forwarding Process in Bridges (7.7) is such that the frame-ordering characteristics of the MAC Service are preserved.

Where Bridges in a Bridged LAN are capable of connecting the individual MACs in such a way that multiple paths between any source station–destination station pairs exist, the operation of a protocol is required to ensure that a single path is used.

6.3.4 Frame duplication

The MAC Service does not permit the duplication of frames. The operation of Bridges does not introduce duplication of user data frames.

The potential for frame duplication in a Bridged LAN arises through the possibility of duplication of received frames on subsequent transmission within a Bridge, or through the possibility of multiple paths between source and destination end stations.

A Bridge shall not duplicate user data frames. Where Bridges in a Bridged LAN are capable of connecting the individual MACs in such a way that multiple paths between any source station–destination station pairs exist, the operation of a protocol is required to ensure that a single path is used.

6.3.5 Transit delay

The MAC Service introduces a frame transit delay that is dependent on the particular media and MAC method employed. Frame transit delay is the elapsed time between an MA_UNITDATA.request primitive and the corresponding MA_UNITDATA.indication primitive. Elapsed time values are calculated only on Service Data Units that are successfully transferred.

Since the MAC Service is provided at an abstract interface within an end station, it is not possible to specify precisely the total frame transit delay. It is, however, possible to measure those components of delay associated with media access and with transmission and reception; and the transit delay introduced by an intermediate system, in this case a Bridge, can be measured.

The minimum additional transit delay introduced by a Bridge is the time taken to receive a frame plus that taken to access the media onto which the frame is to be relayed. Note that the frame is completely received before it is relayed as the Frame Check Sequence (FCS) is to be calculated and the frame discarded if in error.

6.3.6 Frame lifetime

The MAC Service ensures that there is an upper bound to the transit delay experienced for a particular instance of communication. This maximum frame lifetime is necessary to ensure the correct operation of higher layer protocols. The additional transit delay introduced by a Bridge is discussed in 6.3.5.

To enforce the maximum frame lifetime, a Bridge may be required to discard frames. Since the information provided by the MAC Sublayer to a Bridge does not include the transit delay already experienced by any particular frame, Bridges must discard frames to enforce a maximum delay in each Bridge.

The value of the maximum bridge transit delay is based on both the maximum delays imposed by all the Bridges in the Bridged LAN and the desired maximum frame lifetime. A recommended and an absolute maximum value are specified in Table 8-2.

6.3.7 Undetected frame error rate

The MAC Service introduces a very low undetected frame error rate in transmitted frames. Undetected errors are protected against by the use of an FCS that is appended to the frame by the MAC Sublayer of the source station prior to transmission, and checked by the destination station on reception.

The FCS calculated for a given service data unit is dependent on the MAC method employed. It is therefore necessary to recalculate the FCS within a Bridge providing a relay function between IEEE 802 MACs of dissimilar types if differences in the method of calculation and/or the coverage of the FCS, or changes to the data that is within the coverage of the FCS, would lead to a different FCS being calculated for the service data unit by the two MAC methods. This introduces the possibility of additional undetected errors arising from the operation of a Bridge. For frames relayed between LANs of the same MAC type, the Bridge shall not introduce an undetected frame error rate greater than that which would have been achieved by preserving the FCS.

NOTE—Application of the techniques described in Annex G allow an implementation to achieve an arbitrarily small increase in undetected frame error rate, even in cases where the data that is within the coverage of the FCS is changed. As a maintenance activity on this standard, revision of the wording of this requirement will be initiated, with a view to placing a quantitative limit on the increase in undetected frame error rate that is acceptable in a conformant implementation.

6.3.8 Maximum Service Data Unit Size

The Maximum Service Data Unit Size that can be supported by an IEEE 802 LAN varies with the MAC method and its associated parameters (speed, electrical characteristics, etc.). It may be constrained by the owner of the LAN. The Maximum Service Data Unit Size supported by a Bridge between two LANs is the smaller of that supported by the LANs. No attempt is made by a Bridge to relay a frame to a LAN that does not support the size of Service Data Unit conveyed by that frame.

6.3.9 Priority

The MAC Service includes user priority as a Quality of Service parameter. MA_UNITDATA.request primitives with a high priority may be given precedence over other request primitives made at the same station, or at other stations attached to the same LAN, and can give rise to earlier MA_UNITDATA.indication primitives.

The MAC Sublayer maps the requested user priorities onto the access priorities supported by the individual MAC method. The requested user priority may be conveyed to the destination station.

The transmission delay experienced by a frame in a bridge can be managed by associating a user_priority with the frame.

The transmission delay comprises

- a) A queuing delay until the frame becomes first in line for transmission on the Port, in accordance with the procedure for selecting frames for transmission described in 7.7.4;
- b) The access delay for transmission of the frame.

Queueing delays can be managed using user_priority. Access delays can be managed using user_priority in MAC methods that support more than one access priority.

The user priority associated with a frame can be signaled by means of the priority signaling mechanisms inherent in some IEEE 802 LAN MAC types. Since not all IEEE 802 LAN MAC types are able to signal the user priority associated with a frame, MAC Bridges regenerate user priority based upon a combination of signaled information and configuration information held in the Bridge.

The Bridge maps the user priority onto one or more traffic classes; Bridges that support more than one traffic class are able to support expedited classes of traffic. The Forwarding Process, 7.7, describes the use of user priority and traffic classes in MAC Bridges. Given the constraints placed upon frame misordering in a Bridge, as expressed in 6.3.3, the mappings of priority and traffic class are static.

NOTE 1—The term Traffic Class, as used in this standard, is used only in the context of the operation of the priority handling and queueing functions of the Forwarding Process, as described in 7.7. Any other meanings attached to this term in other contexts do not apply to the use of the term in this standard.

The ability to signal user_priority in IEEE 802 LANs allows user_priority to be carried with end-to-end significance across a Bridged LAN. This, coupled with a consistent approach to the mapping of user_priority to traffic classes, and of user_priority to access_priority, allows consistent use of user_priority information to be made, according to the capabilities of the Bridges and MAC methods that are involved in the transmission path.

NOTE 2—IEEE P802.1Q⁸ defines a frame format and associated procedures that can be used to carry user priority information across LAN MAC types that are not able to signal user priority. Use of the P802.1Q frame format allows the end-to-end significance of user_priority to be maintained regardless of the ability of individual LAN MAC types to signal priority.

Under normal circumstances, user_priority is not modified in transit through the relay function of a Bridge; however, there may be some circumstances where it is desirable for management purposes to control how user_priority is propagated. The User Priority Regeneration Table (Table 7-1) provides the ability to map incoming user_priority values on a per-Port basis, under management control. In its default state, this table

⁸IEEE P802.1Q/D11 (July 30th 1998), is an authorized IEEE Standards Project that was not approved by the IEEE-SA at the time this standard went to press. For information on obtaining the draft, contact the IEEE.

provides an identity mapping from user_priority values to Regenerated user_priority values; i.e., by default, the Regenerated user_priority is identical to the incoming user_priority.

6.3.10 Throughput

The total throughput provided by a Bridged LAN can be significantly greater than that provided by an equivalent single LAN. Bridges may localize traffic within the Bridged LAN by filtering frames. Filtering services available in Bridged LANs are described in 6.6.

The throughput between end stations on individual LANs, communicating through a Bridge, can be lowered by frame discard in the Bridge due to the inability to transmit at the required rate on the LAN forming the path to the destination for an extended period.

6.4 Internal Sublayer Service provided within the MAC Bridge

The Internal Sublayer Service provided by a MAC entity to the MAC Relay Entity within a Bridge is that provided by the individual MAC for the LAN Port. This observes the appropriate MAC procedures and protocol for the LAN to which it attaches. No control frames, i.e., frames that do not convey MAC user data, are forwarded on any LAN other than that on which they originated.

The Internal Sublayer Service is derived from the MAC Service defined by ISO/IEC 15802-1 by augmenting that specification with elements necessary to the performance of the relay function. Within the attached end station, these additional elements can be considered to be either below the MAC Service boundary, and pertinent only to the operation of the service provider; or local matters not forming part of the peer-to-peer nature of the MAC Service. Three parameters are added to the list of parameters associated with the MA_UNITDATA.request and MA_UNITDATA.indication primitives defined by ISO/IEC 15802-1. These are frame_type, MAC_action, and frame_check_sequence. The definition of the Internal Sublayer Service does not add any new service primitives to those defined by the LAN MAC Service Definition.

The Internal Sublayer Service excludes MAC-specific features and procedures whose operation is confined to that of the individual LANs. The unit-data primitives that describe this service are

```
M_UNITDATA.indication    (
                           frame_type,
                           mac_action,
                           destination_address,
                           source_address,
                           mac_service_data_unit,
                           user_priority,
                           frame_check_sequence
                           )
```

Each M_UNITDATA indication primitive corresponds to the receipt of an error-free MAC frame from an individual LAN.

NOTE—Detailed specifications of error conditions in received frames are contained in the relevant MAC standards; for example, FCS errors, length errors, nonintegral number of octets.

The **frame_type** parameter indicates the class of frame. The value of this parameter is one of user_data_frame, mac_specific_frame, or reserved_frame.

The **mac_action** parameter indicates the action requested of a MAC entity receiving the indication. If the value of the frame_type parameter is user_data_frame, then the mac_action parameter is one of

request_with_response, request_with_no_response, or response. For mac_specific_frames and reserved_frames, this parameter does not apply.

The **destination_address** parameter is either the address of an individual MAC entity or a group of MAC entities.

The **source_address** parameter is the individual address of the source MAC entity.

The **mac_service_data_unit** parameter is the service user data.

The **user_priority** parameter is the priority requested by the originating service user. The value of this parameter is in the range 0 through 7.

NOTE 1—The default user_priority value is 0. Values 1 through 7 form an ordered sequence of user_priorities, with 1 being the lowest value and 7 the highest. See 7.7.3 and H.2 for further explanation of the use of user_priority values and how they map to traffic classes.

Bridges have the capability to regenerate user priority from the user priority information contained in the data indication and the User Priority Regeneration Table for the reception Port, as specified in 7.5.1. The user_priority parameter takes the value of the Regenerated user_priority. In the case of IEEE 802 LAN MAC types that are not able to signal priority, the user_priority parameter takes the value of the Default User Priority for the Port on which the indication was received. The default value of Default User Priority is 0 for all Ports of the Bridge; the value for a given Port may be modified by means of the management functionality described in Clause 14 if such management functionality is supported.

The **frame_check_sequence** parameter is explicitly provided as a parameter of the primitive so that it can be used as a parameter to a related request primitive without recalculation.

The identification of the LAN from which particular frames are received is a local matter and is not expressed as a parameter of the service primitive.

```
M_UNITDATA.request      (
    frame_type,
    mac_action,
    destination_address,
    source_address,
    mac_service_data_unit,
    user_priority,
    access_priority,
    frame_check_sequence
)
```

A data request primitive is invoked to transmit a frame to an individual LAN.

The **frame_type** parameter indicates the class of frame.

The **mac_action** parameter indicates the action requested of the destination MAC entity.

The **destination_address** parameter is either the address of an individual MAC entity, or a group of MAC entities.

The **source_address** parameter is the individual address of the source MAC entity.

The **mac_service_data_unit** parameter is the service user data.

The **user_priority** parameter is the priority requested by the originating service user. The value of this parameter is in the range 0 through 7.

NOTE 2—The default user_priority value is 0. Values 1 through 7 form an ordered sequence of user_priorities, with 1 being the lowest value and 7 the highest. See 7.7.3 and H.2 for further explanation of the use of user_priority values and how they map to traffic classes.

The **access_priority** parameter is the priority used by the local service provider to convey the request. It can be used to determine the priority attached to the transmission of frames queued by the local MAC Entity, both locally and among other stations attached to the same individual LAN—if the MAC method permits. The value of this parameter, if specified, is in the range 0 (lowest) through 7 (highest).

The **frame_check_sequence** parameter is explicitly provided as a parameter of the primitive so that it can be used without recalculation.

The identification of the LAN to which a frame is to be transmitted is a local matter and is not expressed as a parameter of the service primitive.

6.5 Support of the Internal Sublayer Service by specific MAC procedures

This subclause specifies the mapping of the Internal Sublayer Service to the MAC Protocol and Procedures of each individual IEEE 802 MAC type, and the encoding of the parameters of the service in MAC frames. The mapping is specified by reference to the IEEE 802 standards that specify the individual MAC methods. The mapping draws attention to any special responsibilities of Bridges attached to LANs of that MAC type.

6.5.1 Support by IEEE Std 802.3 (CSMA/CD)

The CSMA/CD access method is specified in IEEE Std 802.3. Clause 3 of that standard specifies the MAC frame structure, and Clause 4 specifies the MAC method.

On receipt of an M_UNITDATA.request primitive, the local MAC Entity performs Transmit Data Encapsulation, assembling a frame using the parameters supplied as specified below. It prepends a preamble and a Start Frame Delimiter before handing the frame to the Transmit Media Access Management Component in the MAC Sublayer for transmission (IEEE Std 802.3, 4.2.3).

On receipt of a MAC frame by Receive Media Access Management, the MAC frame is passed to Receive Data Decapsulation, which validates the FCS and disassembles the frame, as specified below, into the parameters that are supplied with an M_UNITDATA.indication primitive (IEEE Std 802.3, 4.2.4).

The **frame_type** parameter takes only the value user_data_frame and is not explicitly encoded in MAC frames.

The **mac_action** parameter takes only the value request_with_no_response and is not explicitly encoded in MAC frames.

The **destination_address** parameter is encoded in the destination address field of the MAC frame (IEEE Std 802.3, 3.2.3).

The source_address parameter is encoded in the source address field of the MAC frame (IEEE Std 802.3, 3.2.3).

The number of octets in the mac_service_data_unit parameter is encoded in the length field of the MAC frame (IEEE Std 802.3, 3.2.6), and the octets of data are encoded in the data field (IEEE Std 802.3, 3.2.7).

The **user_priority** parameter provided in a data request primitive is not encoded in MAC frames. The **user_priority** parameter provided in a data indication primitive takes the value of the Default User Priority parameter for the Port through which the MAC frame was received (see 6.4).

The **frame_check_sequence** parameter is encoded in the FCS field of the MAC frame (IEEE Std 802.3, 3.2.8). The FCS is computed as a function of the destination address, source address, length, data, and PAD fields. If an M_UNITDATA.request primitive is not accompanied by this parameter, it is calculated in accordance with IEEE Std 802.3, 3.2.8.

NOTE 1—Since the PAD field, if present, contributes to the FCS, this parameter needs to include at least the contribution of the PAD field to the FCS in order for the original FCS to be preserved (See Annex G).

No special action, above that specified for the support of use of the MAC Service by LLC, is required for the support of the MAC Internal Sublayer Service by the CSMA/CD access method.

NOTE 2—The support by IEEE Std 802.3 is described only in terms of the operation of a Bridge when relaying frames that result from the use of LLC services over an 802.3 MAC. ISO/IEC 11802-5 defines the recommended practice for bridging Ethernet V2.0 frames.

NOTE 3—IEEE Std 802.3, 1998 Edition, describes the use of either a Length or an Ethernet protocol type in its frame format; however, the text of this subclause has yet to be revised to describe the use of Ethernet protocol types.

6.5.2 Support by ISO/IEC 8802-4 (token-passing bus)

The token-passing bus access method is specified in ISO/IEC 8802-4. In that standard, Section 4 specifies frame formats, Section 5 discusses the basic concepts of the access protocols, and Section 7 provides the definitive specification of the token-passing bus MAC operation.

On receipt of an M_UNITDATA.request primitive the local MAC Entity Interface Machine (IFM) queues a frame for transmission by the Access Control Machine (ACM) (ISO/IEC 8802-4, Section 7). On transmission the frame fields are set using the parameters supplied as specified below, and the Preamble, Start Delimiter, and End Delimiter are added (ISO/IEC 8802-4, Section 4).

On receipt of a valid MAC frame by the Receive Machine (RxM) (ISO/IEC 8802-4, 7.1.5), an M_UNITDATA.indication primitive is generated, with parameters derived from the frame fields as specified below.

The **frame_type** parameter is encoded in the FF bits (bit positions 1 and 2) of the frame control (FC) field (ISO/IEC 8802-4, 4.1.3.1, 4.1.3.2). A bit pattern of 0 1 denotes a **user_data_frame**, a bit pattern of 0 0 or 1 0 denotes a **mac_specific_frame**, and a bit pattern of 1 1 denotes a **reserved_frame**.

The **mac_action** parameter is encoded in the MMM bits (bit positions 3, 4, and 5) of the FC field (ISO/IEC 8802-4, 4.1.3.2). For **user_data_frames** these take the values 0 0 0 for **request_with_no_response**, 0 0 1 for **request_with_response**, and 0 1 0 for **response**.

The **destination_address** parameter is encoded in the destination address field of the MAC frame (ISO/IEC 8802-4, 4.1.4.1).

The **source_address** parameter is encoded in the source address field of the MAC frame (ISO/IEC 8802-4, 4.1.4.2).

The **mac_service_data_unit** parameter is encoded in the MAC Data Unit field (ISO/IEC 8802-4, 4.1.5).

The **user_priority** parameter is encoded in the PPP bits (bit positions 6, 7, and 8) of the FC field (ISO/IEC 8802-4, 4.1.3.2; 5.1.7).

The **frame_check_sequence** parameter is encoded in the FCS field of the MAC frame (ISO/IEC 8802-4, 4.1.6). The FCS is computed as a function of the frame control, destination address, source address, and data fields. If an M_UNITDATA.request primitive is not accompanied by this parameter, it is calculated in accordance with ISO/IEC 8802-4, 4.1.6.

No special action, above that specified for the support of use of the MAC Service by LLC, is required for the support of the MAC Internal Sublayer Service by the token-passing bus access method.

6.5.3 Support by ISO/IEC 8802-5 (token-passing ring)

The token-passing ring access method is specified in ISO/IEC 8802-5. Clause 3 of that standard specifies formats and facilities, and Clause 4 specifies token-passing ring protocols.

On receipt of an M_UNITDATA.request primitive the local MAC Entity composes a frame using the parameters supplied as specified below, appending the frame control, destination address, source address, and FCS fields to the user data, and enqueueing the frame for transmission. On transmission, the starting delimiter, access control field, ending delimiter, and frame status fields are added.

On receipt of a valid MAC frame (ISO/IEC 8802-5, 4.1.4) that was not transmitted by the Bridge Port's local MAC Entity, with the Routing Information Indicator bit (which occupies the same position in the source address field as does the Group Address bit in the destination address field) set to zero, an M_UNITDATA.indication primitive is generated, with parameters derived from the frame fields as specified below.

The **frame_type** parameter is encoded in the frame_type bits (FF bits) of the frame control field (ISO/IEC 8802-5, 3.2.3.1). A bit pattern of 0 1 denotes a user_data_frame, a bit pattern of 0 0 denotes a mac_specific_frame, and a bit pattern of 1 0 or 1 1 denotes a reserved_frame.

The **mac_action** parameter only takes the value request_with_no_response and is not explicitly encoded in MAC frames.

The **destination_address** parameter is encoded in the destination address field of the MAC frame (ISO/IEC 8802-5, 3.2.4.1).

The **source_address** parameter is encoded in the source address field of the MAC frame (ISO/IEC 8802-5, 3.2.4.2).

The **mac_service_data_unit** parameter is encoded in the information field (ISO/IEC 8802-5, 3.2.6).

The **user_priority** parameter associated with user_data_frames is encoded in the YYY bits of the frame control field (ISO/IEC 8802-5, 3.2.3).

The **frame_check_sequence** parameter is encoded in the FCS field of the MAC frame (ISO/IEC 8802-5, 3.2.7). The FCS is computed as a function of the frame control, destination address, source address, and information fields. If an M_UNITDATA.request primitive is not accompanied by this parameter, it is calculated in accordance with ISO/IEC 8802-5, 3.2.7.

The Address Recognized (A) bits in the Frame Status field of a frame (ISO/IEC 8802-5, 3.2.9) may be set to 1 if an M_UNITDATA.indication primitive with frame_type and mac_action parameter values of user_data_frame and request_with_no_response respectively is generated, or if such an indication would be generated if buffering had been available; otherwise the A bits shall not be set except as required by ISO/IEC 8802-5.

If the A bits are set to 1, the Frame Copied (C) bits (ISO/IEC 8802-5, 3.2.9) may be set to 1 to reflect the availability of receive buffering; otherwise the C bits shall not be set.

In order to support the MAC Internal Sublayer Service, a Token Ring Bridge must be capable of recognizing and removing frames transmitted by itself, even though they can carry a source address different from that of the Bridge Port that transmitted them.

6.5.4 Support by fibre distributed data interface (FDDI)

The FDDI access method is specified in ISO 9314-2. Clause 6 of that standard specifies Services, and Clauses 7 and 8 specify Facilities and Operation, respectively.

On receipt of a valid frame (ISO 9314-2, 8.3.1) that was not transmitted by the Bridge Port's local MAC entity, with the first bit of the source address equal to zero, an M_UNITDATA.indication primitive is generated. The parameters associated with the primitive are derived from the frame fields as specified shortly below.

The Address Recognized (A) indicator in the Frame Status field of the frame (ISO 9314-2, 7.3.8) on the ring from which it was received shall not be set except as required by ISO 9314-2. The Frame Copied (C) indicator (ISO 9314-2, 7.3.8) may be set if an M_UNITDATA.indication primitive with frame_type and mac_action parameter values of user_data_frame and request_with_no_response, respectively, is generated, if the frame is to be forwarded, and if receive buffering is available. Otherwise, the C indicator shall not be altered except as required by ISO 9314-2.

NOTE—This specification of the setting of the C indicator by ISO 9314-2 MAC Bridges enhances that given in ISO 9314-2. A Bridge can be required by ISO 9314-2 to alter the A and/or C indicators when receiving a frame addressed to the Bridge as an FDDI end station, or when receiving a frame associated with the operation of the FDDI MAC

The parameters associated with the M_UNITDATA.indication that is generated on receipt of a frame now follow:

The **frame_type** parameter is encoded in the frame format bits (CL, FF, and ZZZZ bits) of the Frame Control field (ISO 9314-2, 7.3.3). The bit pattern 0L01rXXX denotes a user_data_frame (asynchronous LLC frame, where L represents the address length and can be 0 or 1, r is reserved and can be received as 0 or 1, and XXX can range from 000 to 111). All other bit patterns yield a frame_type parameter value of not_user_data_frame.

The **mac_action** parameter takes only the value request_with_no_response and is not explicitly encoded in MAC frames.

The **destination_address** parameter is enclosed in the destination address field of the MAC frame (ISO 9314-2, 7.3.4–7.3.4.1).

The **source_address** parameter is encoded in the source address field of the MAC frame (ISO 9314-2, 7.3.4–7.3.4.2).

The **mac_service_data_unit** parameter is encoded in the information field (ISO 9314-2, 7.3.5).

The **user_priority** parameter associated with user_data_frames is encoded in the PPP bits of the frame control field (ISO 9314-2, 7.3.3.4) when the frame is an asynchronously transmitted LLC frame whose frame control field value is 0L010PPP, where L represents the address length (ISO 9314-2, 7.3.3.2).

The **frame_check_sequence** parameter is encoded in the Frame Check Sequence Field of the MAC frame (ISO 9314-2, 7.3.6). The frame_check_sequence is computed as a function of the frame control, destination address, source address, and information fields.

On receipt of an M_UNITDATA.request primitive, the local MAC entity composes a frame using the parameters supplied as specified above, appending the frame control, destination address, source address, and frame check sequence to the user data, and enqueueing the frame for transmission on reception of a suitable token (ISO 9314-2, 8.3.1). On transmission, the preamble, starting delimiter, ending delimiter, and frame status fields are added.

If an M_UNITDATA.request primitive is not accompanied by a frame check sequence, one is calculated in accordance with ISO 9314-2, 7.3.6.

The bit pattern of the frame control field shall be 0L01rPPP, indicating an asynchronous LLC frame with L representing the address length (ISO 9314-2, 7.3.3.2), r being reserved and set to zero, and PPP indicating the frame's priority (ISO 9314-2, 7.3.3.4).

If the **user_priority** parameter value is specified, it is encoded in the PPP bits and the access priority (ISO 9314-2, 8.1.4) is derived from the token-holding timer (THT) or otherwise by implementor option. If the user_priority parameter value is unspecified, the PPP bits shall be set to zero and the access priority derived from the THT.

In order to support the MAC Internal Layer Service, an FDDI bridge removes frames transmitted by itself as required by ISO 9314-2, even though they can carry a source address different from that of the bridge port that transmitted them.

6.5.5 Support by ISO/IEC 8802-6 (Distributed Queue Dual Bus)

The ISO/IEC 8802-6 access method is specified in ISO/IEC 8802-6. Subclause 5.1 of that standard specifies the provision of the MAC Service to LLC, and Section 6 specifies DQDB Layer Protocol Data Unit (PDU) formats.

On receipt of an M_UNITDATA.request primitive, the local MAC entity (the MAC Convergence Function [MCF], ISO/IEC 8802-6, 5.1.1) shall compose an Initial MAC Protocol Data Unit (IMPDU) using the parameters supplied, by encoding and concatenating a Common PDU Header (ISO/IEC 8802-6, 6.5.1.1), a MAC Convergence Protocol (MCP) Header (ISO/IEC 8802-6, 6.5.1.2), a Header Extension (ISO/IEC 8802-6, 6.5.1.3), an INFO field (ISO/IEC 8802-6, 6.5.1.4), a PAD field (ISO/IEC 8802-6, 6.5.1.5), an optional CRC32 field (ISO/IEC 8802-6, 6.5.1.6) and a Common PDU Trailer (ISO/IEC 8802-6, 6.5.1.7). The values set within these headers and trailers are as specified and are in conformance with ISO/IEC 8802-6, 5.1.1.1.1 (Creation of the IMPDU). The IMPDU shall then be presented to the IMPDU Segmentation machine for transmission (ISO/IEC 8802-6, 5.1.1.1.2).

The **frame_type** parameter shall take the value user_data_frame and is not explicitly encoded in IMPDUs.

The **mac_action** parameter shall take the value request_with_no_response and is not explicitly encoded in IMPDUs.

The Common PDU Header shall be encoded according to ISO/IEC 8802-6, 6.5.1.1.

The **destination_address** parameter shall be encoded right-justified in the Destination Address (DA) subfield of the MCP Header, with the Address_Type subfield set to 48_bit_address (binary 1000), and padded with 12 zeroes to left-fill the 60-bit address field (ISO/IEC 8802-6, 6.5.1.2.1).

The **source_address** parameter shall be encoded right-justified in the Source Address (SA) subfield of the MCP Header, with the Address_Type subfield set to 48_bit_address (binary 1000), and padded with 12 zeroes to left-fill the 60-bit address field (ISO/IEC 8802-6, 6.5.1.2.1).

The Protocol Identifier (PI) subfield of the MCP header shall be encoded to decimal 1 (to indicate LLC) (ISO/IEC 8802-6, 6.5.1.2.4.1).

The PAD Length (PL) subfield of the MCP header shall be encoded according to ISO/IEC 8802-6, 6.5.1.2.4.2.

The Bridging field of the MCP Header shall be set to all zeroes (ISO/IEC 8802-6, 6.5.1.2.6). This field is reserved for the bridging of 60-bit ISO/IEC 8802-6 PDUs only.

If a Header Extension field was present in the corresponding data indication, then the Header Extension field shall be encoded using the received value. Otherwise, the Header Extension field shall be encoded according to ISO/IEC 8802-6, 5.1.1.1.1, steps 11) and 13).

NOTE—The Header Extension field in ISO/IEC 8802-6 is a MAC-specific facility that is not relevant to the operation of the MAC Bridge; hence, its value is not represented in the Internal Sublayer service. However, if the Header Extension is present in received MAC frames, its value is preserved in corresponding transmitted frames.

The **mac_service_data_unit** parameter shall be encoded into the INFO field of the IMPDU (ISO/IEC 8802-6, 6.5.1.4).

The **user_priority** parameter shall be encoded in the QOS_DELAY subfield of the MCP Header (ISO/IEC 8802-6, 6.5.1.2.5.1). The QOS_LOSS subfield of the MCP Header shall be encoded to zero (ISO/IEC 8802-6, 6.5.1.2.5.2). The CRC32 Indicator Bit (CIB) subfield of the MCP Header shall be set to one if the value of the frame_check_sequence parameter is specified (ISO/IEC 8802-6, 6.5.1.2.5.3), or if the frame_check_sequence parameter is unspecified but the FCS is calculated and included in the CRC32 field. The length of the header_extension parameter shall be encoded in the Header Extension Length (HEL) subfield of the MCP Header (ISO/IEC 8802-6, 6.5.1.2.5.4).

The PAD field shall be encoded according to ISO/IEC 8802-6, 6.5.1.5.

The **frame_check_sequence** parameter, if specified, shall be encoded in the CRC32 field (ISO/IEC 8802-6, 6.5.1.6). If the frame_check_sequence parameter is unspecified, then the implementor has the choice of either

- a) Calculating and including the CRC32 field and setting the CIB to one, or
- b) Not including the CRC32 field and setting the CIB to zero.

The Common PDU Trailer shall be encoded according to ISO/IEC 8802-6, 6.5.1.1.

On receipt of a valid IMPDU by the MCF Receive Block (ISO/IEC 8802-6, 5.1.1.2), and if it is verified to contain 48-bit addresses by inspecting the Address_Type subfield in the destination and source address fields (ISO/IEC 8802-6, 6.5.1.2.1), an M_UNITDATA.indication primitive shall be generated, with the parameters derived from the IMPDU fields as indicated below. In the event that the Address_Type does not indicate a 48-bit address, the IMPDU shall be discarded, and no M_UNITDATA.indication primitive shall be generated.

The **frame_type** parameter shall take the value user_data_frame since it is not explicitly encoded in IMPDUs.

The **mac_action** parameter shall take the value request_with_no_response since it is not explicitly encoded in IMPDUs.

The **destination_address** parameter shall be given the value of the MSAP address of the Destination Address (DA) subfield of the MCP Header (ISO/IEC 8802-6, 6.5.1.2.1).

The **source_address** parameter shall be given the value of the MSAP address of the Source Address (SA) subfield of the MCP Header (ISO/IEC 8802-6, 6.5.1.2.1).

The **mac_service_data_unit** parameter shall be given the value of the INFO field of the IMPDU (ISO/IEC 8802-6, 6.5.1.4).

The **user_priority** parameter shall be given the value of the QOS_DELAY subfield of the MCP Header (ISO/IEC 8802-6, 6.5.1.2.5.1).

The **frame_check_sequence** parameter shall be given the value of the CRC 32 field (ISO/IEC 8802-6, 6.5.1.6) if the CRC32 Indicator Bit (CIB) (ISO/IEC 8802-6, 6.5.1.2.5.3) is set to 1; else it shall be unspecified.

No special action, above that specified for the support of use of the MAC Service by LLC, is required for the support of the MAC Internal Sublayer Service by the DQDB Access Method.

6.5.6 Support by IEEE Std 802.11 (Wireless LANs)

The wireless LAN access method is specified in IEEE Std 802.11. Clause 7 of that standard specifies frame formats, Clause 9 specifies the MAC sublayer function, and Clause 11 specifies the mandatory MAC sublayer management function.

A Bridge to an 802-11 LAN shall connect to an 802-11 Portal, which in turn connects to an 802-11 Distribution System. For the purposes of bridging, the service interface presented at the Portal is identical to the service interface presented at the 802-11 MAC SAP. An instance of an 802-11 Distribution System can be implemented from 802 LAN components. 802-11 STAs attach to the Distribution System via an 802-11 Access Point. A bridge shall not connect to an 802-11 Independent BSS. For a description of the 802-11 architecture, see Clause 5 of IEEE Std 802.11.

On receipt of an M_UNITDATA.request primitive the portal constructs a MAC Service Data Unit and passes it to the MAC Data service for transmission, in accordance with the frame formats and procedures specified in IEEE Std 802.11, Clauses 6, 7, 9, and Annex C, using the parameters supplied as specified below.

On receipt of a valid MAC Service Data Unit (see IEEE Std 802.11, Clauses 6, 7, 9, and Annex C), the portal generates an M_UNITDATA.indication primitive with parameter values derived from the frame fields as specified below.

The frame_type parameter only takes the value user_data_frame. When processing MSDU_from_LLC, the frame_type of user_data_frame shall be translated according to parameters specified in 7.1.3.1 of IEEE Std 802.11 and is explicitly encoded in MAC frames.

The mac_action parameter only takes the value request_with_no_response and is not explicitly encoded.

The destination_address parameter is encoded in MAC frames as the DA described in Table 4 of 7.2.2 of IEEE Std 802.11.

The source_address parameter is encoded in MAC frames as the SA described in Table 4 of 7.2.2 of IEEE Std 802.11.

The **mac_service_data_unit** parameter is encoded in the Frame Body field (IEEE Std 802.11, 7.1.3.5) of MAC frames. The length of the MSDU shall be ≤ 2304 octets. The length is not encoded in MAC frames, but is conveyed in the PHY headers.

The **user_priority** parameter is not encoded in MAC frames. The **user_priority** parameter provided in an **M_UNITDATA.indication** primitive shall take the value of the **Default_User_Priority** parameter for the port through which the MAC Service Data Unit was received (see 6.4).

The **frame_check_sequence** parameter is encoded in the Frame Check Sequence (FCS) field of MAC frames in accordance with IEEE Std 802.11, 7.1.3.6 FCS.

The **access_priority** parameter is not encoded in MAC frames.

No special action, above that specified in IEEE Std 802.11, is required for the support of the MAC Internal Sublayer Service by the wireless LAN access method.

6.5.7 Support by ISO/IEC 8802-12 (Demand Priority)

The demand priority access method is specified in ISO/IEC 8802-12. Clause 10 of that standard specifies frame formats, and Clause 11 specifies the MAC protocol. Two formats of MAC frame are specified, one compatible with the IEEE Std 802.3 frame format, and one compatible with the ISO/IEC 8802-5 frame format (a given demand-priority LAN operates using only one of these formats throughout).

Following receipt of an **M_UNITDATA.request** primitive the local MAC entity constructs and transmits the corresponding MAC frame as specified in ISO/IEC 8802-12, 11.5.7 (FUNCTION **Build_Frame**) and 11.6.6 (MAC6_TRANSMIT_FRAME).

On receipt of a MAC frame (ISO/IEC 8802-12, 11.6.5, **MAC_READ_FRAME**), the local MAC entity generates an **M_UNITDATA.indication** primitive as specified in ISO/IEC 8802-12, 11.5.6 (PROCEDURE **Process_Received_MAC_Frame**).

The **frame_type** parameter only takes the value **user_data_frame** and is not explicitly encoded in MAC frames.

The **mac_action** parameter only takes the value **request_with_no_response** and is not explicitly encoded in MAC frames.

The **destination_address** parameter is encoded in the Destination Address (DA) field of the MAC frame (ISO/IEC 8802-12, 10.2.1 and 10.3.3).

The **source_address** parameter is encoded in the Source Address (SA) field of the MAC frame (ISO/IEC 8802-12, 10.2.1 and 10.3.3).

The **mac_service_data_unit** parameter is encoded in the Data field (IEEE Std 802.3 frame format, ISO/IEC 8802-12, 10.2.3) or Information field (ISO/IEC 8802-5 frame format, ISO/IEC 8802-12, 10.3.5) of the MAC frame.

For the IEEE Std 802.3 frame format, the **user_priority** parameter is not encoded in the MAC frame, but corresponds to the ISO/IEC 8802-12 priority value “normal” or “high.” On frame reception, the value “normal” maps to **user_priority** 0 and the value “high” maps to **user_priority** 4. On frame transmission, **user_priority** values 0 through 3 map to “normal” and values 4 through 7 map to “high.”

For the ISO/IEC 8802-5 frame format, the **user_priority** parameter is encoded in the YYY bits of the Frame Control field (ISO/IEC 8802-12, 10.3.2.2).

The **access_priority** parameter in an M_UNITDATA.request primitive is mapped to the ISO/IEC 8802-12 priority value “normal” or “high”: access_priority values 0 through 3 map to “normal,” access_priority values 4 through 7 map to “high.”

The **frame_check_sequence** parameter is encoded in the Frame Check Sequence (FCS) field of the MAC frame (ISO/IEC 8802-12, 10.2.4 and 10.3.6).

No special action, above that specified in ISO/IEC 8802-12, is required for the support of the MAC Internal Sublayer Service by the demand-priority access method.

6.6 Filtering services in Bridged LANs

MAC Bridges provide filtering services in Bridged LANs that support some aspects of the maintenance of Quality of Service; in particular, transit delay, priority, and throughput. In addition, these services provide for a degree of administrative control over the propagation of particular MAC Addresses in the Bridged LAN.

The services described are services in the most general sense; i.e., they are descriptions of the functionality that are made available to the MAC Service user or an administrator in order to control and access filtering capabilities in Bridged LANs. The description of each service makes no assumptions in terms of how the service might be realized. There are at least the following possibilities:

- a) Use of existing protocols and mechanisms, defined in IEEE 802 standards and elsewhere;
- b) Use of management functionality, either locally defined or implemented via remote management protocols;
- c) Other means, standardized or otherwise.

6.6.1 Purpose(s) of filtering service provision

Filtering services are provided in Bridged LANs for the purposes described in the following subclauses.

6.6.1.1 Administrative control

Filtering services provide for administrative control over the use of particular source and destination addresses in designated parts of the network. Such control allows network managers and administrators to limit the extent of operation of network layer and other protocols that make use of individual and group MAC Addresses by establishing administrative boundaries across which specific MAC Addresses are not forwarded.

6.6.1.2 Throughput and end station load

Filtering services increase the overall throughput of the network, and reduce the load placed on end stations caused by the reception of frames that are destined for other end stations. They achieve this end by

- a) Limiting frames destined for specific MAC Addresses to parts of the network which, to a high probability, lie along a path between the source MAC Address and the destination MAC Address;
- b) Reducing the extent of group addressed frames to those parts of the network which contain end stations that are legitimate recipients of that traffic.

NOTE—Some aspects of the filtering services described in this standard are dependent upon the active participation of end stations. Where such participation is not possible, those aspects of the filtering services will be unavailable.

6.6.2 Goals of filtering service provision

The filtering services provided in Bridged LANs offer a set of capabilities that may be used in order to

- a) Allow the MAC Service provider to dynamically learn where the recipients of frames addressed to individual MAC Addresses are located;
- b) Allow end stations that are the potential recipients of MAC frames destined for group MAC Addresses to dynamically indicate to the MAC Service provider which destination MAC Address(es) they wish to receive;
- c) Exercise administrative control over the extent of propagation of specific MAC Addresses.

6.6.3 Users of filtering services

The filtering services provided in Bridged LANs are available to the following users:

- a) Network management and administration, for the purposes of applying administrative control. Interactions between administrators of the network and the filtering service provider may be achieved by local means or by means of explicit management mechanisms;
- b) End stations, for the purposes of controlling the destination addresses that they will receive. Interactions between end stations and the filtering service provider may be implicit, as is the case with the filtering services provided by the Learning Process (7.8), or by explicit use of filtering service primitives.

6.6.4 Basis of service

All filtering services in Bridged LANs rely on the establishment of filtering rules, and subsequent filtering decisions, that are based on the value(s) contained in the Source or Destination MAC Address fields in MAC frames propagated in the Bridged LAN.

NOTE—The filtering services defined by this standard are based on source address learning and filtering on destination address.

6.6.5 Categories of service

Filtering services in Bridged LANs fall into the following categories:

- a) *Basic Filtering Services.* These services are supported by the Forwarding Process (7.7) and by Static Filtering Entries (7.9.1) and Dynamic Filtering Entries (7.9.2) in the Filtering Database. The information contained in the Dynamic Filtering Entries is maintained through the operation of the Learning Process (7.8).
- b) *Extended Filtering Services.* These services are supported by the Forwarding Process (7.7), and the Static Filtering Entries (7.9.1) and Group Registration Entries (7.9.3) in the Filtering Database. The information contained in the Group Registration Entries is maintained through the operation of GMRP (10). The categories of Extended Filtering Service are as follows:
 - 1) Support of dynamic Group forwarding and filtering behavior;
 - 2) The ability for static filtering information for individual MAC Addresses to specify a subset of Ports for which forwarding or filtering decisions are taken on the basis of dynamic filtering information.

NOTE—Basic Filtering Services as defined in this standard correspond exactly to the filtering capabilities provided by the MAC Bridges standard in its previously published form, ISO/IEC 10038: 1993 [IEEE Std 802.1D, 1993 Edition].

All Bridges shall support Basic Filtering Services. Support of either category of Extended Filtering Services by a Bridge is optional.

6.6.6 Service configuration

In the absence of explicit information in the Filtering Database, the behavior of the Forwarding Process with respect to the forwarding or filtering of frames destined for group MAC Addresses depends upon the categories of service supported by the Bridge.

Basic Filtering Services support the filtering behavior required for regions of a Bridged LAN in which potential recipients of multicast frames exist, but where either the recipients or the Bridges are either unable to support the dynamic configuration of filtering information for those group MAC Addresses, or the recipients have a requirement to receive all traffic destined for group MAC Addresses.

Extended Filtering Services support the filtering behavior required for regions of a Bridged LAN in which potential recipients of multicast frames exist, and where both the potential recipients of frames and the Bridges are able to support dynamic configuration of filtering information for group MAC Addresses. In order to integrate this extended filtering behavior with the needs of regions of the network that support only Basic Filtering Services, Bridges that support Extended Filtering Services can be statically and dynamically configured to modify their filtering behavior on a per-group MAC Address basis, and also on the basis of the overall filtering service provided by each outbound Port with regard to multicast frames. The latter capability permits configuration of the Port's default forwarding or filtering behavior with regard to group MAC Addresses for which no specific static or dynamic filtering information has been configured.

Service configuration provides the ability to configure the overall filtering for the following cases:

- a) Bridges that only implement Basic Filtering Services;
- b) Bridges that support Extended Filtering Services in a heterogeneous environment, where some equipment is unable to participate in Dynamic Multicast Filtering, or where some equipment (e.g., routers) have specific needs to see unfiltered traffic; and
- c) Bridges that support Extended Filtering Services in a homogeneous environment, where all equipment is able to participate in Dynamic Multicast Filtering.

6.6.7 Service definition for Extended Filtering Services

The Filtering Services are described by means of service primitives that define particular types of interaction between MAC Service users and the MAC Service provider across the MAC Service boundary. As these interactions are not defined between peer entities, they are described simply in terms of service requests sent from the MAC Service user to the MAC Service provider.

6.6.7.1 Dynamic registration and de-registration services

These services allow MAC Service users dynamic control over the set of destination Group MAC Addresses that they will receive from the MAC Service provider, by

- a) Registering/de-registering membership of specific Groups associated with those addresses;
- b) Registering/de-registering their service requirements with regard to the overall forwarding/filtering behavior for Groups.

Provision of these services is achieved by means of GMRP and its associated procedures, as described in Clause 10.

NOTE—The intent of these services is to provide the MAC Service user with dynamic control over access to multicast data streams, for example, multiple video channels made available by a server using a different group MAC Address for each channel. The ability to both register and de-register Group membership, coupled with the filtering action associated with the Group membership, limits the impact of such services on the bandwidth available in the Bridged LAN. These services can be used to control the reception of other categories of multicast traffic, for similar reasons.

REGISTER_GROUP_MEMBER (MAC_ADDRESS)

Indicates to the MAC Service provider that the MAC Service user wishes to receive frames containing the group MAC Address indicated in the MAC_ADDRESS parameter as the destination address. The MAC Addresses that can be carried by this parameter do not include

- a) Any individual address;
- b) Any of the Reserved Addresses identified in Table 7-9;
- c) Any of the GARP Application addresses, as defined in Table 12-1.

DEREGISTER_GROUP_MEMBER (MAC_ADDRESS)

Indicates to the MAC Service provider that the end station no longer wishes to receive frames containing the group MAC Address indicated in the MAC_ADDRESS parameter as the destination address.

REGISTER_SERVICE_REQUIREMENT (REQUIREMENT_SPECIFICATION)

Indicates to the MAC Service provider that the MAC Service user has a requirement for any devices that support Extended Filtering Services to forward frames in the direction of the Mac Service User in accordance with the definition of the service requirement defined by the REQUIREMENT_SPECIFICATION parameter. The values that can be carried by this parameter are

- a) Forward All Groups;
- b) Forward Unregistered Groups.

DEREGISTER_SERVICE_REQUIREMENT (REQUIREMENT_SPECIFICATION)

Indicates to the MAC Service provider that the MAC Service user no longer has a requirement for any devices that support Extended Filtering Services to forward frames in the direction of the Mac Service User in accordance with the definition of the service requirement defined by the REQUIREMENT_SPECIFICATION parameter. The values that can be carried by this parameter are

- a) Forward All Groups;
- b) Forward Unregistered Groups.

The use of these services can result in the propagation of group MAC Address and service requirement information across the Spanning Tree, affecting the contents of Group Registration Entries (7.9.3) in Bridges and end stations in the Bridged LAN, and thereby affecting the frame forwarding behavior of the Bridges and end stations with regard to multicast frames.

7. Principles of operation

This clause establishes the principles and a model of the operation of a Bridge as follows:

- a) Explains the principal elements of Bridge operation and lists the functions that support these.
- b) Establishes an architectural model for a Bridge that governs the provision of these functions.
- c) Provides a model of the operation of a Bridge in terms of Processes and Entities that support the functions.
- d) Details the addressing requirements in a Bridged LAN and specifies the addressing of Entities in a Bridge.

7.1 Bridge operation

The principal elements of Bridge operation are

- a) Relay and filtering of frames.
- b) Maintenance of the information required to make frame filtering and relaying decisions.
- c) Management of the above.

7.1.1 Relay

A MAC Bridge relays individual MAC user data frames between the separate MACs of the Bridged LANs connected to its Ports. The order of frames shall be preserved as defined in 7.7.3.

The functions that support the relaying of frames and maintain the Quality of Service supported by the Bridge are

- a) Frame reception.
- b) Discard on received frame in error (6.3.2).
- c) Frame discard if the `frame_type` is not `user_data_frame`, or if its `mac_action` parameter is not `request_with_no_response` (6.4).
- d) Regeneration of user priority, if required (6.4).
- e) Frame discard following the application of filtering information.
- f) Frame discard on transmittable service data unit size exceeded (6.3.8).
- g) Forwarding of received frames to other Bridge Ports.
- h) Selection of traffic class, following the application of filtering information.
- i) Queuing of frames by traffic class.
- j) Frame discard to ensure that a maximum bridge transit delay is not exceeded (6.3.6).
- k) Selection of queued frames for transmission.
- l) Selection of outbound access priority (6.3.9).
- m) Mapping of service data units and recalculation of Frame Check Sequence, if required (6.3.7, 7.7.6).
- n) Frame transmission.

7.1.2 Filtering and relaying information

A Bridge filters frames, i.e., does not relay frames received by a Bridge Port to other Ports on that Bridge, in order to prevent the duplication of frames (6.3.4). The function that supports the use and maintenance of information for this purpose is

- a) Calculation and configuration of Bridged LAN topology.

A Bridge also filters frames in order to reduce traffic in parts of the Bridged LAN that do not lie in the path between the source and destination of that traffic. The functions that support the use and maintenance of information for this purpose are:

- b) Permanent configuration of reserved addresses.
- c) Explicit configuration of static filtering information.
- d) Automatic learning of dynamic filtering information for unicast destination addresses through observation of source addresses of Bridged LAN traffic.
- e) Ageing out of dynamic filtering information that has been learned.
- f) Automatic addition and removal of dynamic filtering information as a result of GMRP protocol exchanges.

A Bridge classifies frames into traffic classes in order to expedite transmission of frames generated by critical or time-sensitive services. The function that supports the use and maintenance of information for this purpose is

- g) Explicit configuration of traffic class information associated with the Ports of the Bridge.

7.1.3 Bridge Management

The functions that support Bridge Management control and monitor the provision of the above functions. They are specified in Clause 14.

7.2 Bridge architecture

7.2.1 Architectural model of a Bridge

Figure 7-1 gives an example of the physical topology of a Bridged LAN. The component LANs are interconnected by means of MAC Bridges; each Port of a MAC Bridge connects to a single LAN. Figure 7-2 illustrates a Bridge with two Ports, and Figure 7-3 illustrates the architecture of such a Bridge.

A Bridge is modeled as consisting of

- a) A MAC Relay Entity that interconnects the Bridge's Ports;
- b) At least two Ports;
- c) Higher layer entities, including at least a Bridge Protocol Entity.

7.2.2 MAC Relay Entity

The MAC Relay Entity handles the MAC method independent functions of relaying frames between Bridge Ports, filtering frames, and learning filtering information. It uses the Internal Sublayer Service provided by the separate MAC Entities for each Port. (The Internal Sublayer Service and its support are described in 6.4 and 6.5.) Frames are relayed between Ports attached to different LANs.

7.2.3 Ports

Each Bridge Port transmits and receives frames to and from the LAN to which it is attached. An individual MAC Entity permanently associated with the Port provides the Internal Sublayer Service used for frame transmission and reception. The MAC Entity handles all the MAC method dependent functions (MAC protocol and procedures) as specified in the relevant standard for that IEEE 802 LAN MAC technology.

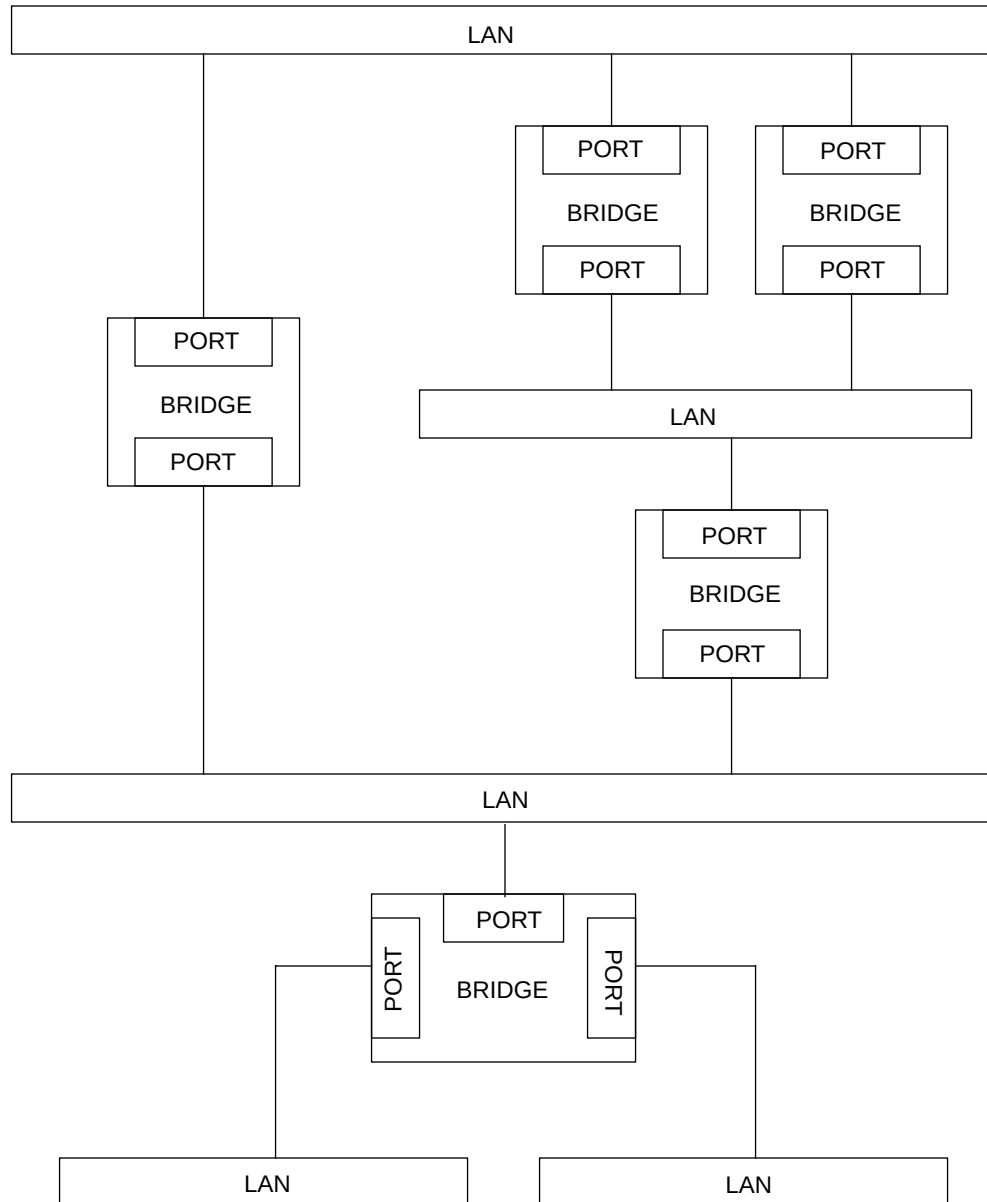


Figure 7-1—A Bridged local area network

7.2.4 Higher Layer Entities

The Bridge Protocol Entity handles calculation and configuration of Bridged LAN topology.

The Bridge Protocol Entity and other higher layer protocol users, such as Bridge Management (7.1.3) and GARP application entities including GARP Participants (Clause 12), make use of Logical Link Control procedures. These procedures are provided separately for each Port, and use the MAC Service provided by the individual MAC Entities.

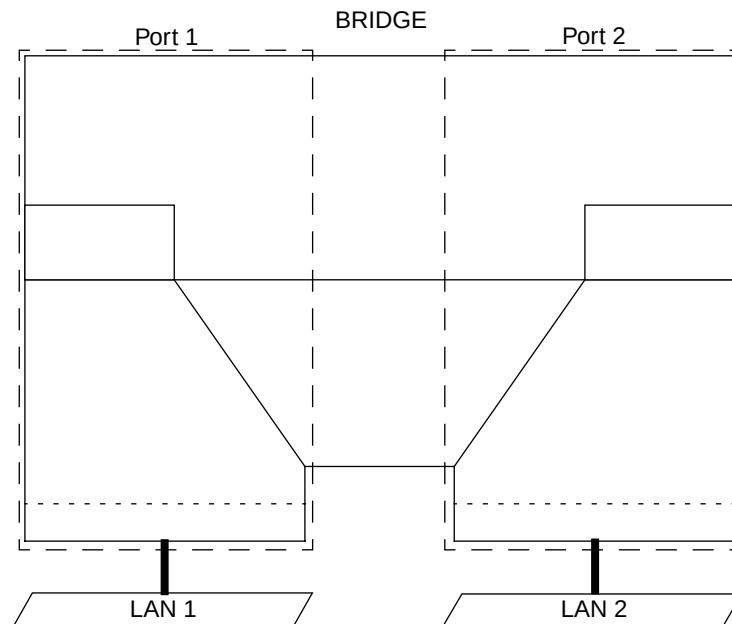


Figure 7-2—Bridge ports

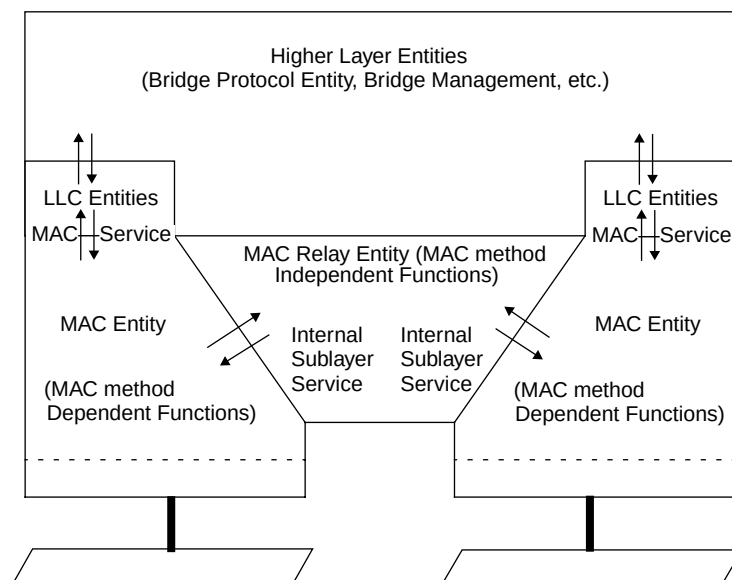


Figure 7-3—Bridge architecture

7.3 Model of operation

The model of operation is simply a basis for describing the functionality of the MAC Bridge. It is in no way intended to constrain real implementations of a MAC Bridge; these may adopt any internal model of operation compatible with the externally visible behavior that this standard specifies. Conformance of equipment to this standard is purely in respect of observable protocol.