INTERNATIONAL STANDARD

ISO/IEC/IEEE 8802-1Q

Second edition
2020-08

AMENDMENT 31
2021-10

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

Part 1Q:
Bridges and bridged networks

AMENDMENT 31: Stream Reservation Protocol (SRP) enhancements and performance improvements

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

Partie 1Q: Ponts et réseaux pontés

AMENDEMENT 31: Perfectionnement et améliorations des performances du protocole de réservation de flux (SRP)

Reference number
ISO/IEC/IEEE 8802-1Q:2020/Amd.31:2021(E)

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IEEE Std 802.1Qcc™-2018
(Amendment to
IEEE Std 802.1Q™-2018
as amended by
IEEE Std 802.1Qcp™-2018)

IEEE Standard for
Local and Metropolitan Area Networks—

Bridges and Bridged Networks

Amendment 31: Stream Reservation Protocol (SRP) Enhancements and Performance Improvements

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Approved 14 June 2018

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Abstract: Enhancements to the configuration of time-sensitive streams are provided by this amendment to IEEE Std 802.1Q-2018.

Keywords: amendment, Bridged Local Area Networks, IEEE 802©, IEEE 802.1Q™, IEEE 802.1Qcc™, SRP, Stream Reservation Protocol, MSRP, Multiple Stream Registration Protocol, Time-Sensitive Networking, TSN

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PDF: ISBN 978-1-5044-5064-5 STD23223
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This amendment to IEEE Std 802.1Q-2018 provides enhancements to the configuration of time-sensitive streams.

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Amendment 31:
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Enhancements and Performance Improvements

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1. Overview

1.3 Introduction

Insert the following text at the end of 1.3:

This standard specifies enhancements to protocols, procedures, and managed objects for the configuration of network resources for time-sensitive (i.e., bounded latency) applications. The enhancements address Time-Sensitive Networking (TSN) application requirements beyond audio/video (AV) traffic. To this end, it

cl) Specifies a software interface between the user (i.e., time-sensitive application) and network components, such that the user provides Stream requirements (e.g., for bounded latency), and the network configures resources from Talker to Listeners to meet those requirements. This user/network interface (UNI) is specified as an information model that can be applied to any protocol.
cm) Specifies three models for the UNI: fully distributed, centralized network/distributed user, and fully centralized.
cn) Specifies enhancements to the Stream Reservation Protocol (SRP), using a new application version, MSRPv1. MSRPv1 integrates the UNI TLVs for the benefits of enhanced configuration. For compatibility, MSRPv1 translates to the previous version (MSRPv0).
co) Specifies enhancements to the managed objects for forwarding and queuing enhancements for time-sensitive streams (FQTSS).
cp) Specifies enhancements to the managed objects for SRP.
cq) Specifies managed objects for configuration of Bridges by a Centralized Network Configuration (CNC) component.

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2. Normative references

Insert the following reference into Clause 2 in alphanumeric order:

IETF RFC 7950, The YANG 1.1 Data Modeling Language, August 2016.[2]

[2] IETF documents (i.e., RFCs) are available from the Internet Engineering Task Force (https://www.rfc-editor.org/).

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3. Definitions

Change the following definition as shown:

3.259 stream reservation (SR) class: A traffic class whose bandwidth can be reserved for ~~audio/video (AV) traffic~~ time-sensitive streams using the Stream Reservation Protocol (SRP). A priority value is associated with each SR class. SR classes are denoted by consecutive letters of the alphabet, starting with A and continuing for up to seven classes.

Insert the following terms into Clause 3 in alphabetic order, number them appropriately, and renumber the subsequent terms in the clause accordingly:

3.x Centralized Network Configuration (CNC): A centralized component that configures network resources on behalf of TSN applications (users).

3.x Centralized User Configuration (CUC): A centralized entity that discovers end stations, retrieves end station capabilities and user requirements, and configures TSN features in end stations. The protocols that the CUC uses for communication with end stations are specific to the user application, not specified in this standard. A CUC exchanges information with a CNC in order to configure TSN features on behalf of its end stations.

3.x time-aware: An adjective to describe use of time that is synchronized with other stations using a protocol (e.g., IEEE Std 802.1AS).

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4. Abbreviations

Insert the following abbreviations into Clause 4 in alphabetic order:

CNC	Centralized Network Configuration
CUC	Centralized User Configuration
TSN	Time-Sensitive Networking

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5. Conformance

5.2 Conformant components and equipment

Insert the following item at the end of the lettered list in 5.2:

r) TSN CNC station (5.29)

5.4 VLAN Bridge component requirements

5.4.1 VLAN Bridge component options

Insert the following item at the end of the lettered list in 5.4.1:

ae) Support Stream reservation remote management (5.4.1.10).

5.4.1.5 Forwarding and queuing enhancements for time-sensitive streams (FQTSS)—requirements

Insert the following items at the end of the lettered list in 5.4.1.5:

h) Support the classMeasurementInterval attribute (12.20.1).
i) Support the SR Class to Priority Mapping Table (12.20.4).

Insert the following subclause (5.4.1.10) after 5.4.1.9:

5.4.1.10 Stream reservation remote management (optional)

A VLAN-aware Bridge component implementation that conforms to the provisions of this standard for Stream reservation remote management shall

a) Support the management functionality defined in Clause 12.
b) Support the use of a remote management protocol. Bridges claiming to support remote management shall state the following:
    1) Which remote management protocol standard(s) or specification(s) are supported for the server implementation.
    2) Which standard(s) or specification(s) for managed object definitions and encodings are supported for use by the remote management protocol.
c) Support TE-MSTID (5.5.2).
d) Support the entities for Stream reservation remote management (12.32).
e) Support the adminIdleSlope attribute (12.20.1).

5.5 C-VLAN component conformance

5.5.1 C-VLAN component options

Insert the following item at the end of the lettered list in 5.5.1:

d) Support TE-MSTID (5.5.2).

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Insert the following subclause (5.5.2) after 5.5.1:

5.5.2 TE-MSTID (optional)

A C-VLAN component implementation that conforms to the provisions of this standard for TE-MSTID shall

a) Disable learning for a set of Customer VLAN Identifiers (C-VIDs) allocated to the Traffic Engineering Multiple Spanning Tree Instance Identifier (TE-MSTID) as specified in 8.4 and 8.9, with the exception that support for PBB-TE is not required; and
b) Discard frames with unregistered destination addresses for C-VIDs allocated to the TE-MSTID (8.8.1).

A C-VLAN component implementation that conforms to the provisions of this standard for TE-MSTID may

c) Allow control of all C-VIDs by an external agent, conforming to the Reserved VID values of Table 9-2.

Insert the following subclause (5.29) after 5.28:

5.29 TSN CNC station requirements

This subclause defines the conformance requirements for a station that supports the Time-Sensitive Networking (TSN) Centralized Network Configuration (CNC) requirements (46.1.3). The TSN CNC station component is implemented within an end station or Bridge.

A TSN CNC station implementation that conforms to the provisions of this standard shall:

a) Support the use of a remote management protocol. The TSN CNC claiming to support remote management shall state the following:
   1) Which remote management protocol standard(s) or specification(s) are supported for the client implementation.
   2) Which standard(s) or specification(s) for managed object definitions and encodings are supported for use by the remote management protocol.
b) Support the managed object definitions and encodings for Stream reservation remote management (12.32).
c) Support the use of at least one protocol for User/network configuration information that complies with the requirements for protocol integration defined in 46.2. The TSN CNC shall state which User/network configuration information protocol standard(s) or specification(s) are supported.
d) If a YANG-based protocol is supported by the TSN CNC for the User/network configuration information, that protocol shall use the YANG module specified in 46.3.
e) If SRP (Clause 35) is supported by the TSN CNC for the User/network configuration information, the TSN CNC shall support MRP External Control (12.32.4).

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10. Multiple Registration Protocol (MRP) and Multiple MAC Registration Protocol (MMRP)

10.6 Protocol operation

Change NOTE 4 in 10.6 as shown:

NOTE 4—In the face of changing inputs, arbitrary loss, delay, reordering, and unsignaled interruption in participation, no protocol will meet its objectives. What can be said is that the objectives will be met after a known period of operation within specified limits, and what failures are most likely otherwise. MRP favors ensuring that registrations are made, at the expense of tolerating prolonged registrations. Thus, the LeaveAll mechanism, when it has an effect, most often implements "garbage collection." At the same time it will also ensure that failed registrations are (re-)established. These objectives cannot be ensured if the LeaveAllTime is set to zero; therefore, it is recommended to set the LeaveAllTime to a nonzero value as soon as is practicable.

10.7 Protocol specification

10.7.4 Protocol timers

10.7.4.3 leavealltimer

Change 10.7.4.3 as shown:

The Leave All Period Timer, leavealltimer, controls the frequency with which the LeaveAll state machine generates LeaveAll PDUs. The timer is required on a per-Port, per-MRP Participant basis. If LeaveAllTime is zero, the Leave All Period Timer is not started; otherwise, t~~T~~he Leave All Period Timer is set to a random value, T, in the range LeaveAllTime < T < 1.5 × LeaveAllTime when it is started. LeaveAllTime is defined in Table 10-7.

10.7.6 Protocol Action definitions

10.7.6.10 Start leavealltimer

Change 10.7.6.10 as shown:

When LeaveAllTime is nonzero, this c~~C~~auses leavealltimer to be started, in accordance with the definition of the timer in 10.7.4.3.

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10.7.8 Registrar state machine

Change Table 10-4 as shown:

Table 10-4—Registrar state table

		STATE		
		IN	**LV**	**MT**
EVENT	**Begin!**	MT	MT	MT
	rNew!	New IN	New Stop leavetimer IN	New IN
	rJoinIn! || rJoinMt!	IN	Stop leavetimer IN	Join IN
	rLv! || rLA! || txLA! || Re-declare!	Start leave-timer[a] LV	-x-	-x-
	Flush!	Lv MT	Lv MT	MT
	leavetimer!	-x-	Lv MT	MT

[a] If operPointToPointMAC is TRUE, proceed directly to the Lv/MT transition as defined in the LV State for the leavetimer! Event. This avoids the delay resulting from the leavetimer. If operPointToPointMAC is FALSE, the state machine is executed as shown.

10.7.9 LeaveAll state machine

Change the text of 10.7.9 as shown (Table 10-5 remains unchanged):

A single LeaveAll state machine exists for each full MRP Participant. Leave All messages generated by this state machine also generate LeaveAll events against all the Applicant and Registrar state machines associated with that Participant and Port; hence, LeaveAll generation is treated by those state machines in the same way as reception of a LeaveAll message from an external source.

If the LeaveAllTime is changed from a value of zero to a nonzero value, a Begin! event shall be signaled to the LeaveAll state machine to cause it to reinitialize.

The detailed operation of this state machine is described in Table 10-5.

10.7.11 Timer values

Change the title of Table 10-7 as shown:

Table 10-7—MRP timer parameter default values

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Insert the following subclause (10.7.14) after 10.7.13:

10.7.14 External control

The MRP External Control feature (12.32.4) specifies a managed object that the network manager uses to

a) Disable MRP attribute propagation (MAP) for the MRP Participant of a Bridge Port.
b) Read MRP attribute registrations that the MRP Participant receives.
c) Write MRP attribute values for the MRP Participant to declare.

There is one MRP External Control managed object for each MRP Participant (per Port per MRP application per MAP Context, as specified in 10.2 and 10.3.1).

Under default operation, the MRP External Control feature (externalControl attribute FALSE) is ignored by the operation of MRP and has no effect on MRP Attribute Propagation (MAP) specified in 10.3.

When the MRP External Control feature is enabled by network management (externalControl attribute TRUE), the operation of MAP in the Bridge performs as specified in 12.32.4, but all other aspects of MRP operation are performed as specified in Clause 10.

10.8 Structure and encoding of Multiple Registration Protocol Data Units (MRPDUs)

10.8.3 Packing and parsing MRPDUs

10.8.3.5 Handling of protocol versions

Change list item c) in the lettered list in 10.8.3.5 as shown:

c) Where the MRPDU carries a higher protocol version than the version implemented, then
   1) If a Message is encountered in which the AttributeType is not recognized, then that Message is discarded. This is achieved by discarding the successive VectorAttributes in the AttributeList until either an EndMark or the end of the PDU is reached. If an EndMark is reached, processing continues with the next Message.
   2) If a VectorAttribute is encountered in which the AttributeEvent is not recognized for the AttributeType concerned, then the VectorAttribute is discarded and processing continues with the next VectorAttribute, if the end of the PDU has not been reached.
   3) For the MSRP application (Clause 35), if a FirstValue is encountered in which a TLV is not recognized for the Type concerned, then the TLV is discarded and processing continues with the next TLV, if the end of the PDU has not been reached.

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12. Bridge management

12.20 Management entities for FQTSS

Change the second paragraph of 12.20 as shown:

This managed resource comprises the following objects:

a) The Bandwidth Availability Parameter Table (12.20.1)
b) The Transmission Selection Algorithm Table (12.20.2)
c) The Priority Regeneration Override Table (12.20.3)
d) The SR Class to Priority Mapping Table (12.20.4)

12.20.1 Bandwidth Availability Parameter Table

Change 12.20.1, including Table 12-4, as shown:

There is one Bandwidth Availability Parameter Table per Port of a Bridge component. Each table row contains a set of parameters for each traffic class ~~that supports the credit-based shaper algorithm (8.6.8.2)~~ configured for use with time-sensitive streams, as detailed in Table 12-4. Rows in the table can be created or removed dynamically in implementations that support dynamic configuration of ~~p~~Ports and components.

Table 12-4—Bandwidth Availability Parameter Table row elements

Name	Data type	Operations supported[a]	Conformance[b]	References
~~Traffic class~~trafficClass[c]	unsigned integer [0..7]	R	BE	~~34.3~~ 3.268, 8.6.8
deltaBandwidth	percentage	RW	BE	34.3
adminIdleSlope	unsigned integer	RW	BEC	34.3
operIdleSlope	unsigned integer	R	BE	34.3
classMeasurementInterval	unsigned integer	RW	be	34.3, 34.4, 34.6
lockClassBandwidth	Boolean	RW	be	34.3

[a] R = Read only access; RW = Read/Write access.
[b] B = Required for Bridge or Bridge component support of FQTSS; E = Required for end station support of FQTSS~~.~~; b = Optional for Bridge or Bridge component support of FQTSS; e = Optional for end station support of FQTSS; C = Required for Bridge or Bridge component support of Stream reservation remote management.
[c] The term “trafficClass” in this table is the same as the “traffic class” definition of this standard.

The classMeasurementInterval attribute provides management control of the classMeasurementInterval parameter specified in 34.3. The classMeasurementInterval attribute uses units of nanoseconds, converted to/from units of seconds for use in 34.3. If management of classMeasurementInterval is not supported, the default values (34.5) are used as the fixed Port configuration.

If management of lockClassBandwidth is not supported, the default value of false is used as the fixed Port configuration.

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12.20.2 Transmission Selection Algorithm Table

Change the text of 12.20.2 as shown (Table 12-5 remains unchanged):

There is one Transmission Selection Algorithm Table per Port of a Bridge component. ~~This is in addition to the Traffic Class Table managed object (12.6.3) that would also exist per Port of a bridge component.~~ Each table row contains a set of parameters for each traffic class that the Port supports, as detailed in Table 12-5.

NOTE—In order to manage the mapping of traffic class to priority, refer to the Traffic Class Table managed object (12.6.3).

12.20.3 Priority Regeneration Override Table

Change the text of 12.20.3 as shown (Table 12-6 remains unchanged):

There is one Priority Regeneration Override Table per Port of a Bridge component. This is in addition to the Priority Handling managed object (12.6.2) that would also exist per Port of a Bridge component. Each table row contains a set of parameters for each received priority value that is associated with an SR class (3.259, 6.9.4), as detailed in Table 12-6.

Insert the following subclause (12.20.4, including Table 12-7) after 12.20.3, and renumber the subsequent tables in Clause 12 accordingly:

12.20.4 SR Class to Priority Mapping Table

There is one SR Class to Priority Mapping Table per Bridge component. Each table row corresponds to an SR class, as detailed in Table 12-7. Rows in the table can be created or removed dynamically in implementations that support dynamic configuration of Ports and components, using Priority to specify the row to create/delete.

Table 12-7—SR Class to Priority Mapping Table row elements

Name	Data type	Operations supported[a]	Conformance[b]	References
Priority	unsigned integer [0..7]	R	b	6.9.3
SRclassID	unsigned integer [0..6]	RW	b	35.2.2.9.2

[a] R = Read only access; RW = Read/Write access.
[b] b = Optional for Bridge or Bridge component support of FQTSS.

The SRclassID attribute specifies the SR class ID from Table 35-7 of 35.2.2.9.2, mapped to the associated Priority (SRclassPriority of 35.2.2.9.3). The default values for this managed object use the default values specified in 34.5 (i.e., Priority 3 for SRclassID 6 and Priority 2 for SRclassID 5).

If this managed object is not supported, the default values specified in 34.5 are used as the fixed configuration.

NOTE 1—This managed object is not needed for an end station, since according to the requirements of 35.2.2.9.3, an end station uses the SR class to priority mapping that the neighboring Bridge provides in SRP's Domain attribute.

NOTE 2—In order to manage the mapping of traffic class to priority, refer to the Traffic Class Table managed object (12.6.3).

NOTE 3—The maximum number of rows supported for this table is provided in the maxSRclasses parameter of 12.22.1.

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12.22 Stream Reservation Protocol (SRP) entities

12.22.1 SRP Bridge Base Table

Change Table 12-14 (formerly Table 12-13) as shown:

Table 12-14—SRP Bridge Base Table row elements

Name	Data type	Operations supported[a]	Conformance[b]	References
msrpEnabledStatus	Boolean	RW	B	35.2.1.4 item d)
talkerPruning	Boolean	RW	B	35.2.1.4 item b)
msrpMaxFanInPorts	unsigned integer	RW	B	35.2.1.4 item f)
msrpLatencyMaxFrameSize	unsigned integer	RW	B	35.2.1.4 item g)
talkerVlanPruning	Boolean	RW	b	35.2.1.4 item l)
maxSRclasses	unsigned integer	R	b	35.2.1.4 item m)

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

12.22.2 SRP Bridge Port Table

Change 12.22.2, including Table 12-15 (formerly Table 12-14) as shown:

There is one SRP Configuration Parameter Table per Port of a Bridge component. Each table row contains a set of parameters for each MSRP entity per ~~p~~Port, as detailed in Table 12-15.

Table 12-15—SRP Bridge Port Table row elements

Name	Data type	Operations supported[a]	Conformance[b]	References
msrpPortEnabledStatus	Boolean	RW	B	35.2.1.4 item e)
MSRP Failed Registrations	counter	R	B	10.7.12.1
MSRP Last PDU Origin	MAC Address	R	B	10.7.12.2
SR_PVID	unsigned integer[1..4094]	RW	B	Table 9-2, 35.2.1.4 item i)
talkerPruningPerPort	Boolean	RW	b	35.2.1.4 item k)

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

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Insert the following subclauses (12.22.6 and 12.22.7, including Table 12-19 and Table 12-20) after 12.22.5:

12.22.6 SRP Stream Preload Table

There is one SRP Stream Preload Table per Bridge component. Each table contains a set of parameters for each StreamID that is preloaded on the Bridge as it initializes (i.e., powers up/reboots), as detailed in Table 12-19. The preloading of Table 12-19 on each Port of the Bridge is specified in 12.22.7. Rows in the table can be created or removed dynamically in implementations that support dynamic configuration of Ports and components.

Table 12-19—SRP Stream Preload Table row elements

Name	Data type	Operations supported[a]	Conformance[b]	References
StreamID	octet string(size(8))	RW	b	35.2.2.8.2
Stream Destination Address	MAC Address	RW	b	35.2.2.8.3 item a)
Stream VLAN ID	unsigned integer [0..4094]	RW	b	35.2.2.8.3 item b)
MaxFrameSize	unsigned integer [0..65535]	RW	b	35.2.2.8.4 item a)
MaxIntervalFrames	unsigned integer [0..65535]	RW	b	35.2.2.8.4 item b)
Data Frame Priority	unsigned integer [0..7]	RW	b	35.2.2.8.5 item a)
Rank	unsigned integer [0..1]	RW	b	35.2.2.8.5 item b)

[a] R = Read only access; RW = Read/Write access.
[b] b = Optional for Bridge or Bridge component support of SRP.

12.22.7 SRP Reservations Preload Table

There is one SRP Reservations Preload Table per reservation direction per Port of a Bridge component. Each table contains a set of parameters for each Talker or Listener registration that is preloaded on the Bridge as it initializes (i.e., powers up/reboots), as detailed in Table 12-20. Rows in the table can be created or removed dynamically in implementations that support dynamic configuration of Ports and components.

Table 12-20—SRP Reservations Preload Table row elements

Name	Data type	Operations supported[a]	Conformance[b]	References
StreamID	octet string(size(8))	RW	b	35.2.2.8.2
Direction	unsigned integer[0..1]	RW	b	35.2.1.2
Accumulated Latency	unsigned integer	RW	b	35.2.2.8.6

[a]R = Read only access; RW = Read/Write access.
[b]b = optional for Bridge or Bridge component support of SRP.

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The SRP preload tables (Table 12-19 and Table 12-20) are used to initialize Streams within each Bridge as it powers up, to preload the Stream registrations that will later be provided by operation of SRP. When the Bridge initializes, the SRP preload tables shall be used for a two phase operation as follows:

In the first phase, the Bridge iterates Table 12-20 to find rows for which the Direction is Talker. For each Talker row, if the StreamID in Table 12-20 is also found in Table 12-19, the Bridge shall

a) Invoke the MVRP ES_REGISTER_VLAN_MEMBER service primitive (11.2.3.2.1) on the Port. The attribute_type parameter carries the VID Vector Attribute Type (11.2.3.1.6). The attribute_value parameter carries the Stream VLAN ID for the associated StreamID in Table 12-19.
b) Invoke MSRP REGISTER_STREAM.request (35.2.3.1.1) on the Port. The attribute_type parameter carries the Talker Advertise Vector Attribute Type [item a) in 35.2.2.4]. The Declaration Type in the attribute_value parameter is Talker Advertise. The attribute_value parameter carries the following parameters from Table 12-19: StreamID, DataFrameParameters.destination_address from Stream Destination Address, DataFrameParameters.vlan_identifier from Stream VLAN ID, TSpec.MaxFrameSize, TSpec.MaxIntervalFrames, PriorityAndRank.Data Frame Priority, and PriorityAndRank.Rank. The attribute_value parameter carries the following per-Port parameters from Table 12-20: Accumulated Latency. The Failure Information in the attribute_value parameter is not applicable to Talker Advertise.

In the second phase, the Bridge iterates Table 12-20 to find rows for which the Direction is Listener. For each Listener row, if the StreamID was processed as a Talker during the first phase, then the Bridge shall:

c) Invoke MSRP REGISTER_ATTACH.request (35.2.3.1.5) on the Port. The attribute_type parameter carries the Listener Vector Attribute Type [item c) in 35.2.2.4]. The Declaration Type in the attribute_value parameter is Listener Ready. The attribute_value parameter carries StreamID from Table 12-20.
d) Invoke the MVRP ES_REGISTER_VLAN_MEMBER service primitive (11.2.3.2.1) on the Port. The attribute_type parameter carries the VID Vector Attribute Type (11.2.3.1.6). The attribute_value parameter carries the Stream VLAN ID for the associated StreamID in Table 12-19.
e) Update the Dynamic Reservation Entries (8.8.7) for the Port to Forwarding, using the Stream Destination Address for the associated StreamID in Table 12-19.
f) For traffic class *N* that is mapped to the Data Frame Priority of Table 12-19, increase the *operIdleSlope(N)* variable [item d) in 34.3] using the bandwidth requirements of the Stream (MaxFrameSize and MaxIntervalFrames of Table 12-19).

Insert the following subclause (12.32, including Table 12-38 through Table 12-41) after 12.31.4:

12.32 Stream reservation remote management

Clause 46 defines Time-Sensitive Networking (TSN) configuration, including a Centralized Network Configuration (CNC) station that uses managed objects for configuration of each Bridge. This subclause specifies managed objects within the Bridge that can be used by the TSN CNC station or any other management component.

This managed resource comprises the following objects:

a) Bridge Delay (12.32.1)
b) Propagation Delay (12.32.2)
c) Static Trees (12.32.3)
d) MRP External Control (12.32.4)

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12.32.1 Bridge Delay

This subclause specifies attributes of a managed object that is used to determine the delay of frames as they pass through the Bridge's relay. There is one Bridge Delay managed object per Port pair per traffic class of a Bridge component. Each set of Bridge Delay attributes is accessed using three indices: ingress Port, egress Port, and traffic class. The set of managed object attributes is shown in Table 12-38.

Table 12-38—Bridge Delay attributes

Name	Data type	Operations supported[a]	Conformance[b]	References
independentDelayMin	unsigned integer	R	B	12.32.1.1
independentDelayMax	unsigned integer	R	B	12.32.1.1
dependentDelayMin	unsigned integer	R	B	12.32.1.2
dependentDelayMax	unsigned integer	R	B	12.32.1.2

[a] R = Read only access; RW = Read/Write access.
[b] B = Required for Bridge or Bridge component support of Stream reservation remote management; b = Optional for Bridge or Bridge component support of Stream reservation remote management.

For each set of Bridge Delay attributes, the total delay through the Bridge consists of the delay that is independent of frame length, plus the delay that is dependent on frame length.

Each delay is provided as a range, with both minimum attribute and maximum attribute.

The delays represent the worst-case range per the design of the Bridge, and are not measured. If the Bridge design varies based on the configuration of features in the Bridge, the delays are returned according to the current configuration of the Bridge.

NOTE 1—In order to obtain the most accurate delays, the TSN CNC typically configures the Stream from Talker to Listeners, and then reads the delays for the Ports that ingress/egress that Stream. For example, use of IEEE Std 802.1CB could change the implementation in the Bridge, and therefore it is best to configure those features in the Bridge prior to reading the delays.

Each delay is provided as if the corresponding frame encounters zero delay for transmission selection (8.6.8). This occurs when the queue for the frame's traffic class is empty, the frame's traffic class has permission to transmit, and the egress Port is idle (not transmitting).

NOTE 2—Computation of delay factors due to use of multiple traffic classes, frame preemption, traffic shaping, and traffic scheduling is the responsibility of the TSN CNC, and therefore these factors are not included in the delay attributes of this managed object. For example, assume that a frame of a TSN Stream encounters 12 µs of delay due to traffic scheduling (i.e., waiting for gate to open), 5 µs due to a previous frame of the same traffic class, and 700 ns to 800 ns of hardware delay (e.g., PHYs and relay). For this example, independentDelayMin is 700, and independentDelayMax is 800 (i.e., the extra 17 µs for queuing/scheduling is not included in this managed object).

12.32.1.1 independentDelayMin/Max

These attributes provide the portion of delay that is independent of frame length.

Each length-independent delay attribute is an unsigned integer in units of nanoseconds.

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The independentDelayMin attribute provides the minimum length-independent delay for a frame to forward from ingress Port to egress Port for this traffic class. If the actual delay is a fraction of a nanosecond, independentDelayMin shall be the greatest integer number of nanoseconds that is less than or equal to the actual delay.

The independentDelayMax attribute provides the maximum length-independent delay for a frame to forward from ingress Port to egress Port for this traffic class. If the actual delay is a fraction of a nanosecond, independentDelayMax shall be the least integer number of nanoseconds that is greater than or equal to the actual delay.

NOTE 1—Since the minimum to maximum range is intended to be worst-case, the rules for handling a fraction of a nanosecond are intended to result in the widest range.

The delay begins when the message timestamp point of the ingress frame passes the reference plane marking the boundary between the network media and PHY. The delay ends when the message timestamp point of the egress frame passes the reference plane marking the boundary between the network media and PHY. The message timestamp point is specified by IEEE Std 802.1AS for various media, near the start of the frame.

NOTE 2—This delay includes all aspects of length-independent delay for a frame that is forwarded, including handling of error conditions.

12.32.1.2 dependentDelayMin/Max

These attributes provide the portion of delay that is dependent on frame length, where frame length is the number of octets that transfer across the MAC Service interfaces. Each length-dependent delay attribute specifies the time for a single octet of the frame to transfer from ingress to egress.

Each length-dependent delay attribute is an unsigned integer in units of picoseconds.

The dependentDelayMin attribute provides the minimum length-dependent delay from ingress Port to egress Port for this traffic class. If the actual delay is a fraction of a picosecond, dependentDelayMin shall be the greatest integer number of picoseconds that is less than or equal to the actual delay.

The dependentDelayMax attribute provides the maximum length-dependent delay from ingress Port to egress Port for this traffic class. If the actual delay is a fraction of a picosecond, dependentDelayMax shall be the least integer number of picoseconds that is greater than or equal to the actual delay.

NOTE—The length-dependent delay typically includes the time to receive and store each octet of the frame, and this time depends on the link speed of the ingress Port. For example, if the ingress Port is operating at 1 Gb/s, both dependentDelayMin and dependentDelayMax can return 8000. If an internal communication mechanism exists within the Bridge's architecture (i.e., in the relay), the time for that mechanism is added to the frame-dependent delay. For example, if a 100 Mb/s serial link connects the ingress and egress Ports, the previous example with 1 Gb/s link speed can return 88000 for both dependentDelayMin and dependentDelayMax.

12.32.2 Propagation Delay

This subclause specifies attributes of a managed object used to determine the delay along the network media (e.g., cable) for a frame transmitted from the specified Port of this station to the neighboring Port on a different station. There is one Propagation Delay managed object per Port of a station (i.e., Bridge or end station). The set of managed object attributes is shown in Table 12-39.

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Table 12-39—Propagation Delay attributes

Name	Data type	Operations supported[a]	Conformance[b]	References
txPropagationDelay	unsigned integer	R	BE	12.32.2.1

[a] R = Read only access; RW = Read/Write access.
[b] B = Required for Bridge or Bridge component support of Stream reservation remote management; E = Required for end station support of Stream reservation remote management.

12.32.2.1 txPropagationDelay

The txPropagationDelay begins when the message timestamp point of an egress frame passes the reference plane marking the boundary between the network media and PHY of this station's Port. The txPropagationDelay ends when the message timestamp point of an ingress frame on the neighboring station's Port passes the reference plane marking the boundary between the network media and PHY. The message timestamp point is specified by IEEE Std 802.1AS for various media, near the start of the frame.

The txPropagationDelay attribute is an unsigned integer in units of nanoseconds. If the actual propagation delay is measured to a fraction of a nanosecond, the txPropagationDelay value shall be least integer number of nanoseconds that is greater than or equal to the actual delay.

NOTE 1—Propagation delay in one direction of transmit is not necessarily the same as propagation delay of transmit in the reverse direction. In order to determine if a delay asymmetry exists, management can read the txPropagationDelay attribute on the neighboring station's Port. The txPropagationDelay attribute of the neighboring station's Port effectively provides the propagation delay for receiving frames on this station's Port.

NOTE 2—The txPropagationDelay attribute is typically measured using a time synchronization protocol. For example, when IEEE Std 802.1AS is in use, the value of this attribute can be obtained using the managed objects neighborPropDelay and delayAsymmetry.

NOTE 3—One of the primary purposes of the txPropagationDelay attribute is to add to Bridge Delay in order to compute total latency for a Stream. Although time synchronization protocols based on IEEE Std 1588 typically measure propagation delay to units of 2^{-16} ns, that degree of precision is not required for txPropagationDelay, since Bridge Delay is expressed as nanoseconds.

12.32.3 Static Trees

This subclause specifies attributes of a managed object used to determine if the static trees feature is supported by the Bridge. There is one Static Trees managed object that applies to the Bridge. The set of managed object attributes is shown in Table 12-40.

Table 12-40—Static Trees attributes

Name	Data type	Operations supported[a]	Conformance[b]	References
staticTreesSupported	Boolean	R	B	12.32.3.1

[a] R = Read only access; RW = Read/Write access.
[b] B = Required for Bridge or Bridge component support of Stream reservation remote management.

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12.32.3.1 staticTreesSupported

For some use cases, the TSN CNC needs to configure static (persistent) trees through Bridges from Talker to Listeners (e.g., for use of IEEE Std 802.1CB). The Traffic Engineering Multiple Spanning Tree Instance Identifier (TE-MSTID) can be leveraged for these use cases. A VLAN ID is allocated to the TE-MSTID in the MST Configuration Table if it is not under control of either a spanning tree protocol or IS-IS. Static Filtering Entries (8.8.1) specify frame forwarding and filtering for VLAN IDs allocated to the TE-MSTID.

The TE-MSTID feature is used as the basis of a set of features called Provider Backbone Bridge Traffic Engineering (PBB-TE) as specified in 25.10. For many TSN CNCs, use of the TE-MSTID feature is essential, but the additional features of PBB-TE are not necessary. The TSN CNC uses the staticTreesSupported attribute to determine that TE-MSTID is supported by the Bridge. A Bridge that supports PBB-TE without support of Stream reservation remote management is not required to implement the staticTreesSupported attribute.

A Bridge that supports Stream reservation remote management shall return the value TRUE from the staticTreesSupported attribute, and shall support the TE-MSTID as specified in 5.5.2.

NOTE—In order to determine support for TE-MSTID by the Bridge, the TSN CNC attempts to read the staticTreesSupported attribute. If the read operation returns an error, or if the read returns FALSE, then the TSN CNC concludes that TE-MSTID is not supported.

12.32.4 MRP External Control

In the Centralized network/distributed user model shown in Figure 46-2, user configuration data is exchanged in a distributed manner by each Talker/Listener end station, and the network is configured in a centralized manner (using a CNC). A Bridge near the Talker/Listener acts as a proxy with the CNC. One protocol solution for this model is to use the MRP protocol for user data (i.e., MSRP, MVRP, and/or MMRP applications), and a network management protocol as the proxy with the network manager (i.e., CNC). This enables the end stations to use the same MRP protocol as the Fully distributed model of Figure 46-1.

This subclause specifies attributes of a managed object that the network manager uses to

a) Disable MRP attribute propagation (MAP) for the MRP Participant of a Bridge Port.
b) Read MRP attribute registrations that the MRP Participant receives.
c) Write MRP attribute values for the MRP Participant to declare.

There is one MRP External Control managed object for each MRP Participant (per Port per MRP application per MAP Context, as specified in 10.2 and 10.3.1).

For the MSRP application, although 35.2.4.5 implies that a single MAP Context exists, the specifications of 35.1.3.1 ensure that every distinct value of vlan_identifier propagates along the corresponding VLAN context (10.3.1). Therefore, for the purposes of indexing this managed object, MSRP uses the vlan_identifier as the MAP Context identifier.

The set of managed object attributes is shown in Table 12-41.

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Table 12-41—MRP External Control attributes

Name	Data type	Operations supported[a]	Conformance[b]	References
externalControl	Boolean	RW	B	12.32.4.1
indicationList	octet string	R	B	12.32.4.2
indicationListLength	unsigned integer	R	B	12.32.4.3
indicationChangeCounter	counter	R	B	12.32.4.4
adminRequestList	octet string	RW	B	12.32.4.5
adminRequestListLength	unsigned integer	RW	B	12.32.4.6
operRequestList	octet string	R	B	12.32.4.7
operRequestListLength	unsigned integer	R	B	12.32.4.8

[a] R = Read only access; RW = Read/Write access.
[b] B = Required for Bridge or Bridge component when both Stream reservation remote management and the corresponding MRP application are supported.

12.32.4.1 externalControl

When the externalControl attribute is FALSE, MRP attributes propagate on the MRP Participant according to the specifications for MAP in 10.3 and specifications of the MRP Application (e.g., 35.2.4). Ports with the externalControl attribute FALSE are considered as candidates for the MRP Application's MAP Context. The remaining attributes of this managed object (12.32.4.2 through 12.32.4.8) are ignored by Ports with the externalControl attribute FALSE.

When the externalControl attribute is TRUE, the MRP Participant is removed from the MRP Application's MAP Context. The MRP Participant performs all other aspects of MRP, including MRP operation (10.6), MRP specifications (10.7), and MRPDU encodings (10.8). The remaining attributes of this managed object (12.32.4.2 through 12.32.4.8) act as an application component as specified in 10.2. The application component stores MAD indications for registration received on the Port, and invokes MAD requests for declarations on the Port.

The default value of the externalControl attribute is FALSE.

12.32.4.2 indicationList

As specified in 10.2, the MAD_Join.indication primitive is invoked in the application component when MRP detects that an MRP attribute has joined (i.e., registered), and the MAD_Leave.indication primitive is invoked in the application component when MRP detects that the MRP attribute has left (i.e., no longer registered). When the externalControl attribute is TRUE, the indicationList attribute stores the list of all joined MRP attributes for the MRP Participant.

When the MAD_Join.indication primitive is invoked, the MRP Participant forms a sequence of octets, *temporaryIndication*, from the MAD_Join.indication parameters as follows:

a) The first octet of *temporaryIndication* contains the *attribute_type* parameter.
b) The second octet of *temporaryIndication* contains the length of the *attribute_value* parameter as a single octet.

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c) Subsequent octets of *temporaryIndication* contain the sequence of octets for the *attribute_value* parameter.

NOTE 1—The *new* parameter is not used for indicationList.

The MRP Participant searches the indicationList to determine if the same octets as *temporaryIndication* (i.e., same *attribute_type* and *attribute_value*) exist. If no match is found, the contents of *temporaryIndication* are appended to the end of indicationList. The result of this specification is that the indicationList consists of an octet string that represents multiple MAD_Join.indication primitives in the order initially invoked.

When the MAD_Leave.indication primitive is invoked, the MRP Participant forms a sequence of octets, *temporaryIndication*, as specified for MAD_Join.indication. The MRP Participant searches the indicationList to determine if the same octets as *temporaryIndication* exist. If a match is found, the attribute's octets (i.e., matching *temporaryIndication)* are removed from the indicationList.

NOTE 2—When the indication's *attribute_type* is Listener Vector Attribute Type, the Listener's Declaration Type (35.2.1.3) is encoded as the last octet of *attribute_value*, even though the Declaration Type is not encoded in the MRP FirstValue (10.8.2.7), but the MRP FourPackedEvent (10.8.2.10.2). For the Listener Enhanced Vector Attribute Type, the Listener's Declaration Type is not encoded as the last octet, since the equivalent information is available in the ListenerStatus element (46.2.5.1).

The default value of the indicationList attribute is the empty octet string.

NOTE 3—The attribute encoding of indicationList does not correspond directly to the MRPDU. For example, if the received MRPDU uses NumberOfValues of three, then the MRPDU encodes only one attribute value (FirstValue), whereas indicationList encodes three distinct attribute type/length/value triplets.

When the externalControl attribute is FALSE, the indicationList attribute is ignored by the MRP Participant, and returns the empty octet string.

12.32.4.3 indicationListLength

The indicationListLength attribute returns the number of octets in the indicationList attribute.

When the externalControl attribute is FALSE, the indicationListLength attribute returns zero.

12.32.4.4 indicationChangeCounter

The indicationChangeCounter attribute increments by one for each change to indicationList as specified in 12.32.4.2.

The default value of the indicationChangeCounter attribute is zero.

When the externalControl attribute is FALSE, the indicationChangeCounter attribute returns zero.

12.32.4.5 adminRequestList

The adminRequestList attribute provides the administrative value of the current list of MAD requests for the MRP Participant (operRequestList). Changes to adminRequestList result in invocation of MAD_Join.request and MAD_Leave.request primitives (12.32.4.7). Each attribute in adminRequestList is encoded as the *attribute_type* parameter as a single octet, followed by the length of the *attribute_value* parameter as a single octet, followed by a sequence of octets for the *attribute_value* parameter.

NOTE—The *new* parameter is not used for adminRequestList.

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The default value of the adminRequestList attribute is the empty octet string.

When the externalControl attribute is TRUE, the adminRequestList attribute is copied to the operRequestList attribute as soon as possible according to the implementation. For example, the implementation could copy the list between each MRPDU transmit, or it could copy the list after all attributes in the previous operRequestList complete transmission as MRPDUs.

When the externalControl attribute is FALSE, the adminRequestList attribute is ignored by the MRP Participant, but it retains its value.

12.32.4.6 adminRequestListLength

The adminRequestListLength attribute provides the administrative value for the number of octets in adminRequestList.

The default value of the adminRequestListLength attribute is zero.

When the externalControl attribute is TRUE, the adminRequestListLength attribute is copied to the operRequestListLength attribute at the same time that the adminRequestList attribute is copied to the operRequestList attribute.

When the externalControl attribute is FALSE, the adminRequestListLength attribute is ignored by the MRP Participant, but it retains its value.

12.32.4.7 operRequestList

The operRequestList attribute is the operational value of the current list of MAD requests for the MRP Participant. Prior to copying adminRequestList to operRequestList, the lists are compared as follows:

a) If an attribute exists in adminRequestList that does not exist in operRequestList, invoke MAD_Join.request for that attribute, with the *new* parameter set TRUE.
b) If an attribute exists in operRequestList that does not exist in adminRequestList, invoke MAD_Leave.request for that attribute.

When the comparison is complete, adminRequestList is copied to operRequestList.

The default value of the operRequestList attribute is the empty octet string.

12.32.4.8 operRequestListLength

The operRequestListLength attribute is the operational value of the adminRequestListLength attribute, and it is copied at the same time that adminRequestList attribute is copied to operRequestList.

The default value of the operRequestListLength attribute is zero.

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17. Management Information Base (MIB)

17.4 Security considerations

17.4.12 Security considerations of the IEEE8021-FQTSS-MIB

Change the third paragraph and lettered list in 17.4.12 as shown:

The following tables and objects in the IEEE8021-FQTSS-MIB can be manipulated to interfere with the operation of the forwarding and queuing mechanisms in a manner that would be detrimental to the transmission of time-sensitive streams:

ieee8021FqtssDeltaBandwidth
ieee8021FqtssAdminIdleSlopeMs
ieee8021FqtssAdminIdleSlopeLs
ieee8021FqtssClassMeasurementInterval
ieee8021FqtssSrClassId
ieee8021FqtssTxSelectionAlgorithmID
ieee8021FqtssPriorityRegenOverride

a) ieee8021FqtssDeltaBandwidth can be manipulated to reduce the amount of bandwidth available to a given SR class.
b) ieee8021FqtssAdminIdleSlopeMs and ieee8021FqtssAdminIdleSlopeLs can be manipulated to change the overall amount of bandwidth available to stream traffic on a Port, in a network where SRP is not used for stream reservations.
c) ieee8021FqtssClassMeasurementInterval can be manipulated to change the measurement interval that is used, together with TSpec, to calculate reserved bandwidth.
d) ieee8021FqtssSrClassId can be manipulated to change the priority mapping of a SRclassID to a priority. This can impact the behavior of Streams.
e) ~~c)~~ ieee8021FqtssTxSelectionAlgorithmID can be manipulated in order to apply the wrong transmission selection algorithm to a traffic class that was being used by stream traffic.
f) ~~d)~~ ieee8021FqtssPriorityRegenOverride can be manipulated to disrupt stream traffic within an SRP domain with non-stream traffic entering from outside the SRP domain boundary.

17.4.14 Security considerations of the IEEE8021-SRP MIB

Change the third paragraph and lettered list in 17.4.14 as shown:

The following tables and objects in the IEEE8021-SRP MIB can be manipulated to interfere with the operation of the stream reservation mechanisms in a manner that would be detrimental to the transmission of the associated stream data:

ieee8021SrpBridgeBaseMsrpEnabledStatus
ieee8021SrpBridgeBaseMsrpTalkerPruning
ieee8021SrpBridgeBaseMsrpMaxFanInPorts
ieee8021SrpBridgeBaseMsrpLatencyMaxFrameSize
ieee8021SrpBridgeBaseMsrpTalkerVlanPruning
ieee8021SrpBridgePortMsrpEnabledStatus
ieee8021SrpBridgePortSrPvid
ieee8021SrpBridgeBaseMsrpTalkerPruningPerPort

a) ieee8021SrpBridgeBaseMsrpEnabledStatus can be manipulated to enable or disable MSRP operations for the entire Bridge.

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b) ieee8021SrpBridgeBaseMsrpTalkerPruning can be manipulated to stop the propagation of Talker attributes if Listeners are not configured to support Talker Pruning.

c) ieee8021SrpBridgeBaseMsrpMaxFanInPorts can be manipulated to set the number of ingress ~~p~~Ports supporting streaming down to one, which would stop Talkers streams from coming in on any other ~~p~~Port.

d) ieee8021SrpBridgeBaseMsrpLatencyMaxFrameSize can be manipulates to set a frame size that is so large or so small that it causes the Bridge to calculate unreasonable maximum latency.

e) ieee8021SrpBridgeBaseMsrpTalkerVlanPruning can be manipulated to change the behavior of a Bridge regarding Talker declarations. This can either restrict Talker declarations in an unintended way or cause Talker declarations to be forwarded on unintended Ports.

f) ~~e)~~ ieee8021SrpBridgePortMsrpEnabledStatus can be manipulated to enable or disable MSRP on a particular ~~p~~Port, perhaps allowing sensitive stream data to be sent to unacceptable devices.

g) ieee8021SrpBridgePortSrPvid can be manipulated to move Streams to a VLAN that has been blocked by management, thus disabling reception of the Stream by one or more Listeners.

h) ieee8021SrpBridgeBaseMsrpTalkerPruningPerPort can be manipulated to disable MAC address pruning per Port, causing Talker declarations to be forwarded on unintended Ports.

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17.7.12 Definitions for the IEEE8021-FQTSS-MIB module

Replace 17.7.12 with the following text:

```
IEEE8021-FQTSS-MIB DEFINITIONS ::= BEGIN

-- ============================================================
-- MIB for support of the Forwarding & Queuing Enhancements
-- for Time Sensitive Streams (FQTSS) in IEEE 802.1Q Bridges.
-- ============================================================

IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    Unsigned32
        FROM SNMPv2-SMI
    TEXTUAL-CONVENTION,
    TruthValue,
    RowStatus
        FROM SNMPv2-TC
    MODULE-COMPLIANCE,
    OBJECT-GROUP
        FROM SNMPv2-CONF
    ieee802dot1mibs,
    IEEE8021PriorityValue
        FROM IEEE8021-TC-MIB
    ieee8021BridgeBaseComponentId,
    ieee8021BridgeBaseEntry,
    ieee8021BridgeBasePort,
    ieee8021BridgeBasePortEntry
        FROM IEEE8021-BRIDGE-MIB
    BridgeId
        FROM BRIDGE-MIB
    ;

ieee8021FqtssMib MODULE-IDENTITY
    LAST-UPDATED "201810040000Z" -- October 4, 2018
    ORGANIZATION "IEEE 802.1 Working Group"
    CONTACT-INFO
        "  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
```


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```
            E-mail: STDS-802-1-L@IEEE.ORG"
        DESCRIPTION
            "The Bridge MIB module for managing devices that support
            the Forwarding and Queuing Enhancements
            for Time Sensitive Streams.

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

            Copyright (C) IEEE (2018).
            This version of this MIB module is part of IEEE Std 802.1Q;
            see the draft itself for full legal notices."

        REVISION "201810040000Z" -- October 4, 2018
        DESCRIPTION
                "Published as part of IEEE 802.1Qcc-2018.
                      Added managed objects for Stream Reservation
                      Protocol (SRP) Enhancements and Performance
                      Improvements"

        REVISION "201806280000Z" -- June 28, 2018
        DESCRIPTION
                "Published as part of IEEE Std 802.1Q 2017.
                Cross references corrected and updated. "

        REVISION "201512020000Z" -- December 2, 2015
        DESCRIPTION
                "Published as part of IEEE Std 802.1Q 2014 Cor-1.
                ETS code point added to the textual convention
                IEEE8021FqtssTxSelectionAlgorithmIDValue "

        REVISION "201412150000Z" -- December 15, 2014
        DESCRIPTION
                "Published as part of IEEE Std 802.1Q 2014 revision.
                Cross references updated and corrected."

        REVISION     "201102270000Z" -- February 27, 2011
        DESCRIPTION
             "Minor edits to contact information etc. as part of
              2011 revision of IEEE Std 802.1Q."

        REVISION     "200910010000Z" -- October 1, 2009
        DESCRIPTION
             "Initial revision, included in IEEE 802.1Qav."
        ::= { ieee802dot1mibs 16 }

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


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```
-- ============================================================

IEEE8021FqtssTrafficClassValue ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "An 802.1 FQTSS traffic class value.
        This is the numerical value associated with a traffic
        class in a Bridge. Larger values are associated with
        higher priority traffic classes."
    REFERENCE   "12.20.1"
    SYNTAX      Unsigned32 (0..7)

IEEE8021FqtssDeltaBandwidthValue ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "An 802.1 FQTSS delta bandwidth percentage,
        represented as a fixed point number scaled by
        1,000,000."
    REFERENCE   "12.20.1, 34.4"
    SYNTAX      Unsigned32 (0..100000000)

IEEE8021FqtssTxSelectionAlgorithmIDValue ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS      current
    DESCRIPTION
        "An 802.1 transmission selection algorithm identifier
         value. This is an integer, with the following
         interpretation placed on the value:

         0: Strict priority algorithm,
         1: Credit-based shaper algorithm,
         2: Enhanced Transmission Selection algorithm,
         3-255: Reserved for future standardization,
         256-4294967295: Vendor-specific transmission selection
                         algorithm identifiers, consisting of a
                         four-octet integer, where the most
                         significant 3 octets hold an OUI or CID value,
                         and the least significant octet holds
                         an integer value in the range 0-255
                         assigned by the owner of the OUI or CID."
    REFERENCE   "8.6.8, 12.20.2"
    SYNTAX  Unsigned32

-- ============================================================
-- subtrees in the FQTSS MIB
-- ============================================================
```


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```
ieee8021FqtssNotifications
    OBJECT IDENTIFIER ::= { ieee8021FqtssMib 0 }

ieee8021FqtssObjects
    OBJECT IDENTIFIER ::= { ieee8021FqtssMib 1 }

ieee8021FqtssConformance
    OBJECT IDENTIFIER ::= { ieee8021FqtssMib 2 }

ieee8021FqtssBap
    OBJECT IDENTIFIER ::= { ieee8021FqtssObjects 1 }

ieee8021FqtssMappings
    OBJECT IDENTIFIER ::= { ieee8021FqtssObjects 2 }

ieee8021FqtssBapX
    OBJECT IDENTIFIER ::= { ieee8021FqtssObjects 3 }

-- ============================================================
-- The ieee8021FqtssBap subtree
-- This subtree defines the objects necessary for the management
-- of bandwidth allocation for queues that support FQTSS.
-- ============================================================

-- ============================================================
-- the ieee8021FqtssBapTable
-- ============================================================

ieee8021FqtssBapTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF Ieee8021FqtssBapEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "A table containing a set of bandwidth availability
        parameters for each traffic class that supports the
        credit-based shaper algorithm.
        All writable objects in this table must be
        persistent over power up restart/reboot."
    REFERENCE   "12.20.1"
    ::= { ieee8021FqtssBap 1 }

ieee8021FqtssBapEntry OBJECT-TYPE
    SYNTAX      Ieee8021FqtssBapEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "A list of objects containing bandwidth allocation
```


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```
            information for each traffic class that supports the
            credit-based shaper algorithm. Rows in the table are
            automatically created and deleted as a result of the
            operation of the algorithm described in 34.5. "
        INDEX  { ieee8021BridgeBaseComponentId,
                 ieee8021BridgeBasePort,
                 ieee8021FqtssBAPTrafficClass  }
        ::= { ieee8021FqtssBapTable 1 }

    Ieee8021FqtssBapEntry ::=
        SEQUENCE {
            ieee8021FqtssBAPTrafficClass
                IEEE8021FqtssTrafficClassValue,
            ieee8021FqtssDeltaBandwidth
                IEEE8021FqtssDeltaBandwidthValue,
            ieee8021FqtssOperIdleSlopeMs
                Unsigned32,
            ieee8021FqtssOperIdleSlopeLs
                Unsigned32,
            ieee8021FqtssAdminIdleSlopeMs
                Unsigned32,
            ieee8021FqtssAdminIdleSlopeLs
                Unsigned32,
            ieee8021FqtssBapRowStatus
                RowStatus
            }

    ieee8021FqtssBAPTrafficClass OBJECT-TYPE
        SYNTAX      IEEE8021FqtssTrafficClassValue
        MAX-ACCESS  not-accessible
        STATUS      current
        DESCRIPTION
            "The traffic class number associated with the row of
            the table.

            A row in this table is created for each traffic class
            that supports the credit-based shaper algorithm. The
            recommended mappings of priorities to traffic classes
            for support of the credit-based shaper algorithm are
            described in 34.5."
        REFERENCE   "12.20.2, 34.3, 34.5"
        ::= { ieee8021FqtssBapEntry 1 }


    ieee8021FqtssDeltaBandwidth OBJECT-TYPE
        SYNTAX      IEEE8021FqtssDeltaBandwidthValue
        UNITS       "percent"
        MAX-ACCESS  read-write
```


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```
    STATUS      current
    DESCRIPTION
        "The value of the deltaBandwidth parameter
        for the traffic class.
        This value is represented as a fixed point number
        scaled by a factor of 1,000,000; i.e., 100,000,000
        (the maximum value) represents 100%.

        The default value of the deltaBandwidth parameter
        for the highest numbered traffic class that supports
        the credit-based shaper algorithm is 75%; for all
        lower numbered traffic classes that support the
        credit-based shaper algorithm the default value is 0%.

        The value of this object MUST be retained across
        reinitializations of the management system."
    REFERENCE   "12.20.1, 34.3"
    ::= { ieee8021FqtssBapEntry 2}

ieee8021FqtssOperIdleSlopeMs OBJECT-TYPE
    SYNTAX      Unsigned32
    UNITS       "bits per second"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The most significant 32 bits of the bandwidth,
        in bits per second, that is currently allocated to the
        traffic class (idleSlope(N)). This object MUST be read
        at the same time as ieee8021FqtssOperIdleSlopeLs,
        which represents the LS 32 bits of the value, in order
        for the read operation to succeed.

        If SRP is supported and in operation, then the reserved
        bandwidth is determined by the operation of SRP; otherwise,
        the value of ieee8021FqtssOperIdleSlopeMs is equal to
        the value of ieee8021FqtssAdminIdleSlopeMs.

        The value of this object MUST be retained across
        reinitializations of the management system."
    REFERENCE   "12.20.1, 34.3"
    ::= { ieee8021FqtssBapEntry 3 }

ieee8021FqtssOperIdleSlopeLs OBJECT-TYPE
    SYNTAX      Unsigned32
    UNITS       "bits per second"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
```


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```
            "The least significant 32 bits of the bandwidth,
            in bits per second, that is currently allocated to the
            traffic class (idleSlope(N)). This object MUST be read
            at the same time as ieee8021FqtssOperIdleSlopeMs,
            which represents the LS 32 bits of the value, in order
            for the read operation to succeed.

            If SRP is supported and in operation, then the reserved
            bandwidth is determined by the operation of SRP; otherwise,
            the value of ieee8021FqtssOperIdleSlopeLs is equal to
            the value of ieee8021FqtssAdminIdleSlopeMs.

            The value of this object MUST be retained across
            reinitializations of the management system."
        REFERENCE   "12.20.1, 34.3"
        ::= { ieee8021FqtssBapEntry 4 }

    ieee8021FqtssAdminIdleSlopeMs OBJECT-TYPE
        SYNTAX      Unsigned32
        UNITS       "bits per second"
        MAX-ACCESS  read-write
        STATUS      current
        DESCRIPTION
            "The most significant 32 bits of the bandwidth,
            in bits per second, that the manager desires to allocate
            to the traffic class as  idleSlope(N). This object MUST be
            read or written at the same time as
            ieee8021FqtssAdminIdleSlopeLs,
            which represents the LS 32 bits of the value, in order
            for the read or write operation to succeed.

            If SRP is supported and in operation, then the reserved
            bandwidth is determined by the operation of SRP, and any
            changes to the value of this object have no effect on the
            operational value of idleSlope(N).

            The value of this object MUST be retained across
            reinitializations of the management system."
        REFERENCE   "12.20.1, 34.3"
        DEFVAL { 0 }
        ::= { ieee8021FqtssBapEntry 5 }

    ieee8021FqtssAdminIdleSlopeLs OBJECT-TYPE
        SYNTAX      Unsigned32
        UNITS       "bits per second"
        MAX-ACCESS  read-write
        STATUS      current
        DESCRIPTION
```


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```
            "The least significant 32 bits of the bandwidth,
            in bits per second, that the manager desires to allocate
            to the traffic class as  idleSlope(N). This object MUST be
            read or written at the same time as
            ieee8021FqtssAdminIdleSlopeMs,
            which represents the LS 32 bits of the value, in order
            for the read or write operation to succeed.

            If SRP is supported and in operation, then the reserved
            bandwidth is determined by the operation of SRP, and any
            changes to the value of this object have no effect on the
            operational value of idleSlope(N).

            The value of this object MUST be retained across
            reinitializations of the management system."
        REFERENCE   "12.20.1, 34.3"
        DEFVAL { 0 }
        ::= { ieee8021FqtssBapEntry 6 }

    ieee8021FqtssBapRowStatus OBJECT-TYPE
        SYNTAX RowStatus
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
            "Indicates the status of an entry (row) in this table, and is
            used to create/delete entries.

            The corresponding instances of the following objects
            must be set before this object can be made active(1):
               ieee8021FqtssBAPTrafficClass
               ieee8021FqtssDeltaBandwidth
               ieee8021FqtssOperIdleSlopeMs
               ieee8021FqtssOperIdleSlopeLs
               ieee8021FqtssAdminIdleSlopeMs
               ieee8021FqtssAdminIdleSlopeLs

            The corresponding instances of the following objects
            may not be changed while this object is active(1):
               ieee8021FqtssBAPTrafficClass"
    ::= { ieee8021FqtssBapEntry 7 }

    -- ============================================================
    -- The ieee8021FqtssMappings subtree
    -- This subtree defines the objects necessary for the assignment
    -- of transmission selection algorithms to traffic classes,
    -- and definition of regeneration table override values.
    -- ============================================================
```


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```
-- ============================================================
-- the ieee8021FqtssTxSelectionAlgorithmTable
-- ============================================================

ieee8021FqtssTxSelectionAlgorithmTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF Ieee8021FqtssTxSelectionAlgorithmEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "A table containing the assignment of transmission
        selection algorithms to traffic classes for the Port.
        This table provides management of the Transmission
        Selection Algorithm Table defined in 8.6.8.

        For a given Port, a row in the table exists for each
        traffic class that is supported by the Port.

        The default assignments of transmission selection
        algorithms to traffic classes in the table are made
        on instantiation of the table, in accordance
        with the defaults defined in 8.6.8 and 34.5.

        All writable objects in this table must be
        persistent over power up restart/reboot."
    REFERENCE   "8.6.8, 12.20.2, 34.5"
    ::= { ieee8021FqtssMappings 1 }

ieee8021FqtssTxSelectionAlgorithmEntry OBJECT-TYPE
    SYNTAX      Ieee8021FqtssTxSelectionAlgorithmEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "A list of objects that contain the mapping of a
        traffic class value to a transmission selection algorithm
        value."
    INDEX  { ieee8021BridgeBaseComponentId,
             ieee8021BridgeBasePort,
             ieee8021FqtssTrafficClass  }
    ::= { ieee8021FqtssTxSelectionAlgorithmTable 1 }

Ieee8021FqtssTxSelectionAlgorithmEntry ::=
    SEQUENCE {
        ieee8021FqtssTrafficClass
            IEEE8021FqtssTrafficClassValue,
        ieee8021FqtssTxSelectionAlgorithmID
            IEEE8021FqtssTxSelectionAlgorithmIDValue
        }
```


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