

**IEEE Standard for
Local and metropolitan area networks—
Virtual Bridged Local Area Networks—
Amendment 2: VLAN Classification by Protocol
and Port**

Sponsor
**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 17 March 2001

IEEE-SA Standards Board

Abstract: This amendment to IEEE Std 802.1Q, 1998 Edition describes enhancements to allow for classification of incoming packets by methods other than source port. Specifically, it defines rules for classification based on data-link layer protocol identification. The document identifies proposed changes to the text of IEEE Std 802.1Q, 1998 Edition that have arisen as a consequence of this activity. These are documented in the usual form for amendments to IEEE 802® standards; i.e., as an explicit set of editing instructions that, if correctly applied to the text of IEEE Std 802.1Q, 1998 Edition, will create a corrected document.

Keywords: local area networks, MAC Bridge management, media access control bridges, virtual LANs

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Print: ISBN 0-7381-2818-X SH94917
PDF: ISBN 0-7381-2819-8 SS94917

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Introduction

[This introduction is not part of IEEE Std 802.1v-2001 (Amendment to IEEE Std 802.1Q, 1998 Edition), IEEE Standard for Local and metropolitan area networks—Virtual Bridged Local Area Networks—Amendment 2: VLAN Classification by Protocol and Port.]

The MAC Bridge standardization activities that resulted in the development of IEEE Std 802.1D, 1993 Edition and IEEE Std 802.1D, 1998 Edition introduced the concept of Filtering Services for both Unicast and Group-Addressed traffic in Bridged LANs, and mechanisms whereby filtering information in such LANs may be acquired and held in a Filtering Database. They also defined the use of multiple classes of expedited traffic, based on user priority, to support the transmission of time-critical information in a LAN environment.

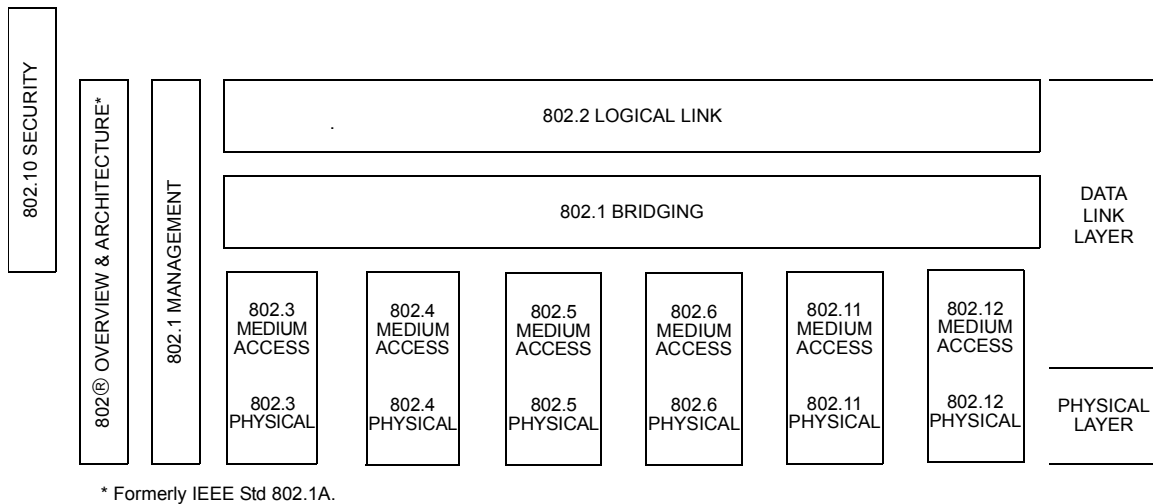
Standardization activities also resulted in the development of IEEE Std 802.1Q, 1998 Edition, Virtual Bridged Local Area Networks, which allows for the implementation of Virtual Bridged LANs. The following capabilities are described in that document:

- a) Virtual LAN Services in Bridged LANs.
- b) The operation of the Forwarding Process that is required in order to support Virtual Bridged LANs.
- c) The structure of the Filtering Database that is required in order to support Virtual Bridged LANs.
- d) The nature of the protocols and procedures that are required in order to provide Virtual LAN services, including the definition of the frame formats used to represent VLAN identification information, and the procedures used in order to insert and remove VLAN identifiers and the headers in which they are carried.
- e) The ability to support end to end signalling of user priority information regardless of the intrinsic ability of the underlying MAC protocols to signal user priority information.
- f) The GARP VLAN Registration Protocol, GVRP, that allows distribution and registration of VLAN membership information. The protocol described makes use of the GARP protocol defined in IEEE Std 802.1D, 1998 Edition.
- g) The management services and operations that are required in order to configure and administer Virtual Bridged LANs.
- h) The classification rules to be used at the ingress to a bridge in order to classify incoming frames as belonging to a particular Virtual LAN. In this revision of the standard, these rules are limited to one of the following:
 - 1) Use of a pre-existing VLAN identifier in the frame
 - 2) Use of the incoming bridge port's PVID

This amendment describes the following additional capabilities:

- i) A third type of rule for ingress classification:
 - 1) Use of a frame's data-link layer protocol identification to determine a VLAN to which the frame belongs.

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.)



This family of standards deals with the Physical and Data Link Layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection Basic Reference Model (ISO/IEC 7498-1:1994). The access standards define several 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 802¹: *Overview and Architecture*. This standard provides an overview to the family of IEEE 802 Standards. This document forms part of the IEEE 802.1 scope of work.
- ANSI/IEEE Std 802.1B and 802.1K [ISO/IEC 15802-2]: *LAN/MAN Management*. Defines an Open Systems Interconnection (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: *Media Access Control (MAC) Bridges*. Specifies an architecture and protocol for the [ISO/IEC 15802-3]: 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.

¹The 802 Architecture and Overview Specification, originally known as IEEE Std 802.1A, has been renumbered as IEEE Std 802. This has been done to accommodate recognition of the base standard in a family of standards. References to IEEE Std 802.1A should be considered as references to IEEE Std 802.

- 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 systems communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.

- ANSI/IEEE Std 802.1H [ISO/IEC TR 11802-5] *Recommended Practice for Media Access Control (MAC) Bridging of Ethernet V2.0 in IEEE 802 Local Area Networks.*

- ANSI/IEEE Std 802.1Q *Virtual Bridged Local Area Networks.* Defines an architecture for Virtual Bridged LANs, the services provided in Virtual Bridged LANs, and the protocols and algorithms involved in the provision of those services.

- 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 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 Access Method and Physical Layer Specifications.*

- ANSI/IEEE Std 802.10: *Interoperable LAN/MAN Security.* Currently approved: Secure Data Exchange (SDE).

- ANSI/IEEE Std 802.11: [ISO/IEC 8802-11] *Wireless LAN Medium Access Control (MAC) Sublayer and Physical Layer Specifications.*

- ANSI/IEEE Std 802.12: [ISO/IEC 8802-12] *Demand Priority Access Method, Physical Layer and Repeater Specification.*

- IEEE Std 802.15: *Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Wireless Personal Area Networks.*

- IEEE Std 802.16: *Standard Air Interface for Fixed Broadband Wireless Access Systems.*

- IEEE Std 802.17: *Resilient Packet Ring Access Method and Physical Layer 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 reader of this standard is urged to become familiar with the complete family of standards.

Conformance test methodology

An additional standards series, identified by the number IEEE 1802, has been established to identify the conformance test methodology documents for the IEEE 802 family of standards. Thus the conformance test documents for IEEE 802.3 are numbered IEEE 1802.3, the conformance test documents for IEEE 802.5 will be 1802.5, and so on. Similarly, ISO will use ISO/IEC 18802 to number conformance test standards for ISO/IEC 8802 standards.

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Contents

3.	Definitions	1
4.	Abbreviations.....	1
5.	Conformance.....	2
5.2	Options.....	2
6.	Architectural overview	3
6.3	Relay	3
8.	Principles of operation	4
8.1	Bridge operation	4
8.4	Port States, Port parameters, Active Ports, and the active topology.....	5
8.6	The ingress rules	6
8.14	Addressing	10
9.	Tagged frame format.....	12
11.	VLAN topology management.....	13
12.	VLAN Bridge Management.....	14
12.10	Bridge VLAN managed objects.....	14
Annex A	(normative) PICS proforma	18
Annex D	(informative) Background to VLANs.....	26
Annex E	(informative) Interoperability considerations	30

IEEE Standard for Local and metropolitan area networks— Virtual Bridged Local Area Networks— Amendment 2: VLAN Classification by Protocol and Port

EDITORIAL NOTE—This amendment to IEEE Std 802.1Q, 1998 Edition defines the changes necessary to the operation of a MAC Bridge implementing Virtual LAN bridging in order to provide the capability for VLAN classification by Protocol and Port. These changes are defined as a series of additions to, and modifications of, the existing text of IEEE Std 802.1Q, 1998 Edition; this amendment therefore assumes all material, including references, abbreviations, definitions, procedures, services, and protocols defined in the base text. Text shown in ***bold italics*** in this amendment defines the editing instructions necessary in order to incorporate the modifications and additions into the base text. Three editing instructions are used: ***change***, ***delete***, and ***insert***. ***Change*** is used to make a change to existing material. The editing instruction specifies the location of the change and describes what is being changed either by using ***strike through*** (to remove old material) or ***underline*** (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without changing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. Editorial notes will not be carried over into future editions of IEEE Std 802.1Q.

3. Definitions

Insert the following new definitions as items 3.21, 3.22, 3.23, and 3.24. In a future revision, these definitions will be placed in alphabetical order and renumbered accordingly:

3.21 protocol template: A tuple of values that specify a data-link encapsulation format and an identification of the protocol layer above the data-link layer.

3.22 protocol group identifier: Designates a group of protocols that are associated together when assigning a VID to a frame.

3.23 protocol group database: Specifies a group of protocols by assigning a unique protocol group identifier to all protocols of the same group.

3.24 detagged frame: The detagged frame of an untagged frame is the frame itself. The detagged frame of a tagged frame or a priority-tagged frame is the frame that results from untagging the frame by the appropriate procedure.

NOTE—The procedure for untagging a frame is discussed in 9.1.

4. Abbreviations

Add the following abbreviations:

PID Protocol IDentifier

5. Conformance

5.2 Options

Insert new list item l) and its sub-items to the end of the list, as follows:

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

- a) Support operation in Extended Filtering Mode (ISO/IEC 15802-3, 6.6.5) and the operation of GARP Multicast Registration Protocol (GMRP) (ISO/IEC 15802-3, Clause 10) as modified by Clause 10;
- b) Support the ability for the Filtering Database to contain static and dynamic configuration information for more than one VLAN, by means of Static and Dynamic VLAN Registration Entries (The Filtering Database), up to a maximum of 4094 VLANs;

NOTE—The maximum number of VLANs that can be supported is 4094 rather than 4096, as the VID values 0 and FFF are reserved, as indicated in Table 9-2. As conformance to this standard is only with regard to externally visible protocol behavior, this limit on the number of VLANs that can be supported does not imply any such limitation with regard to the internal architecture of a Bridge.

- c) On each Port, support both of the permissible values for the Acceptable Frame Types parameter, as defined in Acceptable Frame Types. If both values are supported, then the implementation shall support configuration of the parameter value via management;
- d) Support the ability to enable and disable Ingress Filtering (8.4.5);
- e) Support the ability to configure more than one VLAN whose untagged set includes that Port (8.8 and 8.11.9);
- f) Support the management functionality defined in Clause 12;
- g) Support more than one FID (6.4, 8.11.3, 8.11.7, and 8.11.8);
- h) Support the ability to allocate more than one VID to each FID that is supported (6.4, 8.11.3, 8.11.7, and 8.11.8);
- i) Support the ability to configure VLAN Learning Constraints via management (8.11.7 and 12.10.3);
- j) Support the ability to configure fixed VID to FID allocations via management (8.11.7.1 and 12.10.3);
- k) Support any other optional capabilities defined in ISO/IEC 15802-3, as modified by the provisions of this standard.
- l) Support Port-and-Protocol-based VLAN classification, including multiple VID values per port, administrative control of the values of the multiple VIDs, and a Protocol Group Database. If this option is supported:
 - 1) One or more of the following Protocol Classifications and Protocol Template formats must be supported: Ethernet, RFC_1042, SNAP_8021H, SNAP_Other, or LLC_Other (8.6.1 and 8.6.2).
 - 2) The configuration of the contents of the Protocol Group Database may be supported.

6. Architectural overview

Change the wording in 6.3 as follows:

6.3 Relay

This is concerned with the mechanics of

- a) Classifying each received frame as belonging to one and only one VLAN. This aspect of relay is determined by a set of MAC Bridge *ingress rules*;
- b) Decisions related to where received frames should be forwarded. This aspect of relay is determined by a set of MAC Bridge *forwarding rules*;
- c) Mapping frames for transmission through the appropriate outbound Ports, and in appropriate (VLAN-tagged or untagged) format. These aspects of relay are determined by a set of MAC Bridge *egress rules*;
- d) The procedures used in order to add, modify, and remove tag headers, when relaying frames between LAN segments, in accordance with the details of the VLAN frame format (defined in Clause 9) used to carry VIDs (otherwise referred to as VLAN tags).

Clause 8 defines ingress, forwarding and egress rules, constituting a generic approach to the provision of VLAN functionality with respect to received VLAN-tagged frames, and ~~a Port-based approach~~ two approaches to the VLAN classification of received Priority-tagged and Untagged frames; Port-based VLAN classification and Port-and-Protocol-based VLAN classification. Clause 9 defines the format of the tag headers for different MAC methods, and the procedures for adding, modifying, and removing tag headers.

The ingress, forwarding, and egress rules allow Bridges to

- e) Classify any received untagged frames or priority-tagged frames that are to be submitted to the Forwarding Process as belonging to a particular VLAN, as defined by the PVID or VID Set of ~~for~~ the receiving Port. The default PVID is specified in Table 9-2;

NOTE 1—This classification of untagged and priority-tagged frames is part of the functionality of the MAC relay entity (Figure 8-3, Figure 8-4), and is therefore only of significance for received frames that are potentially to be forwarded through other Ports of the Bridge (see Spanning Tree).

- f) Classify any received VLAN-tagged frames that are to be submitted to the Forwarding Process as belonging to the VLAN identified by the VID carried in the tag header;
- g) Make use of the VLAN classification thus associated with the received frame in order to take appropriate forwarding/filtering decisions;
- h) Transmit frames in VLAN-tagged or untagged format, as defined for a given Port/VLAN pairing.

NOTE 2—This standard defines a default Port-based classification and an optional Port-and-Protocol-based classification for VLANs implemented using the procedures and VLAN frame format specified herein. End stations that transmit VLAN-tagged frames, and ~~in the future~~, Bridges capable of other classification methods, may actually do much of the VLAN classification of frames. More sophisticated tagging will be the rule for these devices, and bridges conformant to this standard will work with them. In this scenario, most or all LAN segments are likely to carry VLAN-tagged frames belonging to various VLANs, but each such LAN segment has its own “local default” VLAN (or set of such VLANs in the case of Port-and-Protocol-based classification). This “local default” defines the VLAN(s) to which untagged or priority-tagged frames are presumed to belong when received on the Ports of IEEE 802.1Q conformant bridges attached to that LAN segment.

NOTE 3—This standard uses the concept of a “VID Set” when Port-and-Protocol-based ingress classification rules are used. There is presumed to exist a mapping for any given untagged frame to one and only one of these VIDs. In the degenerate case, frames of all protocols are mapped onto the same, single PVID and this case is then identical to that defined by IEEE 802.1Q, 1998 Edition.

8. Principles of operation

8.1 Bridge operation

Change the wording of 8.1.2 as follows:

8.1.2 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 (ISO/IEC 15802-3, 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.

A Bridge classifies untagged frames and priority-tagged frames as belonging to a particular VLAN in accordance with the *ingress rules* defined in the *ingress rules*. The function that supports the use and maintenance of information for this purpose is

- h) Explicit configuration of the Port VID and, for bridges supporting VLAN classification by Port and Protocol, VID Set (PVID, 8.4.4) associated with each Port of the Bridge.
- i) Explicit configuration of the Protocol Group Database (8.6.4) of the Bridge.

A Bridge may filter frames in order to prevent the injection of untagged and priority-tagged frames on a Port on which the reception of untagged and priority-tagged frames is disallowed. The function that supports the use and maintenance of information for this purpose is

- j) Explicit configuration of the Acceptable Frame Types parameter (Acceptable Frame Types) associated with each Port of the Bridge.

A Bridge may filter frames in order to prevent the injection of traffic for a given VLAN on a Port on which that VLAN is disallowed. The function that supports the use and maintenance of information for this purpose is

- k) Explicit configuration of the Enable Ingress Filtering parameter (8.4.5) associated with each Port of the Bridge.

A Bridge filters frames in order to confine traffic destined for a given VLAN to LAN segments that form a path from the source of the traffic to recipients that are members of that VLAN. The functions that support the use and maintenance of information for this purpose are

- l) Automatic configuration of Dynamic VLAN Registration Entries by means of GVRP (8.11.5 and 11.2);
- m) Explicit configuration of management controls associated with the operation of GVRP by means of Static VLAN Registration Entries (8.11.2 and 11.2);
- n) Automatic learning of MAC Addresses in associated VLANs through the observation of network traffic (The Learning Process).

A Bridge adds and removes tag headers (9.3) from frames, and performs the associated frame translations that may be required, in accordance with the *egress rules* (8.8). The function that supports the use and maintenance of information for this purpose is

- o) Explicit configuration of tagging requirements on egress for each Port (8.11.2 and 8.11.9).

8.4 Port States, Port parameters, Active Ports, and the active topology

Change the wording of 8.4.4 as follows:

8.4.4 Port VLAN identifier and VID Set

A VLAN Bridge supports Port-based VLAN classification, and may, in addition, support Port-and-Protocol-based VLAN classification.

In Port-based VLAN classification within a Bridge, the VID associated with an untagged or priority-tagged frame (i.e., a frame with no tag header, or a frame with a tag header that carries the null VLAN ID) is determined, based on the Port of arrival of the frame into the Bridge, as described in 8.6. This classification mechanism requires the association of a specific ~~VLAN ID~~, the *Port VLAN Identifier*, or *PVID*, with each of the Bridge's Ports. In this case, the PVID for a given Port provides the VID for untagged and priority-tagged frames received through that Port.

In addition to the PVID, for bridges that implement Port-and-Protocol-based VLAN classification, the VID associated with an Untagged or Priority-tagged Frame is determined based on the Port of arrival of the frame into the bridge and on the protocol identifier of the frame, as described in 8.6. This classification mechanism requires the association of multiple VIDs with each of the Ports of the Bridge: this is known as the "VID Set" for that port. Each VID of a Port of a Bridge that supports Port-and-Protocol-based VLAN classification is also associated with a Protocol Group Identifier. A Protocol Group Identifier is not relevant in a Bridge that supports only Port-based VLAN classification. The contents of the VID Set for each port may be configured by management. The VID Set is in addition to the PVID value described above.

The PVID and VID Set for each Port shall contain a valid VID values, and shall not contain the value of the null VLAN ID (Table 9-2).

NOTE 1—This rule ensures that the process of ingress classification of frames always associates a ~~non-null valid~~ VID with each received frame. As a consequence, a VLAN-aware Bridge can never transmit priority-tagged frames; all frames transmitted are either untagged or carry a ~~non-null valid~~ VID in their tag header.