

**IEEE Standard for
Local and metropolitan area networks—**

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

Amendment 22: Equal Cost Multiple Path (ECMP)

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 802.1Qbp™-2014
(Amendment to
IEEE Std 802.1Q™-2011)

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Abstract: Routing algorithms and relay behavior supporting equal cost multipath forwarding in shortest path bridged VLANs are specified in this amendment to IEEE Std 802.1Q.

Keywords: amendment, Bridged Local Area Networks, ECMP, Equal Cost Multiple Paths, IEEE 802.1Q™, IEEE 802.1Qbp™, LANs, local area networks, MAC Bridges, MANs, metropolitan area networks, Shortest Path Bridging, Virtual Bridged Local Area Networks

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Introduction

This introduction is not part of IEEE Std 802.1Qbp-2014, IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks—Amendment 22: Equal Cost Multiple Path (ECMP).

This amendment to IEEE Std 802.1Q-2011 specifies extensions to Shortest Path Bridging MAC Mode (SPBM) to support utilizing multiple next hop choices for frames within a single service. A new tag is defined to carry a flow hash value and an ECMP algorithm uses the flow hash value in selecting a next hop port from among a set of equal cost alternatives so that frames belonging to the same data flow take the same path.

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IEEE Standard for Local and metropolitan area networks—

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

Amendment 22: Equal Cost Multiple Path (ECMP)

[This amendment is based on IEEE Std 802.1Q™-2011 as amended by IEEE Std 802.1Qbe™, IEEE Std 802.1Qbc™, IEEE Std 802.1Qbb™, IEEE Std 802.1Qaz™, IEEE Std 802.1Qbf™, IEEE Std 802.1aq™, and IEEE Std 802.1Qbg™.]

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

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1. Overview

1.3 Introduction

Change the item following the paragraph beginning “This standard specifies shortest path bridging” that begins “Requires that active topologies” as shown:

- bj) Requires that active topologies calculated by spanning tree protocols and Shortest Path Tree (SPT) protocols be stable, predictable, and reproducible to, ~~reverse path congruent and unicast-multicast congruent to; permit learning of station location from the source addresses of all frames, simplify the detection and management of faults, and~~ maintain the characteristics of the MAC Service provided.

Insert the following item and note after the item above, renumbering the list accordingly and numbering the NOTE appropriately:

- bk) Requires, except in the case of SPB using ECMP, active topologies that are reverse path congruent and unicast-multicast congruent to permit learning of station location from the source addresses of all frames and simplify the detection and management of faults.

NOTE 5—Equal Cost Multiple Paths operation does not provide (nor does this standard attempt to define for ECMP VLANs) reverse path congruence and unicast-multicast congruence as these concepts cease to have utility in an ECMP context.

Insert the following items at the end of the list, numbering appropriately:

- bl) Specifies load spreading by distributing unicast traffic over the set of available equal cost paths and assigning multicast traffic flows to a variety of trees.
- bm) Specifies a Flow Filtering Tag containing a flow hash used in unicast ECMP traffic distribution and a time-to-live (TTL) field used to mitigate the effects of traffic loops resulting from transient conditions or control software errors or faults.

3. Definitions

Insert the following definitions into Clause 3 in alphabetical order, number them appropriately, and renumber the remaining definitions in Clause 3 accordingly:

3.1 ECMP path MA: A maintenance association that monitors a set, which can be complete, of equal connectivity paths between two specific end points as constructed by ECMP.

3.2 Equal Cost Multiple Paths (ECMP): ECMP enables the use of multiple possible next hop choices for frames within a single service in Shortest Path Bridging MAC Mode (SPBM) networks.

3.3 flow filtering tag (F-TAG): A tag with a Tag Protocol Identification value allocated for “IEEE 802.1Q Flow Filtering Tag EtherType.”

3.4 flow hash: An arbitrary value that serves to distinguish flows that may be subject to different treatment in a bridged network, for example, flows subject to independent treatment by ECMP.

3.5 SPBM MA: A maintenance association for monitoring and diagnosing connectivity associated with a VID assigned to the SPBM MSTID. There are three types of SPBM MA—SPBM VID MAs, SPBM path MAs, and SPBM group MAs (27.18.1).

3.6 SPBM VID: A VID associated with the SPBM-MSTID value of the Multiple Spanning Tree Instance Identifier (MSTID) in the MST Configuration Table.

4. Abbreviations

Add the following abbreviations to Clause 4 in the appropriate location:

ECMP	Equal Cost Multiple Paths
F-TAG	flow filtering tag

5. Conformance

5.4 VLAN-aware Bridge component requirements

Change 5.4.5 as shown:

5.4.5 Shortest Path Bridging operation (optional)

A VLAN-aware Bridge implementation that conforms to the provisions of this standard for SPB in Clause 27 shall:

- a) Support SPB, in either VID mode (SPBV) or MAC mode (SPBM), as specified in Clause 27;
- b) Support the IS-IS Link State Protocol with procedures to ensure Loop Prevention as specified in Clause 28 to provide SPT computation for shortest path bridging;
- c) Encode, decode, and validate SPT BPDUs for the Agreement Protocol (13.17) and support Agreement Protocol logic in IS-IS as specified in Clause 28;
- d) Support at least three FIDs;
- e) Support the management functionality specified in Clause 12.

A VLAN-aware Bridge implementation in conformance to the provisions of this standard for SPB in Clause 27 may:

- f) Support both SPB VID mode (SPBV) and SPB MAC mode (SPBM);
- g) Support the SPB Management Information Base (MIB) module defined in 17.7.19;
- h) Support both the VID Translation Table and Egress VID translation table (6.9) on SPBV Boundary Ports;
- i) [Support the CFM modifications for SPBM as specified in Clause 20 and summarized in 27.18;](#)
- j) [Support Equal Cost Multiple Paths operation of SPBM \(5.4.5.1\);](#)
- k) [Support Equal Cost Multiple Paths operation of SPBM with flow filtering \(5.4.5.2\).](#)

5.4.5.1 SPBM Equal Cost Multiple Paths operation (optional)

[An SPBM capable VLAN-aware bridge implementation that conforms to the provisions of this standard for ECMP in 44.1 shall:](#)

- a) [Support SPBM ECMP as specified in 44.1;](#)
- b) [Support the management functionality specified in Clause 12.](#)

[An SPBM capable VLAN-aware bridge implementation that conforms to the provisions of this standard for ECMP may:](#)

- c) [Support the IEEE8021-ECMP-MIB module objects ieee8021EcmpEctStaticTable and ieee8021EcmpTopSrvTable defined in 17.7.21.](#)

5.4.5.2 SPBM Equal Cost Multiple Paths operation with flow filtering (optional)

[An SPBM capable VLAN-aware bridge implementation that conforms to the provisions of this standard for ECMP with flow filtering shall:](#)

- a) [Support SPBM ECMP as specified in 44.1;](#)
- b) [Support flow filtering as specified in 44.2, including inserting, modifying, and removing F-TAGs from relayed frames as required by the applicable values in the Flow Filtering Control Table for each port;](#)

- c) [Support the management functionality specified in Clause 12.](#)

[An SPBM capable VLAN-aware bridge implementation that conforms to the provisions of this standard for ECMP with flow filtering may:](#)

- d) [Support the CFM modifications for ECMP using flow filtering as specified in Clause 20 and summarized in 44.2.5:](#)
- e) [Support the IEEE8021-ECMP-MIB module defined in 17.7.21.](#)

5.6 S-VLAN component conformance

Insert new subclause 5.6.4 after 5.6.3:

5.6.4 S-VLAN component requirements for ECMP with flow filtering

An S-VLAN component implementation that conforms to the provisions of this standard for ECMP with flow filtering shall

- a) Support F-TAG processing as specified in 44.2.2 on each PNP.

5.8 B-component conformance

Insert new subclause 5.8.4 after 5.8.3:

5.8.4 B-component requirements for ECMP with flow filtering

A B-component implementation that conforms to the provisions of this standard for ECMP with flow filtering shall

- a) Support F-TAG processing as specified in 44.2.2 on each CBP and PNP.

6. Support of the MAC Service

6.5 Quality of service maintenance

6.5.3 Frame misordering

Change 6.5.3 as shown:

The MAC Service ~~(9.2 of ISO/IEC 15802-1)~~ permits a negligible rate of reordering of frames with a given priority for a given combination of destination address ~~and~~ source address and flow hash, if present, transmitted on a given VLAN. MA_UNITDATA.indication service primitives corresponding to MA_UNITDATA.request primitives, with the same requested priority and for the same combination of VLAN classification, destination address, ~~and~~ source address and flow hash, if present, are received in the same order as the request primitives were processed.

NOTE 1—The operation of the Forwarding Process in Bridges (8.6) is such that the frame-ordering characteristics of the MAC Service are preserved.

Where Bridges in a network 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 for every sequence of frames whose order must be maintained.

NOTE 2—Where STP is in use (see Clause 8 of IEEE Std 802.1D, 1998 Edition), frame misordering cannot occur during normal operation. When a protocol that is capable of rapid reconfiguration after network component failure, such as RSTP, MSTP, or SPB is used, there is an increased probability that frames that are in transit through the network will be misordered, because a Bridge can buffer frames awaiting transmission through its Ports. The probability of misordering occurring as a result of such an event is dependent on implementation choices and is associated with reconfiguration events. Some known LAN protocols, for example, LLC Type 2, are sensitive to frame misordering and duplication; in order to allow Bridges that support RSTP to be used in environments where sensitive protocols are in use, the forceVersion parameter (13.7.2) can be used to force a Bridge that supports RSTP to operate in an STP-compatible manner. A more detailed discussion of misordering in RSTP can be found in K.3 of IEEE Std 802.1D-2004.

6.8 Enhanced Internal Sublayer Service

Change 6.8.1 as shown:

6.8.1 Service primitives

The unit-data primitives that define this service are

```
EM_UNITDATA.indication    (
    destination_address,
    source_address,
    mac_service_data_unit,
    priority,
    drop_eligible,
    vlan_identifier,
    frame_check_sequence,
    service_access_point_identifier,
    connection_identifier,
    flow_hash,
    time_to_live
)
```

```
EM_UNITDATA.request      (  
    destination_address,  
    source_address,  
    mac_service_data_unit,  
    priority,  
    drop_eligible,  
    vlan_identifier,  
    frame_check_sequence,  
    service_access_point_identifier,  
    connection_identifier,  
    flow\_hash,  
    time\_to\_live  
)
```

The **destination_address**, **source_address**, **mac_service_data_unit**, **priority**, **drop_eligible**, **service_access_point_identifier**, **connection_identifier**, and **frame_check_sequence** parameters are as defined for the ISS.

NOTE 1—Some of the functions supporting the EISS may result in changes to the `mac_service_data_unit` or other parameters used to construct a frame. The original FCS associated with a frame is invalidated if there are changes to any fields of the frame, if fields are added or removed, or if bit ordering or other aspects of the frame encoding have changed. An invalid FCS is signaled in the EISS by an unspecified value in the `frame_check_sequence` parameter. This signals the need for the FCS to be regenerated according to the normal procedures for the transmitting MAC. The options for regenerating the FCS under these circumstances are discussed in Annex F of IEEE Std 802.1D-2004.

The **vlan_identifier** parameter carries the VLAN identifier (VID).

The **flow_hash** parameter is either null or carries a value that may be used by the forwarding process in selecting a single forwarding port from a set of available forwarding ports (8.6.3). Transmission order is maintained for all frames from a source to a destination with the same flow hash value. A flow hash value may be retrieved from an F-TAG or otherwise derived from the contents of a service primitive (44.2.2). A flow hash is not required by the MAC Relay Entity, and successful filtering can be provided without this additional information; however, it is required for flow filtering services supported by SPBM with ECMP. Any protocol entity in the interface stack that does not specify use of the flow_hash assigns the flow_hash value (if any) supplied with a request from the user of the protocol entity (or with an indication from the provider of the service used by the protocol entity) to the flow_hash on associated requests made (or indications generated) by the protocol entity.

The **time_to_live** parameter is either null or carries a value that may be used to filter frames that have reached their limit of permitted network hops. A time_to_live value may be retrieved from an F-TAG in the mac_service_data_unit and processed as described in 44.2.2. Any protocol entity in the interface stack that does not specify use of the time_to_live assigns the time_to_live value (if any) supplied with a request from the user of the protocol entity (or with an indication from the provider of the service used by the protocol entity) to the time_to_live on associated requests made (or indications generated) by the protocol entity.

8. Principles of bridge operation

8.6 The Forwarding Process

8.6.3 Frame filtering

Change the initial text in 8.6.3 as shown:

The Forwarding Process takes filtering decisions, i.e., reduces the set of potential transmission Ports (8.6.1), for each received frame on the basis of

- a) Destination MAC Address;
- b) VID;
- c) [Flow hash](#);
- d) The information contained in the Filtering Database for that MAC Address and VID;
- e) The default Group filtering behavior for the potential transmission Port (8.8.6);

in accordance with the definition of the Filtering Database entry types (8.8.1, 8.8.3, and 8.8.4). The required behavior is summarized in 8.8.6, 8.8.9, Table 8-7, Table 8-8, and Table 8-9. [Flow hash is only applicable on Bridges supporting flow filtering \(44.2\).](#)

8.6.6 Queuing frames

Change the initial text in 8.6.6 as shown:

The Forwarding Process provides storage for queued frames, awaiting an opportunity to submit these for transmission. The order of frames received on the same Bridge Port shall be preserved for

- a) unicast frames with a given VID, priority, [flow hash](#), and destination address and source address combination;
- b) multicast frames with a given VID, priority, [flow hash](#), and destination address.

[Flow hash is only applicable on Bridges supporting flow filtering \(44.2\).](#)

8.8 The Filtering Database

8.8.3 Dynamic Filtering Entries

Change 8.8.3 as shown:

A Dynamic Filtering Entry specifies

- a) An individual MAC Address;
- b) The FID, an identifier assigned by the MAC Bridge (8.8.8) to identify a set of VIDs for which no more than one Dynamic Filtering Entry can exist for any individual MAC Address;

NOTE 1—An FID identifies a set of VIDs among which *Shared VLAN Learning* (3.165) takes place. Any pair of FIDs identifies two sets of VIDs between which *Independent VLAN Learning* (3.75) takes place. The allocation of FIDs by a Bridge is described in 8.8.8.

- c) A Port Map specifying forwarding for the destination MAC Address and FID to a single Port [or, in the case of ECMP with flow filtering \(44.1, 44.2\), to a set of Ports from which one must be selected.](#)

~~NOTE 2—This is equivalent to specifying a single port number; hence, this specification is directly equivalent to the specification of dynamic entries in IEEE Std 802.1D-1993 [B9].~~

The Port Map may contain a **connection_identifier** (8.8.12) for each outbound Port.

Dynamic Filtering Entries can be created, updated, and removed by the Learning Process (8.7). They shall be automatically removed after a specified time, the Ageing Time (8.7.3), has elapsed since the entry was created or last updated.

Dynamic Filtering Entries can also be created and updated by SPB (Clause 27). ISIS-SPB (Clause 28) refreshes these entries, so they are not aged out by the normal operation of the Learning Process. These entries are used by SPBM (Clause 27) to support both unicast loop mitigation (6.5.4.2) and multicast loop prevention (6.5.4.1) for active topology enforcement (8.6.1), as well as to locate end stations. [Entries indicating a set of potential forwarding ports from which one must be selected are used by ECMP with flow filtering.](#) ~~These entries are updated~~ [SPBV updates Dynamic Filtering Entries](#) by the normal Learning Process ~~for SPBV~~, but [they may](#)~~could~~ also be controlled by ISIS-SPB. This allows entries for the higher layer entities in a bridge (see Figure 8-11) to be populated rapidly after any topology change.

No more than one Dynamic Filtering Entry shall be created in the Filtering Database for a given combination of MAC Address and FID. Dynamic Filtering Entries cannot be created or updated by management.

NOTE 3—Dynamic Filtering Entries may be read by management (Clause 12). The FID is represented in the management Read operation by any one of the VIDs that it represents. For a given VID, the set of VIDs that share the same FID may also be determined by management.

12. Bridge management

12.6 Forwarding process

12.6.1 The Port Counters

12.6.1.1 Read forwarding port counters

12.6.1.1.3 Outputs

Insert item i) at the end of 12.6.1.1.3:

- i) If flow filtering is supported (44.2), Discard TTL Expired—count of frames discarded because they were received with the TTL field expired.

12.14 CFM entities

12.14.5 Maintenance Domain managed object

12.14.5.3 Create Maintenance Association managed object

12.14.5.3.2 Inputs

Change item c) in 12.14.5.3.2 as shown:

- c) The list of VIDs, the I-SID, the TE-SID, or the SEG-ID monitored by this MA, or 0, if the MA is not attached to any VID, I-SID, TE-SID, or SEG-ID. In the case that a list of VIDs is specified, the first VID in the list is the MA's Primary VID (default none). The specification of I-SID is allowed only in the case of I- or B- components. The TE-SID is allowed only in the case that PBB-TE [or SPBM](#) is supported. The SEG-ID is allowed only in the case that IPS is supported.

Change item a)7) in 12.14.5.3.3 as shown:

12.14.5.3.3 Outputs

- 7) Operation rejected because the TE-SID value specified does not correspond to a valid TESI [or set of SPBM path endpoints](#);

12.14.7 Maintenance association End Point managed object

12.14.7.1 Read Maintenance association End Point managed object

12.14.7.1.3 Outputs

Insert the following sentence at the end of item d) in 12.14.7.1.3:

In the case of an SPB associated MEP, the Primary VID is not writable but is always associated with the value of the SPVID for the node on which the MEP is configured (for SPBV) or the Base VID (for SPBM).

Insert a new item at the end of the list in 12.14.7.1.3 as shown, numbering as appropriate:

- al) (writable) Only applicable for ECMP path MEPs, a list of flow hash values to be used in a path testing cycle (20.10.5).

12.14.7.3 Transmit Loopback Messages

Change 12.14.7.3.2 as shown:

12.14.7.3.2 Inputs

- a) A reference to a particular Maintenance association End Point managed object (12.14.7);
- b) An indication of the ~~destination~~target MAC address for LBMs transmitted by the MEP (20.31.1):
 - 1) The MEPID of a MEP in that MA; or
 - 2) An Individual destination MAC address; or
 - 3) For PBB-TE and SPBM VID MEPs, an Individual MAC address to be used as the MIP MAC address in a PBB-TE MIP TLV;
- c) The number of LBMs to be transmitted (default 1);
- d) An arbitrary amount of data to be included in a Data TLV, along with an indication whether the Data TLV is to be included (20.31.1) (default no Data TLV); ~~and~~
- e) The priority and drop_eligible parameters to be used in the transmitted LBMs [default is CCM priority item h) in 12.14.7.1.3, drop_eligible false];
- f) In the case of a PBB-TE MEP, the Reverse VID to be used in the associated PBB-TE MIP TLV (21.7.5). The parameter is not required in the case of PBB-TE MEPs associated with point-to-point TESIs or if the ~~b2~~b3) entry is a MAC address corresponding to an entry in the ESP-DA field of any of the MA's ESPs;
- g) In the case of an SPBM VID MEP, an individual or group MAC address to be used as the destination address for the LBM primitive. If no value is provided the group MAC address for the SPBM default I-SID (Table 9-3, Figure 27-3) is used; and
- h) In the case of ECMP with flow filtering, a flow hash value if the destination address is an individual address.

12.14.7.4 Transmit Linktrace Message

Change 12.14.7.4.2 as shown:

12.14.7.4.2 Inputs

- a) A reference to a particular Maintenance association End Point managed object (12.14.7);
- b) The Flags field for LTMs transmitted by the MEP (20.42.1);
- c) An indication of the Target MAC Address field to be transmitted, either:
 - 1) The MEPID of another MEP in the same MA; or
 - 2) An Individual ~~destination~~-MAC address;
- d) An initial value for the LTM TTL field (21.8.4). Default value, if not specified, is 64;
- e) In the case of a PBB-TE MEP, the Reverse VID to be used in the associated PBB-TE MIP TLV (21.7.5). The parameter is not required in the case of PBB-TE MEPs associated with point-to-point TESIs;
- f) In the case of an SPBM VID MEP, an individual or group MAC address to be used as the destination address for the LTM primitive. If no value is provided the group MAC address for the SPBM default I-SID (Table 9-3, Figure 27-3) is used;
- g) In the case of ECMP with flow filtering, a flow hash value if the destination address is an Individual address.

12.14.7.6 Read MEP Database

12.14.7.6.3 Outputs

Change item e) in 12.14.7.6.3 as shown:

- e) A Boolean value indicating the state of the RDI bit in the last received CCM (true for RDI = 1), or false, if none has been received (20.19.2). In the case of an ECMP path MEP, an array of Boolean values indicating the value of rMEPlastRDI[i] for i=0..(Npaths-1) indicating the RDI values in the last CCMs received in each path test cycle period. These values are true for any RDI = 1 or false if all RDI = 0 or if no CCM has ever been received (20.19.2);

12.16 Backbone Edge Bridge management

12.16.5 CBP Configuration managed object

Change 12.16.5 as shown:

The CBP Configuration managed object includes the following:

- a) A Backbone Service Instance table (6.11)
- b) A Flow Filtering Control Table (44.2.2)

Item b) is only applicable on BEBs supporting ECMP with flow filtering.

The management operations that can be performed are as follows:

- c) Read Backbone Service Instance table entry (12.16.5.1)
- d) Set Backbone Service Instance table entry (12.16.5.2)
- e) TESI assignment managed object (12.16.5.3)
- f) Read Flow Filtering Control Table entry (12.16.5.4)
- g) Set Flow Filtering Control Table entry (12.16.5.5)

Change 12.16.5.2.3 as shown:

12.16.5.2 Set Backbone Service Instance table entry

12.16.5.2.3 Outputs

- a) Operation status—this takes one of the following values:
 - 1) Operation rejected because the ComponentID and Port Number do not identify a valid CBP.
 - 2) Operation rejected because the B-VID is assigned to ECMP with flow filtering (12.25.4.1, Table 44-1) and the Bridge does not support flow filtering.
 - 3) Operation accepted.

Insert 12.16.5.4 and 12.16.5.5 after 12.16.5.3:

12.16.5.4 Read Flow Filtering Control Table entry

12.16.5.4.1 Purpose

BEBs supporting ECMP with flow filtering shall implement the read Flow Filtering Control Table entry function to allow reading the Flow Filtering Control Table entries in the CBP configuration managed object.

12.16.5.4.2 Inputs

- a) ComponentID—the number identifying the bridge component associated with this port.
- b) Port Number—that component's Port Number for the Bridge Port.
- c) VID—identifying a B-VID.

12.16.5.4.3 Outputs

- a) Operation status—this takes one of the following values:
 - 1) Operation rejected because the ComponentID and Port Number do not identify a valid CBP;
 - 2) Operation rejected because the CBP does not support F-TAG processing;
 - 3) Operation accepted.
- b) ComponentID—the number identifying the bridge component associated with this port.
- c) Port Number—that component's Port Number for the Bridge Port.
- d) VID—the identifier of a B-VLAN.
- e) Flow Filtering—indicates whether or not flow filtering behavior is enabled on the port for the VID (enabled/disabled).
- f) Flow Hash Generation—indicates whether or not flow hash generation is enabled on the port for the VID (enabled/disabled).
- g) TTL Value—the initial TTL value for frames entering the flow filtering SPT Domain (1..63).

12.16.5.5 Set Flow Filtering Control Table entry

12.16.5.5.1 Purpose

BEBs supporting ECMP with flow filtering shall implement the set Flow Filtering Control Table entry function to allow configuration of the initial TTL value for frames entering an SPT Domain. This information is persistent over power-up or reboot.

12.16.5.5.2 Inputs

- a) ComponentID—the number identifying the bridge component associated with this port.
- b) Port Number—that component's Port Number for the Bridge Port.
- c) VID—12-bit VID.
- d) TTL Value—the initial TTL value for frames entering the SPT Domain, Integer in range 1–63. The default value is 8.

NOTE—The Flow Filtering and Flow Hash Generation fields in the Flow Filtering Control Table are controlled by ISIS-SPB (28.8.2) and therefore are not settable by management.

12.16.5.5.3 Outputs

- a) Operation status—this takes one of the following values:
 - 1) Operation rejected because the ComponentID and Port Number do not identify a valid CBP;
 - 2) Operation rejected because the CBP does not support F-TAG processing;
 - 3) Operation accepted.

12.25 Shortest Path Bridging managed objects

Change 12.25 as shown, replacing Figure 12-3:

The Shortest Path Bridging managed objects model operations that create, modify, delete, or enquire about the configuration and the operation of an SPT Bridge and the region in which it is operating. These managed

objects model only behaviors unique to Shortest Path Bridging. Figure 12-3 illustrates the hierarchical relationships among the various SPB managed objects.

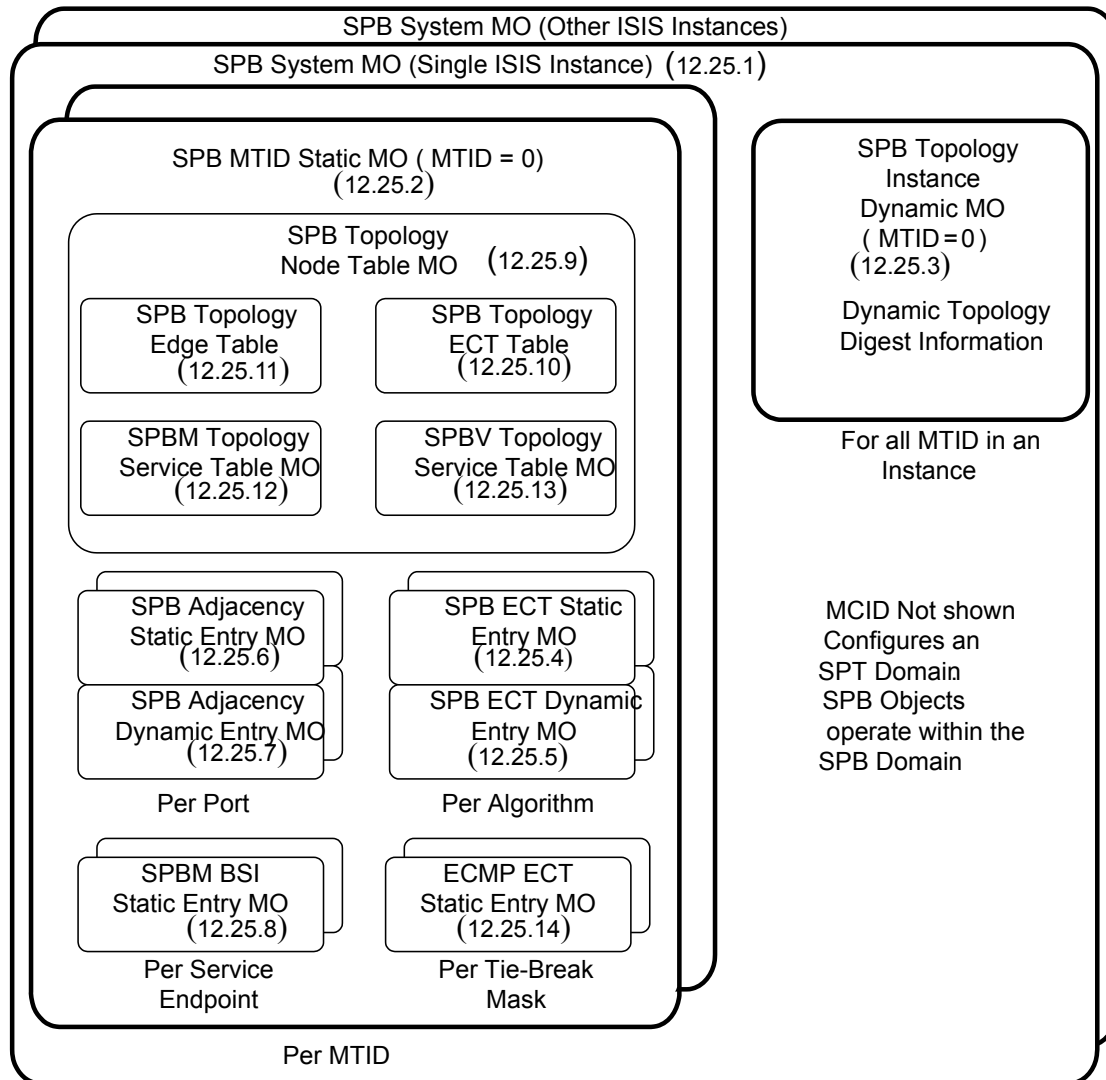


Figure 12-3—SPB Management objects

IS-IS provides a logical topology instance and within each instance the SPT Domain defines a set of managed objects. The following are the managed objects in an SPT Bridge:

- a) The SPB System managed object (12.25.1).
- b) The SPB MTID (Clause 3) Static managed object (12.25.2).
- c) The SPB Topology Instance Dynamic managed object (12.25.3).
- d) The SPB ECT Static Entry managed object (12.25.4).
- e) The SPB ECT Dynamic Entry managed object (12.25.5).
- f) The SPB Adjacency Static Entry managed object (12.25.6).
- g) The SPB Adjacency Dynamic Entry managed object (12.25.7).
- h) [The SPBM BSI Static Entry managed object \(12.25.8\).](#)
- i) The SPB Topology Node Table managed object (12.25.9).
- j) The SPB Topology ECT Table managed object (12.25.10).
- k) The SPB Topology Edge Table managed object (12.25.11).

- l) The SPBM Topology Service Table managed object (12.25.12).
- m) The SPBV Topology Service Table managed object (12.25.13).
- n) [The ECMP ECT Static Entry managed object \(12.25.14\).](#)

12.25.1 The SPB System managed object

12.25.1.3 Read SPB System managed object

12.25.1.3.3 Outputs

Change item e) in 12.25.1.3.3 as shown:

- e) The Bridge Priority (~~13.26.3~~[13.26.2](#)). The value used by SPB is set in the CIST Bridge Protocol Parameters (12.8.1.3).

12.25.4 The SPB ECT Static Entry managed object

12.25.4.1 Create SPB ECT Static Entry managed object

12.25.4.1.2 Inputs

Change 12.25.4.1.2 as shown:

- a) A Topology Index value that uniquely identifies a topology instance.
- b) A Base VID. This VID must have been assigned either to the reserved MSTID value 0xFFC for SPT bridges in SPBM operation, or to the reserved MSTID value 0xFFD for SPBV (27.4) in the FID to MSTI Allocation table (12.12.2.2).
- c) The identifier of the Equal Cost Tree algorithm (ECT-ALGORITHM) to be used for this Base VID ([Table 28-1](#), [Table 44-1](#)). The Default is the LowPATHID 00-80-C2-01- (28.8).
- d) The pre-configured value of the SPVID assigned to this bridge if operating in SPBV mode. This input is ignored if auto-allocated is selected [item c) in 12.25.1.2.2]. This VID value must have been assigned to the reserved MSTID value 0xFFFF (27.4) in the FID to MSTI Allocation Managed Object (12.12.2.2).

Insert new subclause 12.25.8 after 12.25.7, renumbering subsequent subclauses accordingly:

12.25.8 The SPBM BSI Static Entry managed object

There is one SPBM BSI Static Entry managed object for each I-SID assigned to an SPBM VID on a CBP. It contains the SPBM configuration parameters for an I-SID. It is persistent over reboot. The management operations that can be performed on the SPBM BSI Static Entry managed object are as follows:

- a) Write SPBM BSI Static Entry managed object (12.25.8.1).
- b) Read SPBM BSI Static Entry managed object (12.25.8.2).

12.25.8.1 Write SPBM BSI Static Entry managed object

12.25.8.1.1 Purpose

To configure an SPBM BSI Static Entry managed object for an I-SID assigned to an SPBM VID on a CBP.

12.25.8.1.2 Inputs

- a) A Topology Index value which uniquely identifies a topology instance.
- b) The system interface index of a Customer Backbone Port.

- c) The I-SID identifying the backbone service instance.
- d) A B-VID associated with this I-SID. There may be more than one object for a given I-SID, allowing it to be associated with multiple B-VIDs. This B-VID may differ from the B-VID specified in 12.16.5.2 that governs the VID assigned to the I-SID at the CBP; for example, to allow changing ISIS-SPB parameters when moving an I-SID from one B-VID to another. The B-VID to I-SID association in this managed object is advertised in ISIS-SPB so that forwarding state for the association is installed throughout the SPT domain, in addition to CBP state installed by 12.16.5.2. It is only the B-VID defined in 12.16.5.2 on which a CBP transmits; however, a CBP must receive from any B-VID with which its I-SID has an association.
- e) Multicast transmit indication bit [item e) in 28.12.10].
- f) Multicast receive indication bit [item f) in 28.12.10].
- g) Shared tree transmit indication bit [item g) in 28.12.10].
- h) Tie-Break Mask value [item h) in 28.12.10].

12.25.8.1.3 Outputs

- a) Operation status. This takes one of the following values:
 - 1) Operation rejected because the Topology Index value is not defined;
 - 2) Operation rejected because the identified port does not exist or is not a CBP;
 - 3) Operation rejected because the I-SID is not assigned to an SPBM VID;
 - 4) Operation accepted.

12.25.8.2 Read SPBM BSI Static Entry managed object

12.25.8.2.1 Purpose

To read back the parameters of an SPBM BSI Static Entry managed object for an I-SID assigned to an SPBM VID on a CBP.

12.25.8.2.2 Inputs

- a) A Topology Index value that uniquely identifies a topology instance.
- b) The system interface index of a Customer Backbone Port. The value of zero is a wildcard indicating information, for any interface on which SPB operation is enabled, is requested.
- c) An I-SID identifying a backbone service instance. The value 0xFFFFFFFF is a wildcard indicating that information on all I-SIDs on the specified port(s) is requested.
- d) A B-VID associated with this I-SID. The value 4095 is a wildcard indicating that information for any B-VID associated with the specified I-SID(s) is requested.

12.25.8.2.3 Outputs

- a) a) Operation status—this takes one of the following values:
 - 1) Operation rejected because the Topology Index value is not defined;
 - 2) Operation rejected because the identified port does not exist or is not a CBP;
 - 3) Operation rejected because the I-SID is not assigned to an SPBM VID;
 - 4) Operation accepted.
- b) The Topology Index value that uniquely identifies this topology instance.
- c) The system interface index of the port.
- d) The I-SID identifying a backbone service instance.
- e) The B-VID associated with this I-SID.
- f) Multicast transmit indication bit [item e) in 28.12.10].
- g) Multicast receive indication bit [item f) in 28.12.10].
- h) Shared tree transmit indication bit [item g) in 28.12.10].
- i) Tie-Break Mask value [item h) in 28.12.10].

If item b) in 12.25.8.2.2 is configured with the value 0, a list indexed by the CBP ports on the system containing items a) to i) [with the exception of item a2)].

12.25.12 The SPBM Topology Service Table managed object

12.25.12.1 Read SPBM Topology Service Table managed object

Change 12.25.12.1.3 (renumbered from 12.25.11.1.3) as shown:

12.25.12.1.3 Outputs

A list, which may be empty, comprising one entry for each I-SID assigned to a Base VID within the SPT Region of which the local IS-IS instance is aware. Each entry contains the following information about the I-SID:

- a) The Topology Index value that uniquely identifies this topology instance.
- b) The SPB System Identifier of the SPT bridges operating in SPBM mode hosting an I-SID instance.
- c) The I-SID value.
- d) The Base VID associated with this I-SID (and hence the ECT-ALGORITHM applied to this service).
- e) The B-MAC address associated with this I-SID. If multiple I-SID instances are configured on a single bridge but are reachable by different B-MAC addresses, a separate record is returned for each B-MAC address associated with that I-SID.
- f) The I-SID instance service characteristic; transmit-only, receive-only, or both [\[item e\) and item f\) in 28.12.10; item e\) and item f\) in 12.25.8.1.1\]](#).
- g) [If ECMP is supported, the shared tree transmit indication \[item g\) in 28.12.10; item g\) in 12.25.8.1.2\]](#).
- h) [If ECMP is supported, the Tie-Break Mask value \[item h\) in 28.12.10; item h\) in 12.25.8.1.2\]](#).

NOTE—In general, an I-SID will be assigned to a single Base VID. During the administratively mediated migration of traffic from one ECT-ALGORITHM to a new one, an I-SID may be assigned to two Base VIDs for the duration of the transition in order to achieve loss-less migration (28.9.2).

Insert new subclause 12.25.14 after 12.25.12 (renumbered 12.25.13):

12.25.14 The ECMP ECT Static Entry managed object

There is one ECMP ECT Static Entry managed object per Tie-Break Mask. It contains the Bridge Priority to be used for shared tree root selection for that Tie-Break Mask value. It is persistent over reboot. The management operations that can be performed on the ECMP ECT Static Entry managed object are as follows:

- a) Write ECMP ECT Static Entry managed object (12.25.14.1).
- b) Read ECMP ECT Static Entry managed object (12.25.14.2).

12.25.14.1 Write ECMP ECT Static Entry managed object

12.25.14.1.1 Purpose

To configure a different Bridge Priority to be used solely for shared tree root selection for a given Tie-Break Mask (28.12.6.1, 28.8.2).

12.25.14.1.2 Inputs

- a) A Topology Index value which uniquely identifies a topology instance.
- b) A Tie-Break Mask value [item d) in 28.12.6.1].
- c) Bridge Priority [item e) in 28.12.6.1].

12.25.14.1.3 Outputs

- a) Operation status. This takes one of the following values:
 - 1) Operation rejected because the Topology Index value is not defined;
 - 2) Operation accepted.

12.25.14.2 Read ECMP ECT Static Entry managed object**12.25.14.2.1 Purpose**

To read back the Bridge Priority for a given Tie-Break Mask.

12.25.14.2.2 Inputs

- a) A Topology Index value that uniquely identifies a topology instance.
- b) A Tie-Break Mask value [item d) in 28.12.6.1].

12.25.14.2.3 Outputs

- a) a) Operation status—this takes one of the following values:
 - 1) Operation rejected because the Topology Index value is not defined;
 - 2) Operation accepted.
- b) The Topology Index value that uniquely identifies this topology instance.
- c) The Tie-Break Mask value [item d) in 28.12.6.1].
- d) The Bridge Priority [item e) in 28.12.6.1].

17. Management Information Base (MIB)

17.2 Structure of the MIB

Insert the following row at the end of Table 17-1:

Table 17-1—Structure of the MIB modules

Module	Subclause	Defining IEEE standard	Reference	Notes
IEEE8021-ECMP-MIB	17.7.21	802.1Qbp	44, 28	Initial version in IEEE Std 802.1Qbp

17.2.19 Structure of the IEEE8021-SPB-MIB

Insert the following rows at the end of Table 17-25:

Table 17-25—IEEE8021-SPB MIB structure and relationship to this standard

Clause 17 MIB table/object	Reference
ieee8021SpbmBsiStaticTable	12.25.8, 28.12.10
ieee8021SpbmBsiStaticTableEntry	12.25.8
ieee8021SpbmBsiStaticEntryIsid	12.25.8.1, 12.25.8.2
ieee8021SpbmBsiStaticEntryBaseVid	12.25.8.1, 12.25.8.2
ieee8021SpbmBsiStaticEntryTBit	12.25.8.1, 12.25.8.2
ieee8021SpbmBsiStaticEntryRBit	12.25.8.1, 12.25.8.2
ieee8021SpbmBsiStaticEntryTsBit	12.25.8.1, 12.25.8.2
ieee8021SpbmBsiStaticEntryTieBreakMask	12.25.8.1, 12.25.8.2
ieee8021SpbmBsiStaticEntryRowStatus	
dot1agCfmMepSpbmTable	12.14.7, 27.18
dot1agCfmMepSpbmEntry	12.14.7
dot1agCfmMepTransmitLbmSpbmDA	12.14.7.3
dot1agCfmMepTransmitLtmSpbmDA	12.14.7.4
dot1agCfmMepSpbmEspTable	12.14.5.3.2, 27.18.1
dot1agCfmMepSpbmEspEntry	12.14.5.3.2
dot1agCfmMepSpbmEspIndex	12.14.5.3.2
dot1agCfmMepSpbmEspEsp	12.14.5.3.2
dot1agCfmMepSpbmEspRowStatus	

Insert 17.2.21 after 17.2.20:

17.2.21 Structure of the IEEE8021-ECMP-MIB

The IEEE8021-ECMP-MIB provides for configuration of flow filtering (44.2) on ports (CBPs and PNP) and the configuration of ISIS-SPB advertisements specific to the ECMP ECT Algorithm (44.1.2). It also allows reading of FDB state and statistics related to ECMP and flow filtering. Table 17-27 indicates the relationship between the SMIV2 objects defined in the MIB module (17.7.21) and managed objects defined in Clause 12.

Table 17-27—IEEE8021-ECMP-MIB structure and relationship to this standard

Clause 17 MIB table/object	Reference
ieee8021QBridgeEcmpFdbTable	12.7.7.3, 8.8.3
(AUGMENTS ieee8021QBridgeTpFdbEntry)	
ieee8021QBridgeEcmpFdbPortList	
ieee8021EcmpFlowFilterCtlTable	12.16.5.4, 12.16.5.5, 44.2.2
ieee8021EcmpFlowFilterCtlVid	
ieee8021EcmpFlowFilterCtlEnabled	
ieee8021EcmpFlowFilterCtlHashGen	
ieee8021EcmpFlowFilterCtlTtl	
ieee8021EcmpEctStaticTable	12.25.14, 28.12.6.1
ieee8021EcmpEctStaticEntryTieBreakMask	
ieee8021EcmpEctStaticEntryBridgePriority	
ieee8021EcmpEctStaticEntryRowStatus	
ieee8021EcmpTopSrvTable	12.25.12.1.3, 28.12.10
(AUGMENTS ieee8021SpbmTopSrvTableEntry)	
ieee8021EcmpTopSrvEntryTsBit	
ieee8021EcmpTopSrvEntryTieBreakMask	
ieee8021QBridgePortVlanTtlStatisticsTable	12.6.1.1.3, 44.2.2.1
(AUGMENTS ieee8021QBridgePortVlanStatisticsEntry)	
ieee8021QBridgeTpVlanPortTtlDiscards	

17.3 Relationship to other MIBs

Insert 17.3.21 after 17.3.20:

17.3.21 Relationship of the of the IEEE8021-ECMP-MIB to other MIB modules

The IEEE8021-ECMP-MIB extends SPBM functionality and therefore is closely related to the IEEE8021-SPB-MIB and IEEE8021-PBB-MIB. For example it includes configuration for an optional ISIS-SPB

sub-TLV for the ECMP ECT Algorithm (28.12.6.1) and configuration for flow filtering on PNP and CBPs (44.2.2).

Because it provides control functions related to VIDs, it depends on the Q-BRIDGE-MIB. It also augments tables defined in the IEEE8021-Q-BRIDGE-MIB (adding the ability to read the FDB Port Map for an individual address and adding TTL discard statistics). It also imports items from the SNMPv2-SMI, SNMPv2-TC, and IEEE8021-TC-MIB, and requires SNMPv2-CONF for conformance.

17.4 Security considerations

17.4.19 Security considerations of the IEEE8021-SPB MIB

Insert the following two items at the end of the second list, after ieee8021SpbMTidStaticEntryMtidOverload:

```
ieee8021SpbmBsiStaticTable  
dot1agCfmMepSpbmEspTable
```

Insert 17.4.21 after 17.4.20:

17.4.21 Security considerations of the IEEE8021-ECMP-MIB

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These objects and their sensitivity/vulnerability are described next.

The following objects in the IEEE8021-ECMP-MIB could be manipulated to interfere with the operation of ECMP networks. These could, for example, be used to misconfigure the network to cause loss of connectivity or undesirable path selection. The following are vulnerable writable objects from the IEEE8021-ECMP-MIB:

```
ieee8021EcmpFlowFilterCtlTtl  
ieee8021EcmpEctStaticEntryBridgePriority  
ieee8021EcmpEctStaticEntryRowStatus
```

17.7 MIB modules

17.7.1 Definitions for the IEEE8021-TC MIB module

Delete the entire text of 17.7.1, and insert the following text:

```
IEEE8021-TC-MIB DEFINITIONS ::= BEGIN  
  
-- =====  
-- TEXTUAL-CONVENTIONS MIB for IEEE 802.1  
-- =====  
  
IMPORTS  
    MODULE-IDENTITY, Unsigned32, org  
    FROM SNMPv2-SMI -- RFC 2578
```

TEXTUAL-CONVENTION
FROM SNMPv2-TC; -- RFC 2579

ieee8021TcMib MODULE-IDENTITY
LAST-UPDATED "201302050000Z" -- February 5, 2013
ORGANIZATION "IEEE 802.1 Working Group"
CONTACT-INFO
" WG-URL: <http://grouper.ieee.org/groups/802/1/index.html>
WG-EMail: stds-802-1@ieee.org

Contact: David Levi
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445 Hoes Lane
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Contact: Kevin Nolish
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Piscataway
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E-mail: STDS-802-1-L@LISTSERV.IEEE.ORG

DESCRIPTION
"Textual conventions used throughout the various IEEE 802.1 MIB modules.

Unless otherwise indicated, the references in this MIB module are to IEEE 802.1Q-2011.

Copyright (C) IEEE.
This version of this MIB module is part of IEEE802.1Q;
see the draft itself for full legal notices."

REVISION "201302050000Z" -- February 5, 2013

DESCRIPTION
"Added new identifier types for new SPBM MA types"

REVISION "201202150000Z" -- February 15, 2012

DESCRIPTION
"Modified IEEE8021BridgePortType textual convention to include stationFacingBridgePort, uplinkAccessPort, and uplinkRelayPort types."

REVISION "201108230000Z" -- August 23, 2011

DESCRIPTION
"Modified textual conventions to support the IEEE 802.1 MIBs for PBB-TE Infrastructure Protection Switching."

REVISION "201104060000Z" -- April 6, 2011

DESCRIPTION
"Modified textual conventions to support Remote Customer Service Interfaces."

REVISION "201102270000Z" -- February 27, 2011

DESCRIPTION
"Minor edits to contact information etc. as part of

2011 revision of IEEE Std 802.1Q."

REVISION "200811180000Z" -- November 18, 2008

DESCRIPTION

"Added textual conventions needed to support the IEEE 802.1 MIBs for PBB-TE. Additionally, some textual conventions were modified for the same reason."

REVISION "200810150000Z" -- October 15, 2008

DESCRIPTION

"Initial version."

```
::= { org ieee(111) standards-association-numbers-series-standards(2)
      lan-man-stds(802) ieee802dot1(1) 1 1 }
```

ieee802dot1mibs OBJECT IDENTIFIER

```
::= { org ieee(111) standards-association-numbers-series-standards(2)
      lan-man-stds(802) ieee802dot1(1) 1 }
```

```
-- =====
-- Textual Conventions
-- =====
```

IEEE8021PbbComponentIdentifier ::= TEXTUAL-CONVENTION

DISPLAY-HINT "d"

STATUS current

DESCRIPTION

"The component identifier is used to distinguish between the multiple virtual bridge instances within a PB or PBB. Each virtual bridge instance is called a component. In simple situations where there is only a single component the default value is 1. The component is identified by a component identifier unique within the BEB and by a MAC address unique within the PBBN. Each component is associated with a Backbone Edge Bridge (BEB) Configuration managed object."

REFERENCE "12.3 1)"

SYNTAX Unsigned32 (1..4294967295)

IEEE8021PbbComponentIdentifierOrZero ::= TEXTUAL-CONVENTION

DISPLAY-HINT "d"

STATUS current

DESCRIPTION

"The component identifier is used to distinguish between the multiple virtual bridge instances within a PB or PBB. In simple situations where there is only a single component the default value is 1. The component is identified by a component identifier unique within the BEB and by a MAC address unique within the PBBN. Each component is associated with a Backbone Edge Bridge (BEB) Configuration managed object."

The special value '0' means 'no component identifier'. When this TC is used as the SYNTAX of an object, that object must specify the exact meaning for this value."

REFERENCE "12.3 1)"

SYNTAX Unsigned32 (0 | 1..4294967295)

IEEE8021PbbServiceIdentifier ::= TEXTUAL-CONVENTION

DISPLAY-HINT "d"

STATUS current

DESCRIPTION

"The service instance identifier is used at the Customer Backbone Port of a PBB to distinguish a service instance (Local-SID). If the Local-SID field is supported, it is used to perform a bidirectional 1:1 mapping between the Backbone I-SID and the Local-SID. If the Local-SID field is not supported, the Local-SID value is the same as the Backbone I-SID value."

REFERENCE "12.16.3, 12.16.5"

SYNTAX Unsigned32 (256..16777214)

IEEE8021PbbServiceIdentifierOrUnassigned ::= TEXTUAL-CONVENTION

DISPLAY-HINT "d"

STATUS current

DESCRIPTION

"The service instance identifier is used at the Customer Backbone Port of a PBB to distinguish a service instance (Local-SID). If the Local-SID field is supported, it is used to perform a bidirectional 1:1 mapping between the Backbone I-SID and the Local-SID. If the Local-SID field is not supported, the Local-SID value is the same as the Backbone I-SID value."

The special value of 1 indicates an unassigned I-SID."

REFERENCE "12.16.3, 12.16.5"

SYNTAX Unsigned32 (1|256..16777214)

IEEE8021PbbIngressEgress ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"A 2 bit selector which determines if frames on this VIP may ingress to the PBBN but not egress the PBBN, egress to the PBBN but not ingress the PBBN, or both ingress and egress the PBBN."

REFERENCE "12.16.3, 12.16.5, 12.16.6"

SYNTAX BITS {
 ingress(0),
 egress(1)
}

IEEE8021PriorityCodePoint ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Bridge ports may encode or decode the PCP value of the frames that traverse the port. This textual convention names the possible encoding and decoding schemes that the port may use. The priority and drop_eligible parameters are encoded in the Priority Code Point (PCP) field of the VLAN tag using the Priority Code Point Encoding Table for the Port, and they are decoded from the PCP using the Priority Code Point Decoding Table."

REFERENCE "12.6.2.6"

SYNTAX INTEGER {
 codePoint8p0d(1),
 codePoint7p1d(2),
 codePoint6p2d(3),
 codePoint5p3d(4)
}

IEEE8021BridgePortNumber ::= TEXTUAL-CONVENTION