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IEEE P802.1Q-REV/D1.5

Draft Standard for Local and Metropolitan Area Networks—

Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks

Sponsor

LAN/MAN Standards Committee of the IEEE Computer Society

Prepared by the Interworking Task Group of IEEE 802.1

Abstract: This standard specifies how the MAC Service is supported by Virtual Bridged Local Area Networks, the principles of operation of those networks, and the operation of VLAN-aware Bridges, including management, protocols, and algorithms.

Keywords: Bridged Local Area Networks, local area networks (LANs), MAC Bridges, metropolitan area networks, Multiple Spanning Tree Protocol (MSTP), Rapid Spanning Tree Protocol (RSTP), Virtual Bridged Local Area Networks (virtual LANs)

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Introduction

(This introduction is not part of P802.1Q-REV/D1.5, IEEE Standards for Local and metropolitan area networks—Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks.)

The MAC Bridge standardization activities that resulted in the development of IEEE Std 802.1D™-1993 introduced the concept of Filtering Services in Bridged Local Area Networks, and mechanisms whereby filtering information in such LANs may be acquired and held in a Filtering Database.

IEEE Std 802.1D™, 1998 Edition, a revision of IEEE Std 802.1D-1993 [B4], extended this concept of Filtering Services to define additional capabilities aimed at

a) The provision of expedited traffic capabilities, to support the transmission of time-critical information in a LAN environment.

b) The use of signaled priority information as the basis for identifying expedited classes of traffic.

c) 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 particular Group are forwarded only on those LANs that are required to reach members of that Group.

d) The provision of a Generic Attribute Registration Protocol (GARP) that is used to support the mechanism for providing Group filtering capability and is made available for use in other attribute registration applications.

This standard, first published as IEEE Std 802.1Q-1998, makes use of the concepts and mechanisms of LAN Bridging that were introduced by IEEE Std 802.1D, and it defines additional mechanisms that allow the implementation of Virtual Bridged Local Area Networks. The following mechanisms are described:

e) Virtual LAN Services.

f) The operation of the Forwarding Process that is required.

g) The structure of the Filtering Database that is required.

h) The nature of the protocols and procedures that are required to provide Virtual LAN services, including the definition of the frame formats used to represent VLAN identification information, and the procedures used to insert and remove VLAN identifiers (VIDs) and the headers in which they are carried.

i) The ability to support end-to-end signaling of priority information regardless of the intrinsic ability of the underlying MAC protocols to signal priority information.

j) The management services and operations that are required to configure and administer networks.

The 2005 Revision of the standard incorporated three amendments, IEEE Std 802.1u™-2001, IEEE Std 802.1v™-2001, and IEEE Std 802.1s™-2002, into the text of IEEE Std 802.1Q-1998. These amendments describe enhancements to the standard to allow

k) Dynamic Group and VLAN registration to be restricted, based on the contents of static filtering entries.

l) VLAN classification according to link layer protocol type.

m) Support for VLANs carried over multiple Spanning Tree instances.

This revision of the standard incorporates amendments IEEE Std 802.1ad™-2005, IEEE Std 802.1ak™-2007, IEEE Std 802.1ag™-2007, IEEE Std 802.1ah™-2008, IEEE Std 802-1Q-2005/Cor-1-2008, IEEE Std

802.1ap™-2008, IEEE Std 802.1Qaw™-2009, IEEE Std 802.1Qay™-2009, IEEE Std 802.1aj™-2009, and IEEE Std 802.1Qav™-2009 into the text of IEEE Std 802.1Q-2005. These amendments describe enhancements to the standard to allow

n) A service provider to use the architecture and protocols defined in this standard to offer the equivalent of separate LANs, Bridged Local Area Networks, or Virtual Bridged Local Area Networks to a number of customers, while requiring no cooperation between the customers, and minimal cooperation between each customer and the service provider.

o) The distribution and registration of VLAN membership information using the Multiple VLAN Registration Protocol (MVRP), and the distribution of group membership information using the Multiple MAC Registration Protocol (MMRP), replacing the previous GVRP and GMRP protocols.

p) Support of Connectivity Fault Management (CFM) capabilities for detecting, isolating, and reporting connectivity faults.

q) Interconnection of multiple Provider Bridged Networks, allowing a Provider to support up to 2^{24} service instances.

r) Management of VLAN Bridges via SNMP MIB modules.
s) Diagnosis of data dependent connectivity faults.
t) Support for traffic engineering.
u) The use of Bridging technology as a two-port MAC relay.
v) Support for the relay of time sensitive data streams.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are anticipated within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material. Information on the current revision state of this and other IEEE 802 standards may be obtained from

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IEEE Standard for
Local and metropolitan area networks—

Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks

1. Overview

IEEE 802® Local Area Networks (LANs)[1] of all types can be connected together with Media Access Control (MAC) Bridges, as specified in IEEE Std 802.1D™.[2,3] This standard defines the operation of Bridges that permit the definition, operation, and administration of Virtual LANs (VLANs) within Virtual Bridged Local Area Networks.

This standard further extends the specification of VLAN-aware MAC Bridges to enable a service provider organization to use a common infrastructure of Bridges and LANs to offer the equivalent of separate LANs, Bridged, or Virtual Bridged Local Area Networks to independent customer organizations.

This standard specifies protocols and protocol entities within the architecture of VLAN-aware Bridges that provide capabilities for detecting, verifying, and isolating connectivity failures in Virtual Bridged Local Area Networks. These capabilities can be used in networks operated by multiple independent organizations, each with restricted management access to each other's equipment.

The data driven and data dependent connectivity fault management capabilities include tools to facilitate diagnosis and isolation of faults sensitive to, or caused by, particular data patterns in transmitted frames.

This standard specifies protocols, procedures, and managed objects that support congestion management of long-lived data flows within network domains with a bandwidth-delay product on the order of 5 Mbits or less. Such flows are typically encountered in data centers, backplane fabrics, computing clusters, and storage networks. This is achieved by enabling bridges to signal congestion to end stations capable of transmission rate limiting to avoid frame loss. This mechanism enables support for higher layer protocols that are highly loss or latency sensitive. VLAN tag encoded priority values are allocated to segregate frames subject to congestion control, allowing simultaneous support of both congestion controlled and other higher layer protocols. This standard does not specify communication or reception of congestion notification information to or from end stations outside the congestion controlled domain or encapsulation of frames from those end stations across the domain.

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This standard specifies protocols, procedures and managed objects, usable by existing higher layer mechanisms, that allow network resources to be reserved for specific traffic streams traversing a bridged local area network. It characterizes resource requirements of traffic streams to a level sufficient for bridges to determine the required resources and provides a mechanism for dynamic maintenance of those resources.

1.1 Scope

This standard specifies Media Access Control (MAC) Bridges that interconnect individual Local Area Networks (LANs), each supporting the IEEE 802 MAC service using a different or identical media access control method, to provide Bridged Local Area Networks and Virtual LANs (VLANs).

1.2 Purpose

MAC Bridges, as specified by this standard, allow the compatible interconnection of information technology equipment attached to separate individual LANs.

1.3 Introduction

For the purpose of compatible interconnection of information technology equipment using the IEEE 802 MAC Service supported by interconnected IEEE 802 standard LANs using different or identical media access control methods, this standard specifies the operation of MAC Bridges that support Virtual LANs (VLANs). To this end it

a) Positions the support of VLANs within an architectural description of the MAC Sublayer;
b) Defines the principles of operation of the VLAN-aware Bridge in terms of the support and preservation of the MAC Service, and the maintenance of Quality of Service;
c) Specifies an Enhanced Internal Sublayer Service provided to the Media Access Independent functions that provide frame relay in a VLAN-aware Bridge;
d) Establishes the principles and a model of Virtual Bridged Local Area Network operation;
e) Identifies the functions to be performed by VLAN-aware Bridges, and provides an architectural model of the operation of a Bridge in terms of Processes and Entities that provide those functions;
f) Specifies a frame format that allows a VLAN Identifier (VID) and priority information to be carried by VLAN tagged user data frames;
g) Specifies the rules that govern the addition or removal of VLAN tags to and from user data frames;
h) Specifies the rules that govern the ability to carry user data in either Canonical format or Non-canonical format in VLAN-tagged frames;

NOTE 1—The meanings of the terms *Canonical format* and *Non-canonical format* are discussed in IEEE Std 802.[4]

i) Establishes the requirements for automatic configuration of VLAN topology;
j) Establishes the requirements for VLAN-aware Bridge Management in a Virtual Bridged Local Area Network, identifying managed objects and defining management operations;
k) Defines SMIv2 (IETF STD 58) MIB modules for the management of VLAN-aware Bridge capabilities including Spanning Tree Protocols and Provider Bridges.
l) Defines the operation of the Multiple Spanning Tree algorithm and protocol (MSTP);
m) Describes the protocols and procedures necessary to support interoperation between MST and SST Bridges in the same Virtual Bridged Local Area Networks;
n) Specifies the requirements to be satisfied by equipment claiming conformance to this standard.

[4]Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.