International Standard

ISO/IEC/IEEE 8802-1Q

Telecommunications and exchange between information technology systems — Requirements for local and metropolitan area networks —

Part 1Q: Bridges and bridged networks

AMENDMENT 35: Congestion isolation

Télécommunications et échange entre systèmes informatiques — Exigences pour les réseaux locaux et métropolitains —

Partie 1Q: Ponts et réseaux pontés

AMENDEMENT 35: Prévention de la congestion

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IEEE Standard for
Local and Metropolitan Area Networks—

Bridges and Bridged Networks

Amendment 35: Congestion Isolation

(This amendment is based on IEEE Std 802.1Q™-2022.)

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.

The editing instructions are shown in ***bold italics***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this note will not be carried over into future editions because the changes will be incorporated into the base standard. [6]

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

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1. Overview

1.3 Introduction

Insert new text at the end of 1.3 as follows:

This standard specifies protocols, procedures, and managed objects that support the isolation of congesting data flows within data center environments. This is achieved by enabling systems to individually identify flows creating congestion, isolate those flows to the congesting queue, and signal to neighbors. This mechanism reduces head-of-line blocking for non-congesting flows sharing the same traffic class. Congestion Isolation is used with higher layer protocols that utilize end-to-end congestion control in order to reduce packet loss and latency. To this end, it:

ct) Defines a means for VLAN-aware Bridges that support congestion isolation to identify flows that are creating congestion.

cu) Defines a means for adjusting transmission selection for frames of congesting flows.

cv) Provides a means for discovering peer VLAN-aware Bridges and stations that support congestion isolation.

cw) Defines a means for signaling congestion isolation to supporting peer Bridges and stations.

cx) Defines a means for recognizing a system’s level and port orientation within the topology relative to the edge.

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2. Normative references

Insert the following references into Clause 2 in alphanumeric order:

IEEE Std 802.1CS™, IEEE Standard for Local and Metropolitan Area Networks—Link-local Registration Protocol.[7, 8]

IETF RFC 768 (STD0006), User Datagram Protocol, August 1980.[9]

IETF RFC 791 (STD0005), Internet Protocol—DARPA Internet Program Protocol Specification, September 1981.

IETF RFC 3168, The Addition of Explicit Congestion Notification (ECN) to IP, September 2001.

IETF RFC 3232, Assigned Numbers: RFC 1700 is Replaced by an On-line Database, January 2002.

IETF RFC 6335, Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transport Protocol Port Number Registry, August 2011.

IETF RFC 8200 (STD0086), Internet Protocol, Version 6 (IPv6) Specification, July 2017.

[7] The IEEE standards or products referred to in Clause 2 are trademarks owned by The Institute of Electrical and Electronics Engineers, Incorporated.
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3. Definitions

Insert the following definitions in the appropriate collating sequence, renumbering accordingly:

3.1 congesting flow: A sequence of frames the end-to-end congestion controlled higher layer protocol treats as belonging to a single flow that is experiencing congestion within a congestion isolation aware system.

3.2 congestion isolation aware system: A Bridge component conforming to the congestion isolation provisions of this standard.

3.3 Congestion Isolation Message (CIM): A message transmitted by a congestion isolation aware system, conveying congesting flow information used by the upstream peer congestion isolation aware system.

3.4 Congestion Isolation Point (CIP): A Virtual Local Area Network (VLAN) Bridge or end station Port function that monitors a set of queues for congesting flows, isolates congesting flows to a congesting queue, and can generate Congestion Isolation Messages.

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4. Abbreviations

Insert the following abbreviations into Clause 4, in the appropriate collating sequence:

CI	Congestion Isolation
CIM	Congestion Isolation Message
CIP	Congestion Isolation Point

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5. Conformance

5.4 VLAN Bridge component requirements

5.4.1 VLAN Bridge component options

Insert new list item ag) at the end of the lettered list in 5.4.1 as follows:

ag) Support for Congestion Isolation (CI) operation (5.4.7).

5.4.1.6 ETS Bridge requirements

Insert new list item a) at the beginning of the lettered list in 5.4.1.6 as follows, renumbering all subsequent items:

a) Support the ETS algorithm (8.6.8.3).

Insert 5.4.7 after 5.4.6 as follows:

5.4.7 VLAN Bridge requirements for congestion isolation (optional)

A VLAN-aware Bridge implementation that conforms to the provisions of this standard for congestion isolation in Clause 49 shall:

a) Support, on one or more Ports, the creation of at least one Congestion Isolation Point (49.3.1).
b) Support Explicit Congestion Notification (ECN) as defined by IETF RFC 3168 and associated updates along with Active Queue Management (AQM) as described in 49.2.1.
c) Support per-stream classification and metering for CI as specified in 8.6.5.2.3.
d) Support, at each Congestion Isolation Point, the variables and procedures of the Congestion Isolation Protocol (49.4).
e) Support the ability to configure the variables controlling the operation of Congestion Isolation (12.33.1), the CI Peer Table (12.33.2), the CI Stream Table (12.33.3), and each CIP (12.33.4).
f) Conform to the required capabilities of IEEE Std 802.1AB.
g) Support the use of the Congestion Isolation TLV in LLDP (D.2.15).

A VLAN Bridge implementation that conforms to the provisions of this standard for congestion isolation may:

h) Support the monitoring of more than one queue on a Bridge Port (49.4.1.2.5).
i) Support transmission selection algorithms other than strict priority.
j) Support the de-isolation of congesting flows by means other than the empty status of a congesting queue (49.2.6).
k) Support the Congestion Isolation YANG model (48.3.8).
l) Support Topology Recognition (49.5).

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Insert 5.32 after 5.31 as follows:

5.32 End station requirements for congestion isolation

An end station implementation that conforms to the provisions of this standard for congestion isolation in Clause 49 shall:

a) Support Explicit Congestion Notification (ECN) as defined by IETF RFC 3168 and associated updates along with Active Queue Management (AQM) as described in 49.2.1.
b) Support, at each Congestion Isolation Point, the variables and procedures of the Congestion Isolation Protocol (49.4).
c) Conform to the required capabilities of IEEE Std 802.1AB.
d) Support the use of the Congestion Isolation TLV in LLDP (D.2.15).

An end station implementation that conforms to the provisions of this standard for congestion isolation in Clause 49 may:

e) Support transmission selection algorithms other than strict priority.
f) Support the de-isolation of congesting flows by means other than the empty status of a congesting queue (49.2.6).
g) Support the Congestion Isolation YANG model (48.3.8).
h) Support non-relay end station or server functionality of Topology Recognition (49.5).

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6. Support of the MAC Service

6.10 Support of the ISS/EISS by PIPs

6.10.1 Data indications

Change the first paragraph of 6.10.1 as follows:

On receipt of an M_UNITDATA.indication primitive from the PIP-ISS, if the PIP is congestion aware (5.4.1.4) and the initial octets of the mac_service_data_unit contain a valid CNM encapsulation, the received frame is processed according to 32.16. If the PIP is congestion isolation aware (5.4.7) and the initial octets of the mac_service_data_unit contain a valid CIM encapsulation (49.4.3), the received frame is processed according to 49.4.2.6. Otherwise, the received frame shall be discarded if:

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8. Principles of Bridge operation

8.6 The Forwarding Process

8.6.5 Flow classification and metering

Change the text in 8.6.5 as follows:

The Forwarding Process can apply flow classification and metering to frames that are received on a Bridge Port and have one or more potential transmission ports. Bridge Ports and end stations may support Per-Stream Filtering and Policing (PSFP), Asynchronous Traffic Shaping (ATS) filtering and eligibility time assignment, Congestion Isolation (CI), or the general flow classification rules specified in 8.6.5.1.

NOTE—The general flow classification and metering specification was added to this standard by IEEE Std 802.1Q-2005, PSFP by IEEE Std 802.1Qci-2017, ~~and~~ ATS by IEEE Std 802.1Qcr-2020, and CI by IEEE Std 802.1Qcz-2023.

PSFP ~~and ATS~~, ATS, and CI share common per-stream classification and metering elements, as shown in Figure 8-13. The Stream identification function specified in IEEE Std 802.1CB can be used to associate received frames with these elements.

Change Figure 8-13 as follows:

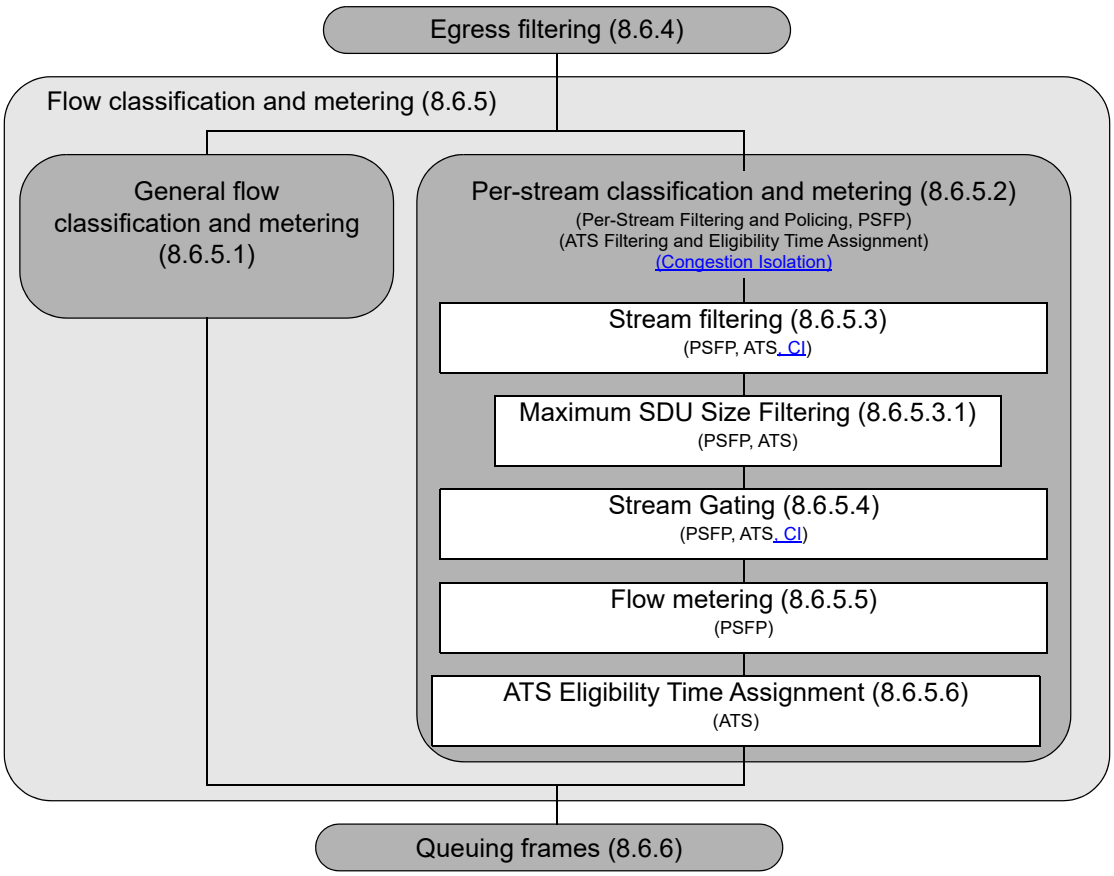


Figure 8-13—Flow classification and metering

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8.6.5.2 Per-stream classification and metering

Change the first sentence of 8.6.5.2 as follows:

When Per-Stream Filtering and Policing (PSFP) ~~or Asynchronous Traffic Shaping (ATS)~~, Asynchronous Traffic Shaping (ATS), or Congestion Isolation (CI) is used, filtering and policing decisions for received frames are made, and subsequent queuing (8.6.6) and transmission selection decisions (8.6.8) supported, as follows:

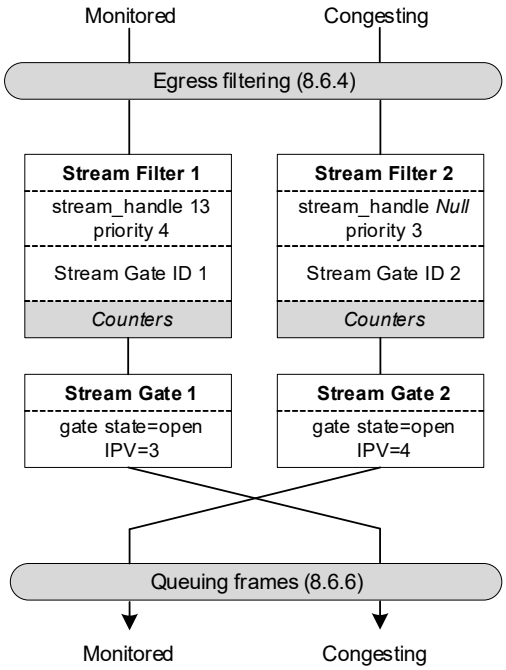
Insert 8.6.5.2.3 after 8.6.5.2.2 as follows:

8.6.5.2.3 CI Support

Each Bridge component or an end station that implements Congestion Isolation supports stream identification and stream gates to allow traffic class modification, with the following:

a) A single Stream Filter Instance Table (8.6.5.3).
b) A single Stream Gate Instance Table (8.6.5.4).

The relationship between stream filters and stream gates for streams subject to CI processing (as identified by the stream filter) is illustrated by Figure 8-15a for a number of streams.



KEY
Stream ID: stream filter instance identifier (8.6.5.3)
Gate ID: stream gate instance identifier (8.6.5.3, 8.6.5.4)

Figure 8-15a—Per-stream classification and assignment for CI

Congestion isolation uses two stream filter instances from the stream filter instance table (8.6.5.3) to select stream gate instances that will modify the priority of flows. One stream filter instance is used to modify the priority of congesting flows from the monitored queue to the congesting queue. The other stream filter instance is used to modify the priority of congesting flows from the congesting queue back to the monitored queue. There are no *filter specifications* used by congestion isolation.

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The *stream_handle* and *priority* parameters associated with a received frame select the stream filter instance of congestion isolation for a particular monitored traffic class. The purpose of the stream filter is to select the stream gate instance that will modify the priority of congesting flow frames so they will traverse the congesting queue. The absence of a *stream_handle* and the *priority* parameter associated with a received frame select the stream gate instance that will modify the priority of received frames back to the priority of the monitored queue.

NOTE—Changes to the frame's priority are intended to persist (see 49.2.4 and 49.2.6) by modifying the Priority Code Point (see 6.9.3) or other indicators used to select the traffic class, such as the Differentiated Services Code Point (see IETF RFC 2474). As noted in 6.8.1, modification to a frame will require the FCS to be regenerated. Options for regenerating the FCS are discussed in Annex O.

Congestion isolation uses two stream gate instances from the stream gate instance table (8.6.5.4) to modify the priority of flows. The operational and an administrative *stream gate state* (8.6.10.4, 8.6.10.5, 12.31.3) is set to Open for Congestion Isolation and the *GateClosedDueToInvalidRxEnable* and *GateClosedDueToOctetsExceededEnable* parameters are set to FALSE. The internal priority value (IPV) is used in place of the priority value associated with the frame to determine the frame's traffic class, using the Traffic Class Table as specified in 8.6.6. The *stream gate control list* feature is not used by Congestion Isolation and is set to null.

8.6.5.3 Stream filtering

Change second paragraph and associated list in 8.6.5.3 as follows:

Each stream filter comprises the following:

a) An integer *stream filter identifier*.
b) A *stream_handle* specification, either:
   1) A single value, as specified in IEEE Std 802.1CB.
   2) A wildcard, that matches any *stream_handle*.
   3) If congestion isolation is supported, a null-handle, that matches when no stream_handle is provided.
c) A *priority* specification, either:
   1) A single priority value.
   2) A wildcard value that matches any priority value.
d) Maximum SDU size filtering (8.6.5.3.1) information, comprising:
   1) An integer *Maximum SDU size*, in octets. A value of 0 disables maximum SDU size filtering for this stream filter.
   2) A boolean *StreamBlockedDueToOversizeFrameEnable* parameter.
   3) A boolean *StreamBlockedDueToOversizeFrame* parameter.
e) An integer *stream gate identifier* (8.6.5.4).
f) An integer *flow meter instance identifier* (8.6.5.5).
   If this parameter is absent, frames associated with the stream filter are not subject to flow metering.
g) An integer ATS *scheduler instance identifier* (8.6.5.6).
   If this parameter is absent, frames associated with the stream filter are not subject to ATS scheduling and transmission selection.

8.6.5.4 Stream gating

Change NOTE 1 in 8.6.5.4 as follows:

NOTE 1—The IPV facilitates ATS per-hop delay bound adjustment to satisfy specific networks' end-to-end delay requirements. Annex T (CQF) describes another IPV use case. Another use case is the ability to isolate congesting flows to a congesting flow queue as specified by Congestion Isolation (Clause 49).

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8.6.5.5 Flow metering

Insert the following after list item j), renumbering subsequent list items as necessary:

Each frame has a predetermined color for subsequent processing by a flow meter. If this color is determined by the drop_eligible parameter (6.9.1), the color is determined as follows:

k) If the drop_eligible parameter is FALSE, the color is green.
l) If the drop_eligible parameter is TRUE, the color is yellow.

8.6.6 Queuing frames

Change the third to last paragraph of 8.6.6 as follows:

In a congestion-aware Bridge (Clause 30) or a congestion isolation aware Bridge (Clause 49), the act of queuing a frame for transmission on a Bridge Port can result in the Forwarding Process generating a CNM or a CIM. The CNM ~~is~~ and CIM are injected back into the Forwarding Process (8.6.1) as if ~~it~~ they had been received on that Bridge Port.

8.6.8 Transmission selection

Insert 8.6.8.6 after 8.6.8.5 as follows:

8.6.8.6 Enhancements for congestion isolation

A Bridge component or an end station may support enhancements to isolate the frames of congesting flows to a designated congesting traffic class. During the isolation of a congesting flow it may be possible for frames of the same flow to queue in both the congesting and non-congesting traffic class. The transmission gate associated with each monitored non-congesting queue and each congesting queue can be used to meet the ordering requirements of 8.6.6. The state of the transmission gate determines whether or not queued frames can be selected for transmission. For a given queue, the transmission gate can be either *Open* or *Closed* as described in 8.6.8.4.

The need to control the transmission gate depends upon the transmission selection algorithm used and the technique for determining when to return a congesting flow to non-congesting status. Congestion isolation specifies that congesting and non-congesting queues use the same Active Queue Management (AQM) approach and the same transmission selection algorithm. Additionally, the congesting queues have lower priority than the monitored non-congesting queues.

When the transmission selection algorithm is strict priority and the technique for returning a congesting flow to non-congesting status is only when the congesting queue is empty, the state of the transmission gate can be set to *Open*. When the transmission selection algorithm is anything other than strict priority or the technique for returning a congesting flow to non-congesting status allows for congesting frames to exist in the congesting queue during the transition, the state of the transmission gate is controlled by the cipGateControl (49.4.1.4.1) variable. An example implementation of setting cipGateControl to provide transmission gate control for the purposes of ensuring ordering can be seen in Annex X.

Congestion isolation controls the transmission gate of the congesting and non-congesting queues to maintain the order of congesting flow frames. As a consequence, transmission gates used for congestion isolation cannot be used for other purposes.

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12. Bridge management

12.1 Management functions

12.1.1 Configuration Management

Insert new item m) at the end of the lettered list in 12.1.1 as follows:

m) The ability to create and delete the functional elements of congestion isolation and to control their operation.

12.2 VLAN Bridge objects

Insert new item s) at the end of the lettered list in 12.2 as follows:

s) The congestion isolation entities (12.33)

12.31 Managed objects for per-stream classification and metering

12.31.1 The Stream Parameter Table

Change 12.31.1 as follows:

There is one Stream Parameter Table per Bridge component. The table contains a set of parameters that supports PSFP (8.6.5.2.1), ~~and~~ ATS (8.6.5.2.2), and CI (8.6.5.2.3), as detailed in Table 12-34. Tables can be created or removed dynamically in implementations that support dynamic configuration of Bridge components.

Table 12-34—The Stream Parameter Table

Name	Data type	Operations supported[a]	Conformance[b]	References
MaxStreamFilterInstances	integer	R	PSFP, ATS, CI	8.6.5.3, 12.31.2
MaxStreamGateInstances	integer	R	PSFP, ATS, CI	8.6.5.4, 12.31.3
MaxFlowMeterInstances	integer	R	PSFP, ats	8.6.5.5, 12.31.4
SupportedListMax	integer	R	PSFP, ats	8.6.5.4, 12.31.4
MaxSchedulerInstances	integer	R	psfp, ATS	8.6.5.4, 12.31.4
MaxSchedulerGroupInstances	integer	R	psfp, ATS	8.6.5.4, 12.31.4

[a] R= Read only access; RW = Read/Write access.
[b] PSFP = Required for Bridge, Bridge component, or end station support of PSFP.
psfp = Optional for Bridge, Bridge component, or end station support of PSFP.
ATS = Required for Bridge or Bridge component support of ATS.
ats = Optional for Bridge or Bridge component support of ATS.
CI = Required for Bridge or Bridge component support of CI.

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12.31.2 The Stream Filter Instance Table

Change Table 12-35 as follows:

Table 12-35—Stream Filter Instance Table

Name	Data type	Operations supported[a]	Conformance[b]	References
StreamFilterInstance	integer	R	PSFP, ATS, CI	8.6.5.3
StreamHandleSpec	stream_handle specification	RW	PSFP, ATS, CI	8.6.5.3
PrioritySpec	priority specification	RW	PSFP, ATS, CI	8.6.5.3
MaximumSDUSize	integer	RW	PSFP, ATS	8.6.5.3.1, 12.31.2.5
StreamGateInstanceID	integer	RW	PSFP, ATS, CI	8.6.5.2, 8.6.5.4
FlowMeterInstanceID	integer	RW	PSFP, ats	8.6.5.5, 12.31.2.5
FlowMeterEnable	Boolean	RW	PSFP, ats	
SchedulerInstanceID	integer	RW	psfp, ATS	
SchedulerEnable	Boolean	RW	psfp, ATS	
MatchingFramesCount	counter	R	PSFP, ats, ci	8.6.5.3
PassingFramesCount	counter	R	PSFP, ats	8.6.5.3, 8.6.5.4
NotPassingFramesCount	counter	R	PSFP, ats	8.6.5.3, 8.6.5.4
PassingSDUCount	counter	R	PSFP, ats	8.6.5.3, 8.6.5.3.1
NotPassingSDUCount	counter	R	PSFP, ats	8.6.5.3, 8.6.5.3.1
REDFramesCount	counter	R	PSFP, ats	8.6.5.3
StreamBlockedDueToOversizeFrameEnable	Boolean	RW	PSFP, ATS	8.6.5.3, 8.6.5.3.1
StreamBlockedDueToOversizeFrame	Boolean	RW	PSFP, ATS	8.6.5.3, 8.6.5.3.1

[a] R= Read only access; RW = Read/Write access.

[b] PSFP = Required for Bridge, Bridge component, or end station support of PSFP.
psfp = Optional for Bridge, Bridge component, or end station support of PSFP.
ATS = Required for Bridge or Bridge component support of ATS.
ats = Optional for Bridge or Bridge component support of ATS.
CI = Required for Bridge component or end station support of CI.
ci = Optional for Bridge component or end station support of CI.

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12.31.2.2 stream_handle specification data type

Change 12.31.2.2 as follows:

The stream_handle specification data type allows either of the following to be represented:

a) A stream_handle value, represented as an integer
b) The wild card value
c) If congestion isolation is supported, the null-handle value.

12.31.3 The Stream Gate Instance Table

Change Table 12-36 as follows:

Table 12-36—The Stream Gate Instance Table

Name	Data type	Operations supported[a]	Conformance[b]	References
StreamGateInstance	integer	R	PSFP, ATS, CI	8.6.5.4
StreamGateEnabled	Boolean	RW	PSFP, ATS, CI	8.6.9.4.14
StreamGateAdminGateStates	StreamGateStatesValue	RW	PSFP, ATS, CI	8.6.10.4, 12.29.1.2.2
StreamGateOperGateStates	StreamGateStatesValue	R	PSFP, ATS, CI	8.6.10.5, 12.29.1.2.2
StreamGateAdminControlListLength	unsigned integer	RW	PSFP, ats	8.6.9.4.6, 12.31.3.2
StreamGateOperControlListLength	unsigned integer	R	PSFP, ats	8.6.9.4.22, 12.31.3.2
StreamGateAdminControlList	sequence of StreamGateGateControl Entry	RW	PSFP, ats	8.6.9.4.2, 12.31.3.2, 12.31.3.2.2
StreamGateOperControlList	sequence of StreamGateGateControl Entry	R	PSFP, ats	8.6.9.4.18, 12.31.3.2, 12.31.3.2.2
StreamGateAdminCycleTime	RationalNumber	RW	PSFP, ats	8.6.9.4.3, 12.29.1.3
StreamGateOperCycleTime	RationalNumber (seconds)	R	PSFP, ats	8.6.9.4.19, 12.29.1.3
StreamGateAdminCycleTime Extension	Integer (nanoseconds)	RW	PSFP, ats	8.6.9.4.4
StreamGateOperCycleTimeExtension	Integer (nanoseconds)	R	PSFP, ats	8.6.9.4.20
StreamGateAdminBaseTime	PTPtime	RW	PSFP, ats	8.6.9.4.1, 12.29.1.4
StreamGateOperBaseTime	PTPtime	R	PSFP, ats	8.6.9.4.17, 12.29.1.4
StreamGateConfigChange	Boolean	RW	PSFP, ats	8.6.9.4.7
StreamGateConfigChangeTime	PTPtime	R	PSFP, ats	8.6.9.4.9, 12.29.1.4

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Table 12-36—The Stream Gate Instance Table *(continued)*

Name	Data type	Operations supported[a]	Conformance[b]	References
StreamGateTickGranularity	Integer (tenths of nanoseconds)	R	PSFP, ats	8.6.9.4.16
StreamGateCurrentTime	PTPtime	R	PSFP, ats	8.6.9.4.10, 12.29.1.4
StreamGateConfigPending	Boolean	R	PSFP, ats	8.6.9.3, 8.6.9.4.8
StreamGateConfigChangeError	Integer	R	PSFP, ats	8.6.9.3.1
StreamGateAdminIPV	IPV	RW	PSFP, ATS, CI	8.6.5.4, 8.6.10.6, 12.31.3.3
StreamGateOperIPV	IPV	RW	PSFP, ats, CI	8.6.5.4, 8.6.10.7, 12.31.3.3
StreamGateGateClosedDueToInvalidRx-Enable	Boolean	RW	PSFP, ats	8.6.5.4
StreamGateGateClosedDueToInvalidRx	Boolean	RW	PSFP, ats	8.6.5.4
StreamGateGateClosedDueToOctetsExceededEnable	Boolean	RW	PSFP, ats	8.6.5.4
StreamGateGateClosedDueToOctetsExceeded	Boolean	RW	PSFP, ats	8.6.5.4

[a] R= Read only access; RW = Read/Write access.
[b] PSFP = Required for Bridge, Bridge component, or end station support of PSFP.
psfp = Optional for Bridge, Bridge component, or end station support of PSFP.
ATS = Required for Bridge or Bridge component support of ATS.
ats = Optional for Bridge or Bridge component support of ATS.
CI = Required for Bridge component or end station support of CI.

Insert 12.33 at the end of Clause 12 as follows:

12.33 Congestion Isolation managed objects

Several variables control the operation of Congestion Isolation in a congestion isolation aware Bridge. The managed objects are as follows:

a) CI entity managed object (12.33.1)
b) CI Peer Table (12.33.2)
c) CI Stream Table (12.33.3)
d) CIP entity managed object (12.33.4)

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12.33.1 CI entity managed object

A single instance of the CI entity managed object shall be implemented by a Bridge component or end station that is congestion isolation aware. It comprises all the variables included in the CI entity variables (49.4.1.1) as illustrated in Table 12-42.

Table 12-42—CI entity managed object

Name	Data type	Operations supported[a]	Conformance[b]	References
ciMasterEnable	Boolean	RW	CI	49.4.1.1.1
ciCIMTransmitPriority	unsigned integer [0..7]	R	CI	49.4.1.1.2
ciMaxFlowLife	unsigned integer	R	CI	49.4.1.1.3

[a] R= Read only access; RW = Read/Write access.
[b] CI = Required for Bridge component or end station support of CI.

12.33.2 CI Peer Table

A single instance of the CI Peer Table shall be implemented by a Bridge component or end station that is congestion isolation aware. Each table row contains the parameters needed to assist in the creation of a CIM as illustrated in Table 12-43. There is a row in the table for each port of the Bridge or router that is supporting congestion isolation.

Table 12-43—CI Peer Table entry

Name	Data type	Operations supported[a]	Conformance	References
ciCIMtype	enum{l2, ipv4, ipv6}	R		49.3.6
ciPeerMacAddress	MAC address	R		49.3.6
ciPeerIPv4Address	IPv4 address	R	IETF RFC 791	49.3.6
ciPeerIPv6Address	IPv6 address	R	IETF RFC 8200	49.3.6
ciPeerUDPPort	UDP Port Number	R	IETF RFC 768	49.3.6
ciPeerCIMEncapLen	integer [0..512]	R		49.3.6

[a] R= Read only access; RW = Read/Write access.

12.33.3 CI Stream Table

A single instance of the CI Stream Table (49.3.7) shall be implemented by a Bridge component or end station that is congestion isolation aware. Each table row contains stream management variables associated with a tsnStreamIdEntry object created in the IEEE Std 802.1CB Stream identity table. The variables assist in the processes associated with the isolating and de-isolating of congesting flows. There is a row in the table for each congesting flow as illustrated in Table 12-44.

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Table 12-44—CI Stream Table entry

Name	Data type	Operations supported[a]	Conformance[b]	References
ciStreamIdHandle	stream_handle value	R	IEEE Std 802.1CB	49.4.1.5.1
ciCIMCount	integer	RW	CI	49.4.1.5.2
ciCreateTime	sysUpTime (IETF RFC 3418)	R	IETF RFC 3418	49.4.1.5.3
ciStreamCreateMask	2-bit mask	RW	CI	49.4.1.5.4
ciQueueKey	integer	R	CI	49.4.1.5.5
ciDestination_address	MAC address	R	CI	49.4.1.5.6
ciSource_address	MAC address	R	CI	49.4.1.5.7
ciVlan_identifier	12-bit VID	R	CI	49.4.1.5.8
ciMsdu	octet string (size 64..512)	R	CI	49.4.1.5.9

[a] R= Read only access; RW = Read/Write access.
[b] CI = Required for Bridge component or end station support of CI.

12.33.4 CIP entity managed object

There is one Congestion Isolation Point (CIP) managed object for each CIP in a Bridge component or end station that is congestion isolation aware. The CIP managed object comprises some of the variables included in the CIP variables (49.4.1.2) as illustrated in Table 12-45.

Table 12-45—CIP entity managed object

Name	Data type	Operations supported[a]	Conformance[b]	References
cipMacAddress	MAC address	R	CI	49.4.1.2.1
cipIPv4Address	IPv4 address	R	IETF RFC 791	49.4.1.2.2
cipIPv6Address	IPv6 address	R	IETF RFC 8200	49.4.1.2.3
cipCIMUDPPort	UDP Port Number	R	IETF RFC 768	49.4.1.2.4
cipQueueMap[]	array of integers [–8..8]	RW	CI	49.4.1.2.5
cipMinHeaderOctets	integer	RW	CI	49.4.1.2.6
cipMaxCIM	integer	RW	CI	49.4.1.2.7

[a] R= Read only access; RW = Read/Write access.
[b] CI = Required for Bridge component or end station support of CI.

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30. Principles of congestion notification

30.1 Congestion notification design requirements

Change item x) in the lettered list in 30.1 as follows:

x) QCN cannot regulate frame transmission by acknowledgments, as does Transmission Control Protocol/Internet Protocol (TCP/IP), see IETF RFC 791 ~~[B18]~~ and IETF RFC 793 [B19].

30.3 Congestion Controlled Flow (CCF)

Change item a) in the lettered list in 30.3 as follows:

a) The frames carrying data for a single User Datagram Protocol (UDP, IETF RFC 768, STD0006 ~~[B17]~~) connection.

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46. Time-Sensitive Networking (TSN) configuration

46.2 User/network configuration information

46.2.1 Data types

Change the lettered list in 46.2.1 as follows:

a) Boolean
b) int8, for a signed 8-bit integer
c) int16, for a signed 16-bit integer
d) int32, for a signed 32-bit integer
e) uint8, for an unsigned 8-bit integer
f) uint16, for an unsigned 16-bit integer
g) uint32, for an unsigned 32-bit integer
h) string
i) enumeration, for a collection of named values
j) rational, for a rational number consisting of a uint32 numerator and uint32 denominator
k) mac-address-type, for an IEEE 802 MAC address
l) ipv4-address-type, for an IPv4 address (IETF RFC 791~~[B18]~~)
m) ipv6-address-type, for an IPv6 address (IETF RFC 8200~~[B46]~~)
n) sequence of <X>, for a list of zero or more instances of data type <X> (e.g., sequence of uint32)

46.2.3 Talker

46.2.3.4 DataFrameSpecification

46.2.3.4.4 IPv6-tuple

Change the first sentence in 46.2.3.4.4 as follows:

The IPv6-tuple group specifies fields to identify an IPv6 (RFC 8200~~[B46]~~) Stream.

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48. YANG Data Models

48.2 IEEE 802.1Q YANG models

Insert 48.2.8 (including Figure 48-17) after 48.2.7 as follows:

48.2.8 Congestion Isolation (CI) model

The CI model augments the Bridge component model (48.2.1) and the Interface Management model for Bridge ports (48.3.1) by nodes that represent the following managed objects:

a) CI entity managed object (12.33.1)
b) CI Peer Table (12.33.2)
c) CI Stream Table (12.33.3)
d) CIP entity managed object (12.33.4)

The UML representation of the CI model is illustrated in Figure 48-17.

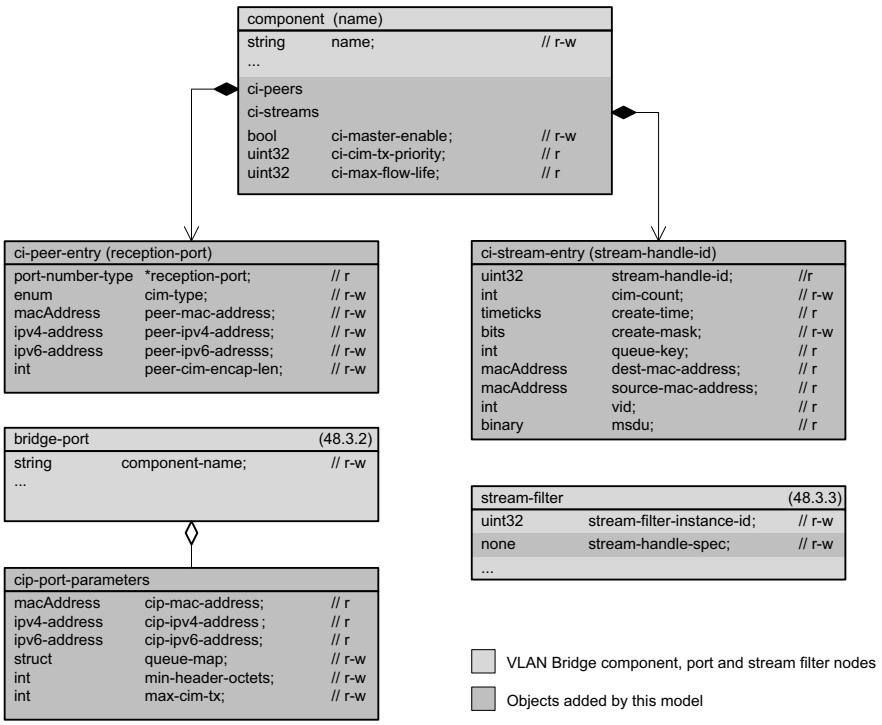


Figure 48-17—Congestion Isolation model

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48.3 Structure of the YANG models

Insert a new row for "ieee802-dot1q-stream-filters-gates-bridge" above the row for "ieee802-dot1q-ats", change the row for "ieee802-dot1q-ats", and insert three new rows below it in Table 48-1 as follows (unchanged rows not shown):

Table 48-1—Summary of the YANG modules

Module	References	Managed functionality	Initial YANG specification Notes
ieee802-dot1q-stream-filters-gates-bridge	48.5.12, 48.6.12	8.6, 8.6.5.3, 8.6.5.4	IEEE Std 802.1Qcz Bridge component augmentation with stream filtering and stream gating capabilities.
ieee802-dot1q-ats	~~48.5.12, 48.6.12~~ 48.5.13, 48.6.13	8.6	IEEE Std 802.1Qcr ATS extensions to ieee802-dot1q-stream-filters-gates and ieee802-dot1q-bridge modules.
ieee802-dot1q-ats-bridge	48.5.14, 48.6.14	8.6	IEEE Std 802.1Qcz Bridge component augmentation with ATS module.
ieee802-dot1q-congestion-isolation	48.5.15, 48.6.15	8.6.5, Clause 49	IEEE Std 802.1Qcz Congestion isolation specific parameters and extensions to the ieee802-dot1q-stream-filters-gates.
ieee802-dot1q-congestion-isolation-bridge	48.5.16, 48.6.16	8.6.5, Clause 49	IEEE Std 802.1Qcz Bridge and Bridge Port extension/augmentation with congestion isolation module.

48.3.7 Asynchronous Traffic Shaping (ATS) model

Change Table 48-7 and Table 48-8 as follows:

Table 48-7—Stream filters and stream gates model YANG modules

YANG module
ieee802-types
ieee802-dot1q-types
ieee802-dot1q-bridge
ieee802-dot1q-stream-filters-gates
ieee802-dot1q-stream-filters-gates-bridge

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Table 48-8—ATS model YANG modules

YANG module
ieee802-types
ieee802-dot1q-types
ieee802-dot1q-bridge
ieee802-dot1q-stream-filters-gates
ieee802-dot1q-ats
ieee802-dot1q-ats-bridge

Insert 48.3.8 (including Table 48-9) after 48.3.7 as follows:

48.3.8 Congestion Isolation (CI) model

A system implementing the CI model (48.3.8) implements the YANG modules in Table 48-9.

Table 48-9—CI model YANG modules

YANG module
ieee802-types
ieee802-dot1q-types
ieee802-dot1q-bridge
ieee802-dot1q-stream-filter-gates
ieee802-dot1q-congestion-isolation
ieee802-dot1q-congestion-isolation-bridge

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48.4 Security considerations

Insert 48.4.8 after 48.4.7 as follows:

48.4.8 Security considerations of the Congestion Isolation model

There are a number of management objects defined in the ieee802-dot1q-congestion-isolation YANG module that are configurable (i.e., read-write) and/or operational (i.e., read-only). Such objects may be considered sensitive or vulnerable in some network environments. A network configuration protocol, such as NETCONF (IETF RFC 6241 [B41]), can support protocol operations that can edit or delete YANG module configuration data (e.g., edit-config, delete-config, copy-config). If this is done in a non-secure environment without proper protection, then negative effects on the network operation are possible.

The following objects in the ieee802-dot1q-congestion-isolation YANG module could be manipulated to interfere with the operation of MAC status propagation on a TPMR port and, for example, be used to cause network instability:

bridges/bridge/component/ci-master-enable

bridges/bridge/component/ci-peers/ci-peer-table

bridges/bridge/component/ci-streams

bridges/bridge/component/stream-gates/stream-gate-instance-table

bridges/bridge/component/stream-filters/stream-filter-instance-table

bridges/bridge/component/queue-map

bridges/bridge/component/min-header-octets

bridges/bridge/component/min-cim-tx

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48.5 YANG schema tree definitions

48.5.11 Schema for the ieee802-dot1q-stream-filters-gates YANG module

Change 48.5.11 as follows:

This YANG module does not have a YANG schema tree.

~~module: ieee802-dot1q-stream-filters-gates~~

~~augment /dot1q:bridges/dot1q:bridge/dot1q:component:~~
~~+--rw stream-filters~~
~~| +--rw stream-filter-instance-table* [stream-filter-instance-id]~~
~~| | +--rw stream-filter-instance-id uint32~~
~~| | +--rw (stream-handle-spec)?~~
~~| | | +--:(wildcard)~~
~~| | | | +--rw wildcard? empty~~
~~| | | +--:(stream-handle)~~
~~| | | +--rw stream-handle uint32~~
~~| | +--rw priority-spec priority-spec-type~~
~~| | +--rw max-sdu-size uint32~~
~~| | +--rw stream-blocked-due-to-oversize-frame-enabled? boolean~~
~~| | +--rw stream-blocked-due-to-oversize-frame? boolean~~
~~| | +--rw stream-gate-ref stream-gate-ref~~
~~| +--ro max-stream-filter-instances? uint32~~
~~+--rw stream-gates~~
~~+--rw stream-gate-instance-table* [stream-gate-instance-id]~~
~~| +--rw stream-gate-instance-id uint32~~
~~| +--rw gate-enable? boolean~~
~~| +--rw admin-gate-states? gate-state-value-type~~
~~| +--rw admin-ipv? ipv-spec-type~~
~~+--ro max-stream-gate-instances? uint32~~

Delete the existing 48.5.12 “Schema for the ieee802-dot1q-ats YANG module”.

Insert new 48.5.12 “Schema for the ieee802-dot1q-stream-filters-gates-bridge YANG module” after 48.5.11 as follows:

48.5.12 Schema for the ieee802-dot1q-stream-filters-gates-bridge YANG module

```
module: ieee802-dot1q-stream-filters-gates-bridge

  augment /dot1q:bridges/dot1q:bridge/dot1q:component:
    +--rw stream-gates
    |  +--rw stream-gate-instance-table* [stream-gate-instance-id]
    |  |  +--rw stream-gate-instance-id    uint32
    |  |  +--rw gate-enable?               boolean
    |  |  +--rw admin-gate-states?         gate-state-value-type
    |  |  +--rw admin-ipv?                 ipv-spec-type
    |  +--ro max-stream-gate-instances?    uint32
    +--rw stream-filters
       +--rw stream-filter-instance-table* [stream-filter-instance-id]
       |  +--rw stream-filter-instance-id                       uint32
       |  +--rw (stream-handle-spec)?
       |  |  +--:(wildcard)
       |  |  |  +--rw wildcard?                                 empty
       |  |  +--:(stream-handle)
       |  |     +--rw stream-handle                             uint32
       |  +--rw priority-spec
       |  |       priority-spec-type
       |  +--rw max-sdu-size                                    uint32
       |  +--rw stream-blocked-due-to-oversize-frame-enabled?   boolean
       |  +--rw stream-blocked-due-to-oversize-frame?           boolean
       |  +--rw stream-gate-ref                                 leafref
       +--ro max-stream-filter-instances?    uint32
```


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Insert new 48.5.13, 48.5.14, 48.5.15, and 48.5.16 after 48.5.12 as follows:

48.5.13 Schema for the ieee802-dot1q-ats YANG module

```
module: ieee802-dot1q-ats
  +--rw stream-gates
  |  +--rw stream-gate-instance-table* [stream-gate-instance-id]
  |  |  +--rw stream-gate-instance-id    uint32
  |  |  +--rw gate-enable?               boolean
  |  |  +--rw admin-gate-states?         gate-state-value-type
  |  |  +--rw admin-ipv?                 ipv-spec-type
  |  +--ro max-stream-gate-instances?    uint32
  +--rw stream-filters
     +--rw stream-filter-instance-table* [stream-filter-instance-id]
     |  +--rw stream-filter-instance-id                       uint32
     |  +--rw (stream-handle-spec)?
     |  |  +--:(wildcard)
     |  |  |  +--rw wildcard?                                 empty
     |  |  +--:(stream-handle)
     |  |     +--rw stream-handle                             uint32
     |  +--rw priority-spec
     |  |       priority-spec-type
     |  +--rw max-sdu-size                                    uint32
     |  +--rw stream-blocked-due-to-oversize-frame-enabled?   boolean
     |  +--rw stream-blocked-due-to-oversize-frame?           boolean
     |  +--rw stream-gate-ref                                 leafref
     |  +--rw schedulers
     |  |  +--rw scheduler-instance-table* [scheduler-instance-id]
     |  |  |  +--rw scheduler-instance-id         uint32
     |  |  |  +--rw committed-information-rate    uint64
     |  |  |  +--rw committed-burst-size          uint32
     |  |  |  +--rw scheduler-group-ref           leafref
     |  |  +--ro max-scheduler-instances?    uint32
     |  +--rw scheduler-groups
     |  |  +--rw scheduler-group-instance-table*
     |  |  |       [scheduler-group-instance-id]
     |  |  |  +--rw scheduler-group-instance-id    uint32
     |  |  |  +--rw max-residence-time             uint32
     |  |  +--ro max-scheduler-group-instances?      uint32
     |  |  +--rw scheduler-timing-characteristics
     |  |     +--ro scheduler-timing-characteristics-table*
     |  |              [reception-port transmission-port]
     |  |        +--ro reception-port
     |  |        |       dot1qtypes:port-number-type
     |  |        +--ro transmission-port
     |  |        |       dot1qtypes:port-number-type
     |  |        +--ro clock-offset-variation-max       uint32
     |  |        +--ro clock-rate-deviation-max         uint32
     |  |        +--ro arrival-recognition-delay-max    uint32
     |  |        +--ro processing-delay-min             uint32
     |  |        +--ro processing-delay-max             uint32
     |  +--rw scheduler
     |     +--rw scheduler-ref?      leafref
     |     +--rw scheduler-enable?   boolean
     +--ro max-stream-filter-instances?    uint32
```

48.5.14 Schema for the ieee802-dot1q-ats-bridge YANG module

```
module: ieee802-dot1q-ats-bridge

  augment /if:interfaces/if:interface/dot1q:bridge-port:
    +--ro discarded-frames-count?   yang:counter64
  augment /dot1q:bridges/dot1q:bridge/dot1q:component:
    +--rw stream-gates
    |  +--rw stream-gate-instance-table* [stream-gate-instance-id]
    |  |  +--rw stream-gate-instance-id    uint32
    |  |  +--rw gate-enable?               boolean
    |  |  +--rw admin-gate-states?         gate-state-value-type
    |  |  +--rw admin-ipv?                 ipv-spec-type
    |  +--ro max-stream-gate-instances?    uint32
    +--rw stream-filters
```


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```
      +--rw stream-filter-instance-table* [stream-filter-instance-id]
      |  +--rw stream-filter-instance-id                        uint32
      |  +--rw (stream-handle-spec)?
      |  |  +--:(wildcard)
      |  |  |  +--rw wildcard?                                  empty
      |  |  +--:(stream-handle)
      |  |     +--rw stream-handle                              uint32
      |  +--rw priority-spec
      |  |       priority-spec-type
      |  +--rw max-sdu-size                                     uint32
      |  +--rw stream-blocked-due-to-oversize-frame-enabled?    boolean
      |  +--rw stream-blocked-due-to-oversize-frame?            boolean
      |  +--rw stream-gate-ref                                  leafref
      |  +--rw schedulers
      |  |  +--rw scheduler-instance-table* [scheduler-instance-id]
      |  |  |  +--rw scheduler-instance-id         uint32
      |  |  |  +--rw committed-information-rate    uint64
      |  |  |  +--rw committed-burst-size          uint32
      |  |  |  +--rw scheduler-group-ref           leafref
      |  |  +--ro max-scheduler-instances?    uint32
      |  +--rw scheduler-groups
      |  |  +--rw scheduler-group-instance-table*
      |  |  |       [scheduler-group-instance-id]
      |  |  |  +--rw scheduler-group-instance-id    uint32
      |  |  |  +--rw max-residence-time             uint32
      |  |  +--ro max-scheduler-group-instances?      uint32
      |  |  +--rw scheduler-timing-characteristics
      |  |     +--ro scheduler-timing-characteristics-table*
      |  |             [reception-port transmission-port]
      |  |        +--ro reception-port
      |  |        |       dot1qtypes:port-number-type
      |  |        +--ro transmission-port
      |  |        |       dot1qtypes:port-number-type
      |  |        +--ro clock-offset-variation-max       uint32
      |  |        +--ro clock-rate-deviation-max         uint32
      |  |        +--ro arrival-recognition-delay-max    uint32
      |  |        +--ro processing-delay-min             uint32
      |  |        +--ro processing-delay-max             uint32
      |  +--rw scheduler
      |     +--rw scheduler-ref?      leafref
      |     +--rw scheduler-enable?   boolean
      +--ro max-stream-filter-instances?    uint32
```

48.5.15 Schema for the ieee802-dot1q-congestion-isolation YANG module

```
module: ieee802-dot1q-congestion-isolation
  +--rw stream-gates
  |  +--rw stream-gate-instance-table* [stream-gate-instance-id]
  |  |  +--rw stream-gate-instance-id    uint32
  |  |  +--rw gate-enable?               boolean
  |  |  +--rw admin-gate-states?         gate-state-value-type
  |  |  +--rw admin-ipv?                 ipv-spec-type
  |  +--ro max-stream-gate-instances?    uint32
  +--rw stream-filters
     +--rw stream-filter-instance-table* [stream-filter-instance-id]
     |  +--rw stream-filter-instance-id                        uint32
     |  +--rw (stream-handle-spec)?
     |  |  +--:(wildcard)
     |  |  |  +--rw wildcard?                                  empty
     |  |  +--:(stream-handle)
     |  |  |  +--rw stream-handle                              uint32
     |  |  +--:(null-handle) {congestion-isolation}?
     |  |     +--rw null-handle?                               empty
     |  +--rw priority-spec
     |  |       priority-spec-type
     |  +--rw max-sdu-size                                     uint32
     |  +--rw stream-blocked-due-to-oversize-frame-enabled?    boolean
     |  +--rw stream-blocked-due-to-oversize-frame?            boolean
     |  +--rw stream-gate-ref                                  leafref
     +--ro max-stream-filter-instances?    uint32
```


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48.5.16 Schema for the ieee802-dot1q-congestion-isolation-bridge YANG module

```
module: ieee802-dot1q-congestion-isolation-bridge

  augment /dot1q:bridges/dot1q:bridge/dot1q:component:
    +--rw ci-master-enable?        boolean {congestion-isolation-bridge}?
    +--ro ci-cim-tx-priority?      dot1q-types:priority-type
    |       {congestion-isolation-bridge}?
    +--ro ci-max-flow-life?        uint32 {congestion-isolation-bridge}?
    +--rw ci-peers {congestion-isolation-bridge}?
    |  +--rw ci-peer-table* [reception-port]
    |  |  +--rw reception-port        dot1q-types:port-number-type
    |  |  +--rw cim-type?             enumeration
    |  |  +--rw peer-mac-address?     ieee:mac-address
    |  |  +--rw peer-ipv4-address?    inet:ipv4-address
    |  |  +--rw peer-ipv6-address?    inet:ipv6-address
    |  |  +--rw peer-udp-port?        inet:port-number
    |  |  +--rw peer-cim-encap-len?   uint16
    |  +--ro max-ci-peer-entries?   uint32
    +--rw ci-streams {congestion-isolation-bridge}?
    |  +--ro ci-stream-table* [stream-handle-id]
    |  |  +--ro stream-handle-id    uint32
    |  |  +--ro cim-count?          uint16
    |  |  +--ro create-time?        yang:timeticks
    |  |  +--ro create-mask?        bits
    |  +--ro queue-key?             uint16
    |  +--ro dest-mac-address?      ieee:mac-address
    |  +--ro source-mac-address?    ieee:mac-address
    |  +--ro vid?                   dot1q-types:vlan-index-type
    |  +--ro msdu?                  yang:hex-string
    +--ro max-ci-stream-entries?   uint32 {congestion-isolation-bridge}?
    +--rw stream-gates {congestion-isolation-bridge}?
    |  +--rw stream-gate-instance-table* [stream-gate-instance-id]
    |  |  +--rw stream-gate-instance-id    uint32
    |  |  +--rw gate-enable?               boolean
    |  |  +--rw admin-gate-states?         gate-state-value-type
    |  |  +--rw admin-ipv?                 ipv-spec-type
    |  +--ro max-stream-gate-instances?    uint32
    +--rw stream-filters {congestion-isolation-bridge}?
       +--rw stream-filter-instance-table* [stream-filter-instance-id]
       |  +--rw stream-filter-instance-id                        uint32
       |  +--rw (stream-handle-spec)?
       |  |  +--:(wildcard)
       |  |  |  +--rw wildcard?                                  empty
       |  |  +--:(stream-handle)
       |  |  |  +--rw stream-handle                              uint32
       |  |  +--:(null-handle) {congestion-isolation-bridge}?
       |  |     +--rw null-handle?                               empty
       |  +--rw priority-spec
       |  |       priority-spec-type
       |  +--rw max-sdu-size                                     uint32
       |  +--rw stream-blocked-due-to-oversize-frame-enabled?    boolean
       |  +--rw stream-blocked-due-to-oversize-frame?            boolean
       |  +--rw stream-gate-ref                                  leafref
       +--ro max-stream-filter-instances?    uint32
  augment /if:interfaces/if:interface/dot1q:bridge-port:
    +--ro cip-mac-address?     ieee:mac-address
    |       {congestion-isolation-bridge}?
    +--ro cip-ipv4-address?    inet:ipv4-address
    |       {congestion-isolation-bridge}?
    +--ro cip-ipv6-address?    inet:ipv6-address
    |       {congestion-isolation-bridge}?
    +--ro cip-cim-port?        inet:port-number
    |       {congestion-isolation-bridge}?
    +--rw queue-map* [priority] {congestion-isolation-bridge}?
    |  +--rw priority                      dot1q-types:priority-type
    |  +--rw abs-traffic-class-plus-one?
    |          abs-traffic-class-plus-one-type
    +--rw min-header-octets?   uint16 {congestion-isolation-bridge}?
    +--rw max-cim-tx?          uint16 {congestion-isolation-bridge}?
```


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48.6 YANG modules[10] [11] [12]

48.6.2 The ieee802-dot1q-types YANG module

Delete the YANG module in 48.6.2.

Insert the following YANG module in 48.6.2:

```
module ieee802-dot1q-types {
  namespace urn:ieee:std:802.1Q:yang:ieee802-dot1q-types;
  prefix dot1q-types;
  import ietf-yang-types {
    prefix yang;
  }
  organization
    "IEEE 802.1 Working Group";
  contact
    "WG-URL: http://ieee802.org/1/
    WG-EMail: stds-802-1-l@ieee.org

    Contact: IEEE 802.1 Working Group Chair
    Postal: C/O IEEE 802.1 Working Group
    IEEE Standards Association
    445 Hoes Lane
    Piscataway, NJ 08854
    USA

    E-mail: stds-802-1-chairs@ieee.org";
  description
    "Common types used within dot1Q-bridge modules.

    References in this YANG module to IEEE Std 802.1Q are to IEEE Std
    802.1Q-2022 as amended by IEEE Std 802.1Qcz-2023.

    Copyright (C) IEEE (2023).

    This version of this YANG module is part of IEEE Std 802.1Q; see the
    standard itself for full legal notices.";
  revision 2023-07-03 {
    description
      "Published as part of IEEE Std 802.1Qcz-2023.";
    reference
      "IEEE Std 802.1Qcz-2023, Bridges and Bridged Networks - Congestion
      Isolation.";
  }
  revision 2022-10-29 {
    description
      "Published as part of IEEE Std 802.1Q-2022.";
    reference
      "IEEE Std 802.1Q-2022, Bridges and Bridged Networks.";
  }
  revision 2020-06-04 {
    description
      "Published as part of IEEE Std 802.1Qcx-2020.";
    reference
      "IEEE Std 802.1Qcx-2020, Bridges and Bridged Networks - YANG Data
      Model for Connectivity Fault Management.";
  }
  revision 2018-03-07 {
    description
      "Published as part of IEEE Std 802.1Q-2018.";
```

[10] Copyright release for YANG: Users of this standard may freely reproduce the YANG modules contained in this standard so that they can be used for their intended purpose.

[11] An ASCII version of each YANG module is attached to the PDF of this standard and can also be obtained from the IEEE 802.1 Website at https://1.ieee802.org/yang-modules/.

[12] References in this standard's YANG module definitions are not clickable, as each module has been incorporated unchanged after development and verification using YANG tools.

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```
  reference
    "IEEE Std 802.1Q-2018, Bridges and Bridged Networks.";
}
identity dot1q-vlan-type {
  description
    "Base identity from which all 802.1Q VLAN tag types are derived
    from.";
}
identity c-vlan {
  base dot1q-vlan-type;
  description
    "An 802.1Q Customer VLAN, using the 81-00 EtherType.";
  reference
    "5.5 of IEEE Std 802.1Q";
}
identity s-vlan {
  base dot1q-vlan-type;
  description
    "An 802.1Q Service VLAN, using the 88-A8 EtherType originally
    introduced in 802.1ad, and incorporated into 802.1Q (2011)";
  reference
    "5.6 of IEEE Std 802.1Q";
}
identity transmission-selection-algorithm {
  description
    "Specify the transmission selection algorithms of IEEE Std
    802.1Q Table 8-6";
}
identity strict-priority {
  base transmission-selection-algorithm;
  description
    "Indicates the strict priority transmission selection algorithm.";
  reference
    "Table 8-6 of IEEE Std 802.1Q";
}
identity credit-based-shaper {
  base transmission-selection-algorithm;
  description
    "Indicates the credit based shaper transmission selection
    algorithm.";
  reference
    "Table 8-6 of IEEE Std 802.1Q";
}
identity enhanced-transmission-selection {
  base transmission-selection-algorithm;
  description
    "Indicates the enhanced transmission selection algorithm.";
  reference
    "Table 8-6 of IEEE Std 802.1Q";
}
identity asynchronous-traffic-shaping {
  base transmission-selection-algorithm;
  description
    "Indicates the asynchronous transmission selection algorithm.";
  reference
    "Table 8-6 of IEEE Std 802.1Q";
}
identity vendor-specific {
  base transmission-selection-algorithm;
  description
    "Indicates a vendor specific transmission selection algorithm.";
  reference
    "Table 8-6 of IEEE Std 802.1Q";
}
typedef name-type {
  type string {
    length "0..32";
  }
  description
    "A text string of up to 32 characters, of locally determined
    significance.";
}
```


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```
typedef port-number-type {
  type uint32 {
    range "1..4095";
  }
  description
    "The port number of the Bridge port for which this entry contains
    Bridge management information.";
}
typedef priority-type {
  type uint8 {
    range "0..7";
  }
  description
    "A range of priorities from 0 to 7 (inclusive). The Priority Code
    Point (PCP) is a 3-bit field that refers to the class of service
    associated with an 802.1Q VLAN tagged frame. The field specifies a
    priority value between 0 and 7, these values can be used by quality
    of service (QoS) to prioritize different classes of traffic.";
}
typedef num-traffic-class-type {
  type uint8 {
    range "1..8";
  }
  description
    "The number of traffic classes supported or participating in a
    particular feature. There are between 1 and 8 supported traffic
    classes defined by IEEE Std 802.1Q.";
}
typedef vid-range-type {
  type string {
    pattern
      "([1-9]"+
      "[0-9]{0,3}"+
      "(-[1-9][0-9]{0,3})?"+
      "(,[1-9][0-9]{0,3}(-[1-9][0-9]{0,3})?)*)";
  }
  description
    "A list of VLAN Ids, or non overlapping VLAN ranges, in ascending
    order, between 1 and 4094.

    This type is used to match an ordered list of VLAN Ids, or
    contiguous ranges of VLAN Ids. Valid VLAN Ids must be in the range
    1 to 4094, and included in the list in non overlapping ascending
    order.

    For example: 1,10-100,250,500-1000";
}
typedef vlanid {
  type uint16 {
    range "1..4094";
  }
  description
    "The vlanid type uniquely identifies a VLAN. This is the 12-bit
    VLAN-ID used in the VLAN Tag header. The range is defined by the
    referenced specification. This type is in the value set and its
    semantics equivalent to the VlanId textual convention of the SMIv2.";
}
typedef vlan-index-type {
  type uint32 {
    range "1..4094 | 4096..4294967295";
  }
  description
    "A value used to index per-VLAN tables. Values of 0 and 4095 are
    not permitted. The range of valid VLAN indices. If the value is
    greater than 4095, then it represents a VLAN with scope local to
    the particular agent, i.e., one without a global VLAN-ID assigned
    to it. Such VLANs are outside the scope of IEEE 802.1Q, but it is
    convenient to be able to manage them in the same way using this
    YANG module.";
  reference
    "9.6 of IEEE Std 802.1Q";
}
```


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```
typedef mstid-type {
  type uint32 {
    range "1..4094";
  }
  description
    "In an MSTP Bridge, an MSTID, i.e., a value used to identify a
    spanning tree (or MST) instance";
  reference
    "13.8 of IEEE Std 802.1Q";
}
typedef pcp-selection-type {
  type enumeration {
    enum 8P0D {
      description
        "8 priorities, 0 drop eligible";
    }
    enum 7P1D {
      description
        "7 priorities, 1 drop eligible";
    }
    enum 6P2D {
      description
        "6 priorities, 2 drop eligible";
    }
    enum 5P3D {
      description
        "5 priorities, 3 drop eligible";
    }
  }
  description
    "Priority Code Point selection types.";
  reference
    "12.6.2.5.3, 6.9.3 of IEEE Std 802.1Q";
}
typedef protocol-frame-format-type {
  type enumeration {
    enum Ethernet {
      description
        "Ethernet frame format";
    }
    enum rfc1042 {
      description
        "RFC 1042 frame format";
    }
    enum snap8021H {
      description
        "SNAP 802.1H frame format";
    }
    enum snapOther {
      description
        "Other SNAP frame format";
    }
    enum llcOther {
      description
        "Other LLC frame format";
    }
  }
  description
    "A value representing the frame format to be matched.";
  reference
    "12.10.1.7.1 of IEEE Std 802.1Q";
}
typedef ethertype-type {
  type string {
    pattern "[0-9a-fA-F]{2}-[0-9a-fA-F]{2}";
  }
  description
    "The EtherType value represented in the canonical order defined by
    IEEE 802. The canonical representation uses uppercase characters.";
  reference
    "9.2 of IEEE Std 802-2014";
}
```


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```
typedef dot1q-tag-type {
  type identityref {
    base dot1q-vlan-type;
  }
  description
    "Identifies a specific 802.1Q tag type";
  reference
    "9.5 IEEE Std 802.1Q";
}
typedef traffic-class-type {
  type uint8 {
    range "0..7";
  }
  description
    "This is the numerical value associated with a traffic class in a
    Bridge. Larger values are associated with higher priority traffic
    classes.";
  reference
    "3.273 of IEEE Std 802.1Q";
}
grouping dot1q-tag-classifier-grouping {
  description
    "A grouping which represents an 802.1Q VLAN, matching both the
    EtherType and a single VLAN Id.";
  leaf tag-type {
    type dot1q-tag-type;
    mandatory true;
    description
      "VLAN type";
  }
  leaf vlan-id {
    type vlanid;
    mandatory true;
    description
      "VLAN Id";
  }
}
grouping dot1q-tag-or-any-classifier-grouping {
  description
    "A grouping which represents an 802.1Q VLAN, matching both the
    EtherType and a single VLAN Id or 'any' to match on any VLAN Id.";
  leaf tag-type {
    type dot1q-tag-type;
    mandatory true;
    description
      "VLAN type";
  }
  leaf vlan-id {
    type union {
      type vlanid;
      type enumeration {
        enum any {
          value 4095;
          description
            "Matches 'any' VLAN in the range 1 to 4094 that is not
            matched by a more specific VLAN Id match";
        }
      }
    }
    mandatory true;
    description
      "VLAN Id or any";
  }
}
grouping dot1q-tag-ranges-classifier-grouping {
  description
    "A grouping which represents an 802.1Q VLAN that matches a range of
    VLAN Ids.";
  leaf tag-type {
    type dot1q-tag-type;
    mandatory true;
    description
```


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```
        "VLAN type";
    }
    leaf vlan-ids {
      type vid-range-type;
      mandatory true;
      description
        "VLAN Ids";
    }
  }
  grouping dot1q-tag-ranges-or-any-classifier-grouping {
    description
      "A grouping which represents an 802.1Q VLAN, matching both the
      EtherType and a single VLAN Id, ordered list of ranges, or 'any' to
      match on any VLAN Id.";
    leaf tag-type {
      type dot1q-tag-type;
      mandatory true;
      description
        "VLAN type";
    }
    leaf vlan-id {
      type union {
        type vid-range-type;
        type enumeration {
          enum any {
            value 4095;
            description
              "Matches 'any' VLAN in the range 1 to 4094.";
          }
        }
      }
      mandatory true;
      description
        "VLAN Ids or any";
    }
  }
  grouping priority-regeneration-table-grouping {
    description
      "The priority regeneration table provides the ability to map
      incoming priority values on a per-Port basis, under management
      control.";
    reference
      "6.9.4 of IEEE Std 802.1Q";
    leaf priority0 {
      type priority-type;
      default "0";
      description
        "Priority 0";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority1 {
      type priority-type;
      default "1";
      description
        "Priority 1";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority2 {
      type priority-type;
      default "2";
      description
        "Priority 2";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority3 {
      type priority-type;
      default "3";
      description
        "Priority 3";
```


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```
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority4 {
      type priority-type;
      default "4";
      description
        "Priority 4";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority5 {
      type priority-type;
      default "5";
      description
        "Priority 5";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority6 {
      type priority-type;
      default "6";
      description
        "Priority 6";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
    leaf priority7 {
      type priority-type;
      default "7";
      description
        "Priority 7";
      reference
        "12.6.2.3, 6.9.4 of IEEE Std 802.1Q";
    }
  }
  grouping pcp-decoding-table-grouping {
    description
      "The Priority Code Point decoding table enables the decoding of the
      priority and drop-eligible parameters from the PCP.";
    reference
      "6.9.3 of IEEE Std 802.1Q";
    list pcp-decoding-map {
      key "pcp";
      description
        "This map associates the priority code point field found in the
        VLAN with a priority and drop eligible value based upon the
        priority code point selection type.";
      leaf pcp {
        type pcp-selection-type;
        description
          "The priority code point selection type.";
        reference
          "12.6.2.7, 6.9.3 of IEEE Std 802.1Q";
      }
      list priority-map {
        key "priority-code-point";
        description
          "This map associates a priority code point value with priority
          and drop eligible parameters.";
        leaf priority-code-point {
          type priority-type;
          description
            "Priority associated with the pcp.";
          reference
            "12.6.2.7, 6.9.3 of IEEE Std 802.1Q";
        }
        leaf priority {
          type priority-type;
          description
            "Priority associated with the pcp.";
          reference
```


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```
            "12.6.2.7, 6.9.3 of IEEE Std 802.1Q";
        }
        leaf drop-eligible {
          type boolean;
          description
            "Drop eligible value for pcp";
          reference
            "12.6.2.7, 6.9.3 of IEEE Std 802.1Q";
        }
      }
    }
  }
  grouping pcp-encoding-table-grouping {
    description
      "The Priority Code Point encoding table encodes the priority and
      drop-eligible parameters in the PCP field of the VLAN tag.";
    reference
      "12.6.2.9, 6.9.3 of IEEE Std 802.1Q";
    list pcp-encoding-map {
      key "pcp";
      description
        "This map associates the priority and drop-eligible parameters
        with the priority used to encode the PCP of the VLAN based upon
        the priority code point selection type.";
      leaf pcp {
        type pcp-selection-type;
        description
          "The priority code point selection type.";
        reference
          "12.6.2.7, 6.9.3 of IEEE Std 802.1Q";
      }
      list priority-map {
        key "priority dei";
        description
          "This map associates the priority and drop-eligible parameters
          with the priority code point field of the VLAN tag.";
        leaf priority {
          type priority-type;
          description
            "Priority associated with the pcp.";
          reference
            "12.6.2.7, 6.9.3 of IEEE Std 802.1Q";
        }
        leaf dei {
          type boolean;
          description
            "The drop eligible value.";
          reference
            "12.6.2, 8.6.6 of IEEE Std 802.1Q";
        }
        leaf priority-code-point {
          type priority-type;
          description
            "PCP value for priority when DEI value";
          reference
            "12.6.2.9, 6.9.3 of IEEE Std 802.1Q";
        }
      }
    }
  }
  grouping service-access-priority-table-grouping {
    description
      "The Service Access Priority Table associates a received priority
      with a service access priority.";
    reference
      "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    leaf priority0 {
      type priority-type;
      default "0";
      description
        "Service access priority value for priority 0";
      reference
```


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```
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority1 {
      type priority-type;
      default "1";
      description
        "Service access priority value for priority 1";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority2 {
      type priority-type;
      default "2";
      description
        "Service access priority value for priority 2";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority3 {
      type priority-type;
      default "3";
      description
        "Service access priority value for priority 3";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority4 {
      type priority-type;
      default "4";
      description
        "Service access priority value for priority 4";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority5 {
      type priority-type;
      default "5";
      description
        "Service access priority value for priority 5";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority6 {
      type priority-type;
      default "6";
      description
        "Service access priority value for priority 6";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
    leaf priority7 {
      type priority-type;
      default "7";
      description
        "Service access priority value for priority 7";
      reference
        "12.6.2.17, 6.13.1 of IEEE Std 802.1Q";
    }
  }
  grouping traffic-class-table-grouping {
    description
      "The Traffic Class Table models the operations that can be
      performed on, or can inquire about, the current contents of the
      Traffic Class Table (8.6.6) for a given Port.";
    reference
      "12.6.3, 8.6.6 of IEEE Std 802.1Q";
    list traffic-class-map {
      key "priority";
      description
        "The priority index into the traffic class table.";
      leaf priority {
        type priority-type;
```


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```
      description
        "The priority of the traffic class entry.";
      reference
        "8.6.6 of IEEE Std 802.1Q";
    }
    list available-traffic-class {
      key "num-traffic-class";
      description
        "The traffic class index associated with a given priority
        within the traffic class table.";
      reference
        "8.6.6 of IEEE Std 802.1Q";
      leaf num-traffic-class {
        type uint8 {
          range "1..8";
        }
        description
          "The available number of traffic classes.";
        reference
          "8.6.6 of IEEE Std 802.1Q";
      }
      leaf traffic-class {
        type traffic-class-type;
        description
          "The traffic class index associated with a given traffic
          class entry.";
        reference
          "8.6.6 of IEEE Std 802.1Q";
      }
    }
  }
}
grouping transmission-selection-table-grouping {
  description
    "The Transmission Selection Algorithm Table models the operations
    that can be performed on, or can inquire about, the current contents
    of the Transmission Selection Algorithm Table (12.20.2) for a given
    Port.";
  reference
    "12.20.2, 8.6.8 of IEEE Std 802.1Q";
  list transmission-selection-algorithm-map {
    key "traffic-class";
    description
      "The traffic class to index into the transmission selection
      table.";
    leaf traffic-class {
      type traffic-class-type;
      description
        "The traffic class of the entry.";
      reference
        "8.6.6 of IEEE Std 802.1Q";
    }
    leaf transmission-selection-algorithm {
      type identityref {
        base dot1q-types:transmission-selection-algorithm;
      }
      description
        "Transmission selection algorithm";
      reference
        "8.6.8, Table 8-6 of IEEE Std 802.1Q";
    }
  }
}
grouping port-map-grouping {
  description
    "A set of control indicators, one for each Port. A Port Map,
    containing a control element for each outbound Port";
  reference
    "8.8.1, 8.8.2 of IEEE Std 802.1Q";
  list port-map {
    key "port-ref";
    description
```


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```
    "The list of entries composing the port map.";
  leaf port-ref {
    type port-number-type;
    description
      "The interface port reference associated with this map.";
    reference
      "8.8.1 of IEEE Std 802.1Q";
  }
  choice map-type {
    description
      "Type of port map";
    container static-filtering-entries {
      description
        "Static filtering entries attributes.";
      leaf control-element {
        type enumeration {
          enum forward {
            description
              "Forwarded, independently of any dynamic filtering
              information held by the FDB.";
          }
          enum filter {
            description
              "Filtered, independently of any dynamic filtering
              information.";
          }
          enum forward-filter {
            description
              "Forwarded or filtered on the basis of dynamic
              filtering information, or on the basis of the default
              Group filtering behavior for the outbound Port (8.8.6)
              if no dynamic filtering information is present
              specifically for the MAC address.";
          }
        }
        description
          "A control element for each outbound Port, specifying that
          a frame with a destination MAC address, and in the case of
          VLAN Bridge components, VID that meets this specification.";
        reference
          "8.8.1 of IEEE Std 802.1Q";
      }
      leaf connection-identifier {
        type port-number-type;
        description
          "A Port MAP may contain a connection identifier (8.8.12)
          for each outbound port. The connection identifier may be
          associated with the Bridge Port value maintained in a
          Dynamic Filtering Entry of the FDB for Bridge Ports.";
        reference
          "8.8.1, 8.8.12 of IEEE Std 802.1Q";
      }
    }
    container static-vlan-registration-entries {
      description
        "Static VLAN registration entries.";
      leaf registrar-admin-control {
        type enumeration {
          enum fixed-new-ignored {
            description
              "Registration Fixed (New ignored).";
          }
          enum fixed-new-propagated {
            description
              "Registration Fixed (New propagated.";
          }
          enum forbidden {
            description
              "Registration Forbidden.";
          }
          enum normal {
            description
```


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```
            "Normal Registration.";
          }
        }
        description
          "The Registrar Administrative Control values for MVRP and
          MIRP for the VID.";
        reference
          "8.8.2 of IEEE Std 802.1Q";
      }
      leaf vlan-transmitted {
        type enumeration {
          enum tagged {
            description
              "VLAN-tagged";
          }
          enum untagged {
            description
              "VLAN-untagged";
          }
        }
        description
          "Whether frames are to be VLAN-tagged or untagged when
          transmitted.";
        reference
          "8.8.2 of IEEE Std 802.1Q";
      }
    }
    container mac-address-registration-entries {
      description
        "MAC address registration entries attributes.";
      leaf control-element {
        type enumeration {
          enum registered {
            description
              "Forwarded, independently of any dynamic filtering
              information held by the FDB.";
          }
          enum not-registered {
            description
              "Filtered, independently of any dynamic filtering
              information.";
          }
        }
        description
          "A control element for each outbound Port, specifying that
          a frame with a destination MAC address, and in the case of
          VLAN Bridge components, VID that meets this specification.";
        reference
          "8.8.4 of IEEE Std 802.1Q";
      }
    }
    container dynamic-vlan-registration-entries {
      description
        "Dynamic VLAN registration entries attributes.";
      leaf control-element {
        type enumeration {
          enum registered {
            description
              "Forwarded, independently of any dynamic filtering
              information held by the FDB.";
          }
        }
        description
          "A control element for each outbound Port, specifying that
          a frame with a destination MAC address, and in the case of
          VLAN Bridge components, VID that meets this specification.";
        reference
          "8.8.5 of IEEE Std 802.1Q";
      }
    }
    container dynamic-reservation-entries {
      description
```


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```
          "Dynamic reservation entries attributes.";
        leaf control-element {
          type enumeration {
            enum forward {
              description
                "Forwarded, independently of any dynamic filtering
                information held by the FDB.";
            }
            enum filter {
              description
                "Filtered, independently of any dynamic filtering
                information.";
            }
          }
          description
            "A control element for each outbound Port, specifying that
            a frame with a destination MAC address, and in the case of
            VLAN Bridge components, VID that meets this specification.";
          reference
            "8.8.7 of IEEE Std 802.1Q";
        }
      }
      container dynamic-filtering-entries {
        description
          "Dynamic filtering entries attributes.";
        leaf control-element {
          type enumeration {
            enum forward {
              description
                "Forwarded, independently of any dynamic filtering
                information held by the FDB.";
            }
          }
          description
            "A control element for each outbound Port, specifying that
            a frame with a destination MAC address, and in the case of
            VLAN Bridge components, VID that meets this specification.";
          reference
            "8.8.3 of IEEE Std 802.1Q";
        }
      }
    }
  }
}
grouping bridge-port-statistics-grouping {
  description
    "Grouping of bridge port statistics.";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
  leaf delay-exceeded-discards {
    type yang:counter64;
    description
      "The number of frames discarded by this port due to excessive
      transit delay through the Bridge. It is incremented by both
      transparent and source route Bridges.";
    reference
      "12.6.1.1.3, 8.6.6 of IEEE Std 802.1Q";
  }
  leaf mtu-exceeded-discards {
    type yang:counter64;
    description
      "The number of frames discarded by this port due to an excessive
      size. It is incremented by both transparent and source route
      Bridges.";
    reference
      "Item g) in 12.6.1.1.3 of IEEE Std 802.1Q";
  }
  leaf frame-rx {
    type yang:counter64;
    description
      "The number of frames that have been received by this port from
      its segment. Note that a frame received on the interface
```


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```
    corresponding to this port is only counted by this object if and
    only if it is for a protocol being processed by the local
    bridging function, including Bridge management frames.";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
}
leaf octets-rx {
  type yang:counter64;
  description
    "The total number of octets in all valid frames received
    (including BPDUs, frames addressed to the Bridge as an end
    station, and frames that were submitted to the Forwarding
    Process).";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
}
leaf frame-tx {
  type yang:counter64;
  description
    "The number of frames that have been transmitted by this port to
    its segment. Note that a frame transmitted on the interface
    corresponding to this port is only counted by this object if and
    only if it is for a protocol being processed by the local
    bridging function, including Bridge management frames.";
}
leaf octets-tx {
  type yang:counter64;
  description
    "The total number of octets that have been transmitted by this
    port to its segment.";
}
leaf discard-inbound {
  type yang:counter64;
  description
    "Count of received valid frames that were discarded (i.e.,
    filtered) by the Forwarding Process.";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
}
leaf forward-outbound {
  type yang:counter64;
  description
    "The number of frames forwarded to the associated MAC Entity
    (8.5).";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
}
leaf discard-lack-of-buffers {
  type yang:counter64;
  description
    "The count of frames that were to be transmitted through the
    associated Port but were discarded due to lack of buffers.";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
}
leaf discard-transit-delay-exceeded {
  type yang:counter64;
  description
    "The number of frames discarded by this port due to excessive
    transit delay through the Bridge. It is incremented by both
    transparent and source route Bridges.";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
}
leaf discard-on-error {
  type yang:counter64;
  description
    "The number of frames that were to be forwarded on the associated
    MAC but could not be transmitted (e.g., frame would be too large,
    6.5.8).";
  reference
    "12.6.1.1.3 of IEEE Std 802.1Q";
```


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