

Draft Standard for Local and metropolitan area networks—

Quality of Service Provision by Network Systems

Unapproved draft, prepared by the

Time-Sensitive Networking (TSN) Task Group of IEEE 802.1

Sponsored by the

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6 **Quality of Service Provision by**
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¹ **Abstract:** This standard specifies procedures and managed objects for Quality of Service (QoS)
² features specified in IEEE Std 802.1Q, such as per-stream filtering and policing, queuing,
³ transmission selection, stream control and frame preemption, in a network system which is not a
⁴ bridge.

⁵ **Keywords:** CQF, IEEE 802.1Q™, LAN, local area network, Time-Sensitive Networking, TSN,
⁶ Virtual Bridged Network, virtual LAN, VLAN Bridge, Quality of Service, priority, credit-based shaper,
⁷ scheduled traffic, asynchronous traffic shaping, cyclic queuing and forwarding, per-Stream filtering
⁸ and policing, frame preemption.

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5 **Jessy Rouyer, *Vice Chair***
6 **János Farkas, *TSN Task Group Chair***
7 **Norman Finn, *Editor***
8

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1 **Introduction**

2

This introduction is not part of P802.1DC/D3.2, Draft Standard for Local and metropolitan area networks—Quality of Service Provision by Network Systems

3 This Standard specifies Quality of Service Provision by Network Systems.

4 This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution.

5 Revisions are anticipated within the next few years to clarify existing material, to correct possible errors, and

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1. Overview

1.1 Scope

This standard specifies procedures and managed objects for Quality of Service (QoS) features specified in IEEE Std 802.1Q, such as per-stream filtering and policing, queuing, transmission selection, stream control and preemption, in a network system which is not a bridge.

1.2 Specification model

The model of operation documented by this standard is simply a basis for describing the functionality of a compliant equipment. Implementations can adopt any internal model of operation compatible with the externally visible behavior that this standard specifies. Conformance of equipment to this standard is purely in respect of observable protocol.

1.3 Specification precedence

If any conflict among parts of this standard become apparent, information in normative Tables takes precedence over other parts of the standard, followed by that in normative text, followed by that in normative Figures. Non-normative Tables, Figures, and text are in Annexes and are clearly marked as such.

1.4 Requirements terminology

For consistency with existing IEEE and IEEE 802.1 standards, requirements placed upon conformant implementations of this standard are expressed using the following terminology:

- a) Shall is used for mandatory requirements;

- 1 b) May is used to describe implementation or administrative choices. “May” means “is permitted to,”
2 and hence, “may” and “may not” mean precisely the same thing;
- 3 c) Should is used for recommended choices. The behaviors described by “should” and “should not” are
4 both permissible but not equally desirable choices.

5 The Protocol Implementation Conformance Statement (PICS) proformas (see Annex A) reflect the
6 occurrences of the words “shall,” “may,” and “should” within the standard.

7 The standard avoids needless repetition and apparent duplication of its formal requirements by using is, is
8 not, are, and are not for definitions and the logical consequences of conformant behavior. Behavior that is
9 permitted but is neither always required nor directly controlled by an implementor or administrator, or
10 whose conformance requirement is detailed elsewhere, is described by can. Behavior that never occurs in a
11 conformant implementation or system of conformant implementations is described by cannot. The word
12 allow is used as a replacement for the phrase “Support the ability for,” and the word capability means “can
13 be configured to.”

14 Where this standard states that “a conformant system shall” support (conform to, provide, etc.) some part of
15 some other IEEE 802 standard, this means that the “shall,” “may,” and “should” terms in the referenced
16 standard apply in the manner described, in that referenced standard, to the conformant system; it does not
17 mean that a “may” or “should” in the referenced standard are promoted to a “shall” for this standard.

18 **1.5 Structure and relationship to other standards**

19 IEEE Std 802.1QTM specifies the operation of Bridges and Bridged Networks, as well as certain end station
20 behaviors. Parts of that standard can be classified as describing Quality of Service functions (QoS). QoS
21 functions are those that affect a network's ability to serve data flows, as measured by the following
22 parameters:

- 23 a) Latency: The time required to forward a frame¹ from source to destination through a Bridged
24 Network.
- 25 b) Frame loss probability: The likelihood of losing a frame, rather than forwarding it, due to various
26 events occurring between the source and destination.
- 27 c) Variability of the above parameters.

28 These parameters can be applied to individual frames, or to collections of frames, such as a single stream of
29 frames from one source application instance to another, all frames sharing the same priority value, or all
30 frames bound for a particular destination. Minimums, maximums, averages, or other mathematical functions
31 can be applied to the parameters of a collection.

32 In defining QoS, IEEE Std 802.1Q makes normative references to IEEE Std 802.1CB, and IEEE Std
33 802.1AC.

34 IEEE Std 802.1Q specifies Quality of Service (QoS) features for bridges. These features are perfectly
35 applicable to other devices, e.g. end stations, routers, or firewall appliances. In IEEE Std 802.1Q, the
36 specifications of these features are scattered, and coupled tightly to the operation of a bridge. There is a need
37 for simple reference points to these QoS specifications that are usable for non-bridge systems, and for
38 managed objects for these features that are not specific to bridges.

1. Bridges, by definition, receive, transmit, and forward “frames”, as specified in IEEE Std 802. Other standards from IEEE and other organizations use the term “packet” for a unit of transmitted data. This standard uses “frame” exclusively, as it indicates the unit of transmission on a port, which is the most useful unit for this standard.

1 This standard specifies General Frame QoS (GFQoS), the IEEE Std 802.1DC Quality of Service. It specifies
2 the behavior of two kinds of systems, a GFQoS end system and a GFQoS forwarding system, each of which
3 supplies the GFQoS.

4 The referenced IEEE 802 standards specify many non-QoS functions that are of no concern to this standard.
5 For example, there are many functions that are performed by an IEEE Std 802.1Q Bridge, or by a GFQoS
6 forwarding system, that are *not* a part of GFQoS:

- 7 d) Frame forwarding, in the sense of choosing the output port(s), to which a given frame is forwarded
8 by a GFQoS forwarding system.
- 9 e) Transformations that frames may undergo as they are forwarded due to forwarding decisions, e.g.
10 adding VLAN (Virtual Local Area Network) tags or updating fields in an IPv6 header [B9].
- 11 f) Frame Replication and Elimination for Reliability. (See 6.5.3 for an explanation why.)
- 12 g) Various control protocols, including resource reservation protocols (e.g. Stream Reservation
13 Protocol, SRP, Clause 35 of IEEE Std 802.1Q-2022, or Resource ReSerVation Protocol, RSVP,
14 IETF RFC 2205[B7]) that can be used to control GFQoS functions. (See 6.5.4 for an explanation
15 why.)

16 Clauses 2, 3, and 4 contain the normative references, definitions, and abbreviations used in this standard,
17 respectively. Clause 5 specifies the requirements for various types of systems to claim compliance to this
18 standard. It is the starting point to answer the question, “What must a compliant implementation do?”
19 Clause 6 introduces the specifications for GFQoS functions specified in IEEE Std 802.1Q, and IEEE Std
20 802.1CB, including, in 6.2, a complete list of GFQoS functions. Clause 7 contains the specifications for
21 certain of the GFQoS functions that cannot be specified, in Clause 5, simply as references to other IEEE
22 802.1 standards. Clause 8 specifies the managed objects required to control the GFQoS functions.

23 1.6 Reference conventions

24 Because this standard makes frequent references to specific subclauses in IEEE Std 802.1Q-2022 and its
25 amendments, IEEE Std 802.1AC-2016, and IEEE Std 802.1CB-2017, as well as to subclauses within this
26 standard, the following conventions are used:

- 27 — A reference to “subclause *x.y* in IEEE Std 802.1Q-2022” is of the form: “[Q] *x.y*”.
- 28 — A reference to “subclause *x.y* in IEEE Std 802.1CB-2017” is of the form: “[CB] *x.y*”.
- 29 — A reference to “subclause *x.y* in IEEE Std 802.1AC-2016” is of the form “[AC] *x.y*”.
- 30 — A reference to “subclause *x.y* in IEEE Std 802.1Qcw-2023” is of the form “[Qcw] *x.y*”.
- 31 — A reference to “subclause *x.y* in IEEE Std 802.1Qcz-2023” is of the form “[Qcz] *x.y*”.
- 32 — A reference to “subclause *x.y* in IEEE Std 802.1Qdx-2024” is of the form “[Qdx] *x.y*”.
- 33 — A reference to subclause *x.y* in this standard has no prefix: “*x.y*”.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used). Each referenced document is cited in text and its relationship to this document is explained. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies. Non-normative references (i.e., that provide additional information not required for the application of this document) are given in Annex B.

NOTE—The inclusion of a document in this list of normative references indicates that certain information in that document is necessary to implement this standard. It does not imply that any other part of that referenced document is to be implemented by a system conformant to this standard.

[IEEE Std 802™](#), IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.^{2, 3}

[IEEE Std 802.1AC™-2016](#), IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Service Definition.

[IEEE Std 802.1Q™-2022](#), IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks.

[IEEE Std 802.1Qcw™-2023](#), IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment: YANG Data Models for Scheduled Traffic, Frame Preemption, and Per-Stream Filtering and Policing.

[IEEE Std 802.1Qcz™-2023](#), IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment: Congestion Isolation.

[IEEE Std 802.1Qdx™-2024](#), IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment: YANG Data Models for the Credit-Based Shaper.

[IEEE Std 802.1CB™-2017](#), IEEE Standard for Local and metropolitan area networks—Frame Replication and Elimination for Reliability.

2. IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ, 08854, USA (<http://standards.ieee.org/>).

3. The IEEE standards or products referred to in this clause are trademarks of the Institute of Electrical and Electronics Engineers, Inc.

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁴

This standard makes use of the following terms defined in IEEE Std 802:

- end station
- frame

This standard makes use of the following terms defined in IEEE Std 802.1Q:

- bit time
- Bridge
- Listener
- Stream
- Talker

NOTE 1—The [IEEE Get program](https://standards.ieee.org/products-programs/ieee-get-program/)⁵ provides certain IEEE standards, including IEEE Std 802 and IEEE Std 802.1Q, at no charge, after a waiting period following publication.

The following terms are specific to this standard:

end system: A system attached to a network that is an initial source or a final destination of data transmitted across that network.

NOTE 2—The term “end system” is often used in this document in places where the reader of IEEE 802 standards would expect the term, “end station,” in order to avoid confusion caused by standards relating to routers. For example, a router, as defined by IETF, is an IEEE 802 “end station,” but not an “end system.” Where this standard specifically refers to the use of IEEE 802 services, the term “end station” is used. Where it refers to more generalized instances of associationless services, the term “end system” is used.

forwarding system: A router, security appliance, address translation appliance, or any other device that forwards a frame from one port to another, such that the frame is, in some useful sense, identifiable to other systems as being the same frame.

NOTE 3—An IEEE Std 802.1Q Bridge is not considered a forwarding system because an IEEE Std 802.1Q Bridge and its forwarding behavior are specified by IEEE Std 802.1Q.

General Frame QoS: The kinds of Quality of Service functions specified by this standard.

GFQoS end system: An end system that is a GFQoS system.

GFQoS forwarding system: A forwarding system that is a GFQoS system.

GFQoS system: An end system or a forwarding system that conforms to this standard.

system: A functional unit.

NOTE 4—No relationship between physical implementation and logical function is implied by the term, “system”; a chassis can be composed of multiple systems, and a system can be spread over multiple chassis.

⁴ *IEEE Standards Dictionary Online* is available at <https://dictionary.ieee.org>.

⁵ <https://standards.ieee.org/products-programs/ieee-get-program/>

4. Abbreviations

This standard contains the following abbreviations:

CBS	Credit-Based Shaper
CQF	Cyclic Queuing and Forwarding
GFQoS	General Frame Quality of Service
DSCP	Differentiated Services Code Point
EISS	Enhanced Internal Sublayer Service
IPV	Internal priority value specification
ISS	Internal Sublayer Service
PSFP	Per-Stream Filtering and Policing
QoS	Quality of Service
TSN	Time-Sensitive Networking

5. Conformance

This clause specifies the mandatory and optional capabilities provided by conformant implementations of this standard. Three terms are used for systems compliant to this standard:

- a) **GFQoS system:** A GFQoS system provides the GFQoS, and is either a GFQoS end system or a GFQoS forwarding system. Common required behaviors for all GFQoS systems are given in 5.3, and optional behaviors in 5.4.
- b) **GFQoS end system:** A GFQoS end system provides the GFQoS on one or more ports for the purpose of sourcing or sinking streams. Required behaviors are given in 5.5, and optional behaviors in 5.6.
- c) **GFQoS forwarding system:** GFQoS forwarding system provides the GFQoS when forwarding frames from one port to another. Required behaviors are given in 5.7, and optional behaviors are given in 5.8.

5.1 Protocol Implementation Conformance Statement (PICS)

A claim of conformance specifies implementation of a GFQoS end system or a GFQoS forwarding system. A GFQoS system can support multiple claims for a range of possible behaviors. The supplier of an implementation that is claimed to conform to this standard shall provide the information necessary to identify both the supplier and the implementation, and shall complete a copy of the PICS proforma provided in Annex A for that specific system implementation.

5.2 Interpreting IEEE Std 802.1Q and IEEE Std 802.1CB for GFQoS systems

IEEE Std 802.1Q is the standard that specifies Bridges and end stations. In order to apply this standard to GFQoS systems, the following systematic substitutions are to be made when reading those standards:

- Bridge:** For “Bridge”, read “GFQoS forwarding system”.
- MAC Relay:** For “MAC Relay”, read “GFQoS forwarding system”.
- Bridge Port:** For “Bridge Port”, read “port”.
- End station:** For “end station”, read “GFQoS end system”.

These transformations apply only to clauses called out in this standard as applying to GFQoS system. No “shall”, “should”, or “may” in IEEE Std 802.1Q is a requirement on a GFQoS system except as called out in this standard.

As defined in this standard, a forwarding system includes the capabilities cited in references to IEEE Std 802.1CB of a relay system except that a forwarding system cannot be an IEEE Std 802.1Q Bridge.

5.3 GFQoS system required behaviors

Any system conformant to this standard shall:

- a) Support the GFQoS provision model (7.2).
- b) Conform to the relevant standard for the MAC technology implemented at each port in support of the MAC Internal Sublayer Service (ISS), as specified in [AC] 11.1.
- c) Support transmission selection by strict priority (7.3.1, [Q] 8.6.8.1).

1 5.4 GFQoS system optional behaviors

2 Any system conformant to this standard may:

- 3 a) Support the Enhanced Internal Sublayer Service (EISS), as specified in 7.3.2.
- 4 b) Support for priority-based flow control ([Q] 5.11).
- 5 c) Support transmission selection by enhanced transmission selection ([Q] 5.4.1.6, [Q] 8.6.8.3), except
- 6 that support for DCBX (Data Center Bridging eXchange Protocol) ([Q] 5.4.1.6:e, [Q] 38) is not
- 7 required.

8 NOTE— [Q] 5.4.1.6 applies only to Bridges, not to end systems. This standard allows GFQoS end systems to claim

9 support for enhanced transmission selection.

- 10 d) Support enhancements for scheduled traffic ([Q] 8.6.8.4, [Q] 8.6.9).
- 11 e) Support management of the system using the YANG modules specified in Clause 9.

12 5.5 GFQoS end system required behaviors

13 An end system conformant to this standard shall, on one or more ports:

- 14 a) Support all of the items listed in 5.3.

15 5.6 GFQoS end system optional behaviors

16 An end system conformant to this standard may, on at least one port:

- 17 a) Support any of the items listed in 5.4.
- 18 b) Support the Credit-Based Shaper (CBS, 7.3.3).
- 19 c) Support Per-Stream Filtering and Policing (PSFP, [Q] 5.27).
- 20 d) Support transmission selection by Asynchronous Traffic Shaping (ATS, [Q] 5.31).
- 21 e) Support cyclic queuing and forwarding (CQF, [Q] 5.28).
- 22 f) Support Talker end system required ([CB] 5.6), recommended ([CB] 5.7), and/or optional ([CB] 5.8)
- 23 behaviors for Frame Replication and Elimination for Reliability.
- 24 g) Support Listener end system required ([CB] 5.9), recommended ([CB] 5.10), and/or optional
- 25 ([CB] 5.11) behaviors for Frame Replication and Elimination for Reliability.
- 26 h) Support frame preemption ([Q] 5.26).

27 5.7 GFQoS forwarding system required behaviors

28 A forwarding system conformant to this standard shall, on more than one port:

- 29 a) Support all of the items listed in 5.3.

30 5.8 GFQoS forwarding system optional behaviors

31 A forwarding system conformant to this standard may, on more than one port:

- 32 a) Support any of the items listed in 5.4.
- 33 b) Support the Credit-Based Shaper (CBS, 7.3.3).
- 34 c) Support Per-Stream Filtering and Policing (PSFP, [Q] 5.4.1.8).

- 1 d) Support transmission selection by Asynchronous Traffic Shaping (ATS, [Q] 5.4.1.10).
- 2 e) Support cyclic queuing and forwarding (CQF, [Q] 5.4.1.9).
- 3 f) Conform to forwarding system required ([CB] 5.12), recommended ([CB] 5.13), and/or optional
- 4 ([CB] 5.14) behaviors for Frame Replication and Elimination for Reliability.
- 5 g) Support frame preemption (7.3.4).
- 6 h) Support General flow classification and metering ([Q] 8.6.5.1).

1 6. IEEE Std 802.1Q Quality of Service provision

2 6.1 Overview

3 The purpose of this Clause 6 is to introduce the model for Quality of Service (QoS) provision in IEEE Std
4 802.1Q. This clause lists the QoS functions, indicates their relationships, and provides references to the
5 clauses in IEEE Std 802.1Q-2022 and its amendments that specify the operation of these functions.

6 The remainder of this clause includes:

- 7 a) In 6.2, a list of GFQoS functions provided in this standard;
- 8 b) In 6.3, a list of the subclauses of IEEE 802.1Q that are relevant to GFQoS;
- 9 c) In 6.4, a list of functions in IEEE 802.1Q that can affect GFQoS, but are not strictly GFQoS
10 functions, and are not addressed in this standard; and
- 11 d) In 6.5, a list of QoS mechanisms in IEEE 802.1Q that are not included in this standard.

12 6.2 List of GFQoS functions

13 Following is a list of the functions that can be provided by GFQoS systems. For each, a reference is given to
14 the requirements in Clause 5 for conformance for that function.

15 6.2.1 Basic GFQoS functionality

16 This specifies the reference model with respect to which the various functions are specified. (5.3:a, 5.3:b)

17 6.2.2 Strict priority

18 The output queues on a port are ranked by priority. The highest priority output queue that is eligible for
19 selection is the one from which the next frame is transmitted. (5.3:c)

20 6.2.3 Extended Internal Sublayer Service (EISS)

21 The EISS is a MAC service interface defined in IEEE Std 802.1Q Bridges to handle VLAN tagging. (5.4:a)

22 6.2.4 Priority-based Flow Control (PFC)

23 PFC allows a receiver to pause the transmission of frames from a queue serving a particular layer 2 priority
24 level in the attached transmitter. (5.4:b)

25 6.2.5 Frame preemption

26 Frame preemption is the process whereby the transmission of a frame can be interrupted one or more times
27 in order to allow the transmission of frames with more critical requirements on delivery time. (5.6:h, 5.8:g)

28 6.2.6 Frame Replication and Elimination for Reliability

29 IEEE Std 802.1CB specifies mechanisms for sequence numbering and then replicating the frames of a
30 stream, sending those replicated streams along multiple disjoint paths through the network, and recombining
31 the streams, eliminating the duplicates, at one or more other points in the network. (5.6:g, 5.8:f)

1 6.2.7 General flow classification and metering

2 This provides mechanisms for discarding and/or marking frames for reduced probability of delivery based
3 on source MAC address, destination MAC addresses, VID or priority. (5.8:h)

4 6.2.8 Per-Stream Filtering and Policing (PSFP)

5 PSFP supports the identification of streams or set of streams for specific treatment based on the contents of
6 the frame, including timed input gates, assignment to specific classes of service, discard based on frame size,
7 flow metering. (5.8:c)

8 6.2.9 Enhanced Transmission Selection (ETS)

9 ETS limits the percentage of an output port's bandwidth that can be taken up by a priority level or set of
10 priority levels. (5.4:c)

11 6.2.10 Scheduled Traffic

12 The Scheduled Traffic function provides schedule for an output port that repeats at a fixed frequency. Each
13 entry in the schedule enables and/or disables specific output queues. (5.4:d)

14 6.2.11 Credit-Based Shaper (CBS)

15 The Credit-Based Shaper paces (shapes) the output from a queue in order to make possible the calculation of
16 worst-case delivery times for classes of flows (5.6:b, 5.8:b). In IEEE Std 802.1Q, CBS is specified as part of
17 Forwarding and Queuing enhancements for Time-Sensitive Streams (FQTSS), which also includes a number
18 of other functions related to the Stream Reservation Protocol, and to altering priority values while
19 forwarding frames. Only the Credit-Base Shaper is specified for GFQoS systems.

20 6.2.12 Cyclic Queuing and Forwarding (CQF)

21 CQF applies the scheduled traffic (6.2.10) and stream gate (6.2.8) functions to alternate two queues between
22 the filling and transmitting states, with ports in all Bridges in a network switching queues synchronously,
23 thus progressing frames at a predictable rate through the network. (5.6:e, 5.8:e)

24 6.2.13 Asynchronous Traffic Shaping (ATS)

25 ATS assigns a state machine to each stream or set of streams of interest to a Bridge. That state machine uses
26 the time of arrival of each identified frame to assign a transmission time to the frame. Frames are output in
27 order of transmission time, with no frame transmitted before its time. This function allows the accurate
28 computation of the worst-case time required for a frame belonging to an ATS stream to traverse the network.
29 (5.6:d, 5.8:d)

30 6.3 IEEE Std 802.1Q clauses and subclauses relevant to GFQoS

31 In IEEE Std 802.1Q-2022, the clauses and subclauses relevant to GFQoS are the following:

- 32 a) [Q] 6 "Support of the MAC service" describes the MAC service, offered by a Bridged network or
33 VLAN Bridged Network, that an IEEE 802.1Q Bridge participates in offering.
- 34 1) Subclause [Q] 6.5 "Quality of service (QoS) maintenance" contains useful definitions and
35 explanations of the GFQoS parameters.
- 36 2) Subclauses [Q] 6.7.1 and [Q] 6.7.2 describe frame preemption. (See also [B1].)

- 1 3) Subclauses [Q] 6.8 and [Q] 6.9 specify support for the Enhanced Internal Sublayer Service
2 (EISS) and the use of VLAN tags.
- 3 b) [Q] 8 “Principles of Bridge operation”, specifies the core operations of a Bridge.
- 4 1) [Q] 8.2 “Bridge architecture” provides a necessary context for the discussion of the functions
5 specific to GFQoS.
- 6 2) [Q] 8.6 “The forwarding process” describes the operation of a Bridge, including many of the
7 GFQoS mechanisms, in a “day in the life of a frame” linear order. [Q] 34.6 “End station
8 behavior” adds end station considerations to this model.
- 9 c) Specific GFQoS functions specified in Clause 7 are described in various places in IEEE Std
10 802.1Q-2022. The functions that occur between input and placing the frames in queues include:
- 11 1) Flow classification and metering, [Q] 8.6.5, 7.2.1 (which contains normative references to
12 IEEE Std 802.1CB-2017), includes the prioritization, identification, and rate marking of
13 specific streams. Both general flow classification and metering (7.2.1.1) and per-stream
14 classification and metering (7.2.1.2) are covered in this subclause.
- 15 2) Stream gate control, [Q] 8.6.10, is a mechanism for admitting or discarding specific streams’
16 frames, and for using stream identification information to assign a frame to a specific class of
17 service. These decisions can be based on a synchronized time schedule. Stream gate control is a
18 part of Per-Stream Filtering and Policing (PSFP), the definition of which is in several
19 subclauses within [Q] 8.6.
- 20 3) Queuing frames, [Q] 8.6.6, assigns frames to a queue, based on the class of service. The
21 selection of an output port, described in other subclauses of IEEE Std 802.1Q-2022, is not
22 relevant to this standard.
- 23 4) Queue management, [Q] 8.6.7, includes provision for dropping frames to be placed in a queue
24 because of maximum forwarding time, red/yellow/green marking, or a full queue.
- 25 d) Having placed the frames in queues, a number of GFQoS functions are described for selecting which
26 frame to transmit next:
- 27 1) Strict priority, [Q] 8.6.8.1, is the simplest selection method. The highest priority frame is
28 transmitted.
- 29 2) The Credit-Based Shaper, [Q] 8.6.8.2 and [Q] Annex L (informative), limits the bandwidth of
30 a queue to a specific maximum value.
- 31 3) Enhanced transmission selection (ETS), [Q] 8.6.8.3 and [Q] 37, allow a group of queues to
32 share the available bandwidth, so that each queue is assured of a specific minimum percentage
33 of the bandwidth available to the group.
- 34 4) Enhancements for scheduled traffic, [Q] 8.6.8.4, [Q] 8.6.9, and [Q] Annex Q (informative),
35 specify a set of gates, one per queue, that open and close on a repeating schedule that is tied to
36 a clock that can be synchronized with other Bridges (forwarding systems) and end stations (end
37 systems) in the network.
- 38 5) Cyclic queuing and forwarding, [Q] Annex T, describes a specific use case of the other
39 functions which, taken together, provide a double buffering scheme for a traffic class that
40 provides streams an assured maximum per-hop latency that is easy to calculate and enforce.
- 41 6) The Asynchronous traffic shaper, [Q] 8.6.11 and [Q] 47, uses more complex queues and a
42 token bucket shaping algorithm in order to provide an assured maximum end-to-end latency
43 without requiring a synchronized clock.
- 44 7) Priority flow control, [Q] 36, allows a receiver at one end of a point-to-point LAN to throttle
45 the transmitter on a per-priority basis.

46 The rest of this Clause 6 contains further text that will be helpful to a reader of IEEE Std 802.1Q and IEEE
47 Std 802.1CB.

1 6.4 Other Bridge functions relevant to GFQoS provision

2 6.4.1 Link Aggregation

3 IEEE Std 802.1AX [B2] specifies Link Aggregation, wherein multiple physical ports can be aggregated
4 together to appear, to the upper layers (e.g. a Bridge Port) to be a single physical port. This allows one to
5 increase the bandwidth and reliability of a link between two systems.

6 IEEE Std 802.1Q does not specify where the queues that are referenced by [Q] 8.6.6, [Q] 8.6.7, and
7 [Q] 8.6.8 physically reside. The first paragraph of [Q] 8.6.6 implies that there is a set of queues attached to
8 each “transmission Port,” not to each “Bridge Port.” Thus, in the case of Link Aggregation, IEEE Std
9 802.1Q does not specify whether the queues are associated with the Aggregator Port (the simulated
10 combined port, which is associated with the Bridge Port, and can be the transmission Port) or the
11 Aggregation Port (the physical port, which can also be a transmission Port). When designing or configuring
12 a network, some GFQoS functions behave very differently, depending on whether the queues are associated
13 with the Aggregator Port or an Aggregation Port.

14 6.4.2 MAC Security entity

15 MAC security, specified in IEEE Std 802.1AE-2006 [B3], can cause some or all of the frames passing into
16 or out of a given port to undergo a cryptographic transformation, which takes a finite, sometimes variable,
17 amount of time. This of course, affects the GFQoS that a system can offer. MAC security is one reason that
18 the QoS specifications in IEEE Std 802.1Q use reference points that are observable outside a system. This
19 enables the implementation and network management to assume the responsibility to account for the impact
20 of MAC security on QoS when configuring a network.

21 6.4.3 Priority / DSCP regeneration

22 IEEE Std 802.1Q Bridges have the capability of altering the priority parameter of a forwarded frame in
23 various ways. Similarly, an IETF router can alter the value of the Differentiated Services Code Point
24 (DSCP). Such actions affect the GFQoS offered, but such actions are too closely connected to the
25 forwarding functions of these devices to specify in this standard.

26 Priority regeneration can be critical, for example to protect the network against the input of frames that have
27 the priority or DSCP of a time-sensitive stream, but which do not, in fact, belong to a reserved stream (see
28 [Q] 6.9.4).

29 6.5 GFQoS functions not specified

30 6.5.1 Congestion notification

31 This standard does not specify any functions for congestion notification, which is specified in IEEE Std
32 801.Q-2022 in Clauses [Q] 30, [Q] 31, [Q] 32, and [Q] 33.

33 6.5.2 Media QoS capabilities

34 Although some media (e.g. IEEE Std 802.11 [B4]) offer a QoS capability, this standard specifies GFQoS
35 functions only for end systems and forwarding systems, and not the QoS functions of specific media.

36 6.5.3 Frame replication and elimination for reliability

37 Frame replication and elimination for reliability is described in IEEE Std 802.1CB. The probability of frame
38 loss is a GFQoS concern. However, the replication, sequencing, and elimination methods described in IEEE

1 Std 802.1CB are described for end systems and forwarding systems, not just for Bridges. IEEE Std 802.1CB
2 is applicable to GFQoS systems without further elaboration, so its functions need not be included in this
3 standard. This standard does make normative references to IEEE Std 802.1CB solely for stream
4 identification for other GFQoS purposes.

5 **6.5.4 Control protocols**

6 Resources in a network have to be reserved for the use of specific streams or for classes of streams before
7 the transmission of the streams begin, in order to obtain the benefits of certain GFQoS functions. For this
8 reason, [Q] 35 specifies the Stream Reservation Protocol. IETF RFC 2205[B7] specifies the Resource
9 ReSerVation Protocol (RSVP) for a similar purpose. These protocols make assumptions about the
10 forwarding system used, either a bridge or a router; they are not a suitable subject for this standard, which
11 makes no such assumptions.

1 7. GFQoS systems

2 7.1 GFQoS end systems, GFQoS forwarding systems, and streams

3 The GFQoS provision model (7.2) is concerned with providing GFQoS to classes of frames and to streams
4 of frames. A stream is a set of frames from a single Talker (source end system) to one (unicast) or one or
5 more (multicast) Listeners (destination end systems). Multiple streams can flow from one Talker A to a
6 Listener B. A class of frames is not limited to a single source. The user responsible for each stream or class
7 has some expectation of GFQoS from the network. A stream is unidirectional, in the sense that there is no
8 association, as far as the GFQoS provision model data plane is concerned, between the frames received by
9 and transmitted from an end system.

10 The GFQoS provision model (7.2) specifies two kinds of GFQoS systems: GFQoS end systems and GFQoS
11 forwarding systems. A GFQoS end system applies the GFQoS provision model (7.2) to frames transmitted
12 and received on one or more ports.

13 A GFQoS forwarding system has two or more ports, and transfers frames from one reception port to one or
14 more transmission ports in a manner such that each transmitted frame is, in some useful sense, identifiable as
15 being the same as, or a copy, perhaps modified, of the received frame. We can thus speak of a frame's path
16 through a network, or of the time taken for a frame to traverse the network. A GFQoS forwarding system
17 applies the GFQoS provision model to the frames that it forwards.

18 A GFQoS end system does not forward frames. A GFQoS forwarding system, or part of a GFQoS
19 forwarding system, can also be a Talker or a Listener, and thus act as a GFQoS end system for the purposes
20 of this standard.

21 All GFQoS systems implement the GFQoS provision model (7.2). There are a number of GFQoS functions
22 that can optionally be implemented, as listed in 7.3.

23 7.2 GFQoS provision model

24 Figure 7-1, below, is based on [Q] Figure 8-12 in [Q] 8.6. It illustrates the operation of the forwarding
25 process in a single instance of a frame forwarded between the ports of a GFQoS forwarding system with two
26 ports. It illustrates just those parts of the forwarding process ([Q] 8.6) that are relevant to a GFQoS
27 forwarding system. The functions are shown in sequence from the top, where a frame is received on the
28 reception port, through the various functions, to the transmission port at the bottom of the figure. Not shown
29 in Figure 7-1 are functions in [Q] Figure 8-12 that only apply to a Bridge, e.g. Egress filtering ([Q] 8.6.4). In
30 particular, there is no function in Figure 7-1 that determines the set of transmission ports on which a given
31 received frame is to be sent. The behavior of any such function, or its relationship to the GFQoS functions
32 shown in Figure 7-1, is not specified in this standard.

33 Figure 7-2, below, illustrates the parts of the IEEE Std 802.1Q forwarding process that are relevant to a
34 GFQoS end system. The transmit path is based upon [Q] Figure 8-12, and upon [Q] Figure 34-1 in
35 [Q] 34.6.1. Only those parts of [Q] Figure 34-1 that are relevant to a GFQoS end system are included. The
36 end system receive data path in Figure 7-2 is based on [Q] Figure 8-12.

37 The models illustrated in Figure 7-1, Figure 7-2, [Q] 8.6.6, and [Q] Figure 22-4 each have a set of queues,
38 and that set is associated with a specific output Bridge Port. As stated in 1.2 and [Q] 8.3, this is a
39 behavioral model, not the design of a specific implementation, and does not preclude an implementation
40 from employing queues on input ports, virtual queues, or queues on the physical ports comprising an IEEE
41 Std 802.1AX aggregation. A number of figures in IEEE Std 802.1Q-2022 show that frames to be output on a
42 physical port, e.g. those from the "LLC" function in [Q] Figure 22-8, can bypass the output queues entirely.

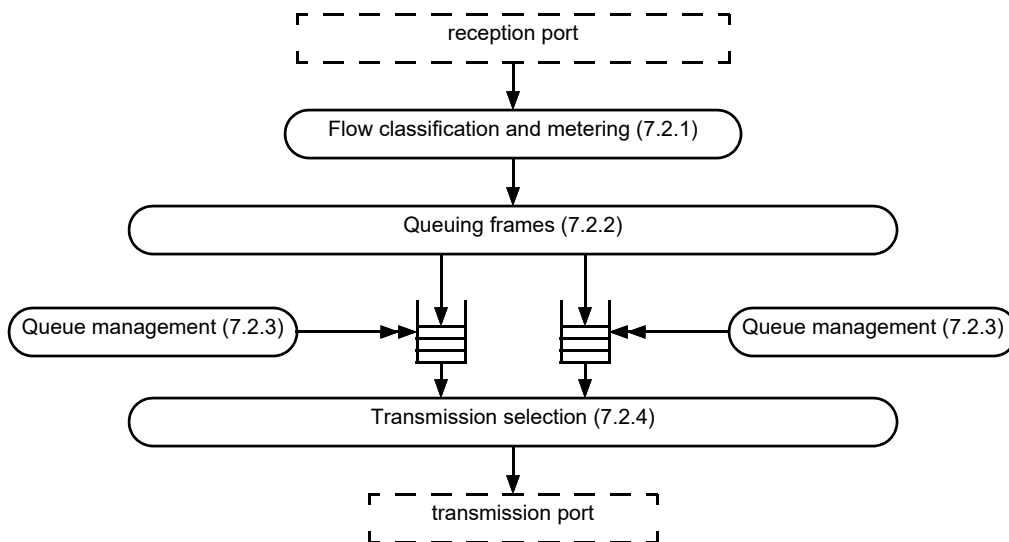


Figure 7-1—GFQoS forwarding system forwarding process functions

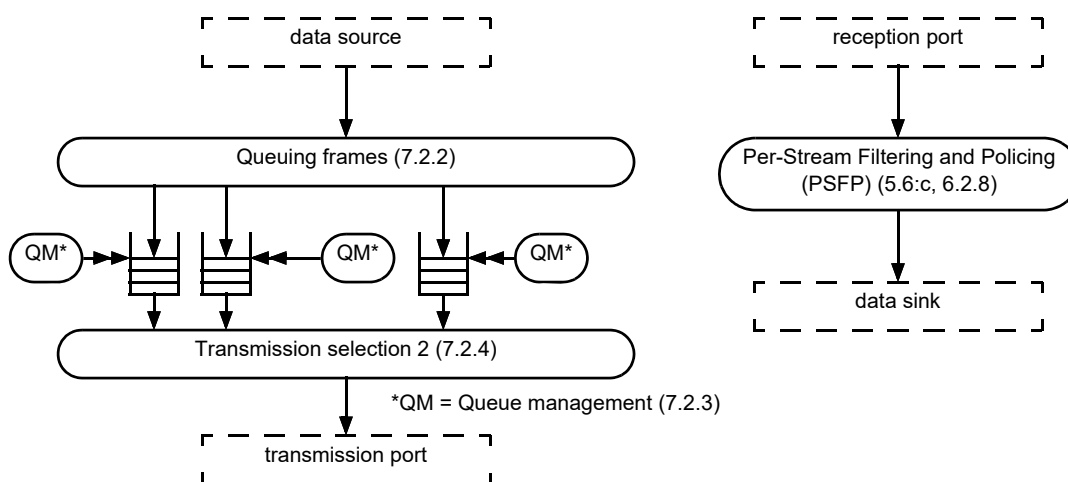


Figure 7-2—GFQoS end system functions

1 Such behavior would adversely impact some GFQoS functions. IEEE Std 802.1Q does not prohibit
2 implementing its QoS functions in other ways, including placing the queuing functions near the MAC layer
3 in individual physical ports.

4 **7.2.1 Flow classification and metering**

5 Flow classification and metering is illustrated in [Q] Figure 8-13. There are two types of flow classification
6 and metering specified by IEEE Std 802.1Q, General flow classification and metering (7.2.1.1) and Per-
7 Stream classification and metering (7.2.1.2).

8 NOTE—In [Q] 8.6.5.3.1, “Maximum SDU size” is the maximum size of the `mac_service_data_unit` parameter of the
9 ISS ([AC] 11.1) or EISS ([Q] 6.8.1).

1 7.2.1.1 General flow classification and metering

2 General flow classification and metering is illustrated in [Q] Figure 8-13 and specified in [Q] 8.6.5.1. It
3 provides functions for discarding and/or marking frames for reduced probability of delivery based on source
4 MAC address, destination MAC address, VID or priority. See 5.8:h for normative requirements.

5 7.2.1.2 Per-Stream classification and metering

6 Per-Stream classification and metering includes a number of functions that are performed and controlled per
7 input port. Per-Stream classification and metering is specified in [Q] 8.6.5 and its subclauses. It includes
8 stream filtering ([Q] 8.6.5.3), maximum SDU size filtering ([Q] 8.6.5.3.1), stream gating ([Q] 8.6.5.4), flow
9 metering ([Q] 8.6.5.5), and Asynchronous Traffic Shaping (ATS) Eligibility Time Assignment ([Q] 8.6.5.6).
10 For the purposes of this standard, these functions are grouped into two functions, Per-Stream Filtering and
11 Policing (5.8:c) and ATS (5.6:d, 5.8:d).

12 7.2.2 Queuing frames

13 In a GFQoS system, each frame is assigned to a queue according to the class of service selected by the Flow
14 classification and metering function (7.2.1). A GFQoS system shall perform the queuing frames functions
15 specified in [Q] 8.6.6, with the following exception:

- 16 a) The in-order delivery requirements for an IEEE Std 802.1Q Bridge are listed in bullets a) and b) of
17 [Q] 8.6.6. For GFQoS, these requirements are modified to say that the order of frames received on
18 the same input port of a GFQoS forwarding system shall be preserved for:
 - 19 1) Unicast frames traversing the same path, at the same quality of service, between the same
20 source and destination addresses.
 - 21 2) Multicast frames traversing the same path, at the same quality of service, and addressed to the
22 same destination.

23 7.2.3 Queue management

24 A GFQoS system shall perform the queue management functions as described in [Q] 8.6.7, with the
25 following exception:

- 26 a) The Bridge transit delay ([Q] 6.5.6) requirement applies only to an IEEE Std 802.1Q Bridge.
27 However, a GFQoS forwarding system may discard frames from a queue to meet a similar
28 requirement for a maximum transit delay across the GFQoS forwarding system.

29 7.2.4 Transmission selection

30 A GFQoS system shall perform the transmission selection functions as described in [Q] 8.6.8. There are
31 optional capabilities within [Q] 8.6.8.

32 7.2.5 Parameterization of frames

33 As explained in [AC] 7, frames are not modeled as passing from layer to layer in the protocol stack as a
34 simple octet string. The MAC service offered by IEEE Std 802.3 Ethernet [B1], for example, passes a frame
35 as a sequence of four parameters, destination_address, source_address, mac_service_data_unit, and
36 frame_check_sequence. IEEE Std 802.1Q makes use of the Internal Sublayer Service (ISS) specified in
37 [AC] 11. The ISS is a medium-independent abstraction of the MAC services specified by the various IEEE
38 802 media. It has parameters, such as “priority”, that are used by some media (e.g. IEEE 802.11 Wireless
39 [B4]), but not others (e.g. IEEE 802.3 Ethernet). The ISS provides a convenient model for describing the
40 reception and transmission of frames, and is required of all systems ([AC] 11.1).

¹ IEEE Std 802.1Q-2022 specifies an Enhanced Internal Sublayer Service (EISS, [Q] 6.8) which extends the
² ISS parameter list. Among other tasks, the Support of the EISS function [Q] 6.9 extracts the VLAN tag
³ information (the EISS parameters vlan_identifier, priority, and drop_eligible) from the ISS
⁴ mac_service_data_unit of a received frame, and packs these parameters back into the mac_service_data_unit
⁵ on a transmitted frame. Support of the EISS is optional for a GFQoS system.

⁶ Table 7-1 extends this model all the way through TCP/UDP headers ([B5], [B11]), and summarizes the list
⁷ of parameters that are directly relevant to the GFQoS provision model.

Table 7-1—Parameter use by the GFQoS provision model

parameter	specified in	port selection ¹	GFQoS differentiation without flow classification ²	stream/ GFQoS differentiation with flow classification ³	modifiable by GFQoS ⁴
destination_address	ISS ([AC] 11)	Yes	no	Yes	no
source_address	ISS ([AC] 11)	Yes	no	Yes	no
mac_service_data_unit	ISS ([AC] 11) and EISS ([Q] 6.8)	no	no	Yes	no
frame size	ISS ([AC] 11.1) ⁵	no	Yes	Yes	Yes
priority	ISS ([AC] 11) and EISS ([Q] 6.8)	no	Yes	Yes	Yes
drop_eligible	ISS ([AC] 11) and EISS ([Q] 6.8)	no	Yes	Yes	Yes
vlan_identifier	EISS ([Q] 6.8)	Yes	no	Yes	no
frame_check_sequence	ISS ([AC] 11)	Yes	no	no	no
service_access_point_identifier	ISS ([AC] 11)	Yes	no	no	no
connection_identifier					
stream_handle	[CB] 6	no	no	Yes	no
other uses of connection_identifier	ISS ([AC] 11)	Yes	no	no	no
flow_hash	EISS ([Q] 6.8)	Yes	no	no	no
time_to_live	EISS ([Q] 6.8)	Yes	no	no	no

Table 7-1—Parameter use by the GFQoS provision model

parameter	specified in	port selection ¹	GFQoS differentiation without flow classification ²	stream/ GFQoS differentiation with flow classification ³	modifiable by GFQoS ⁴
internal priority value specification (IPV)	PSFP ([Q] 8.6.5, [Q] 8.6.10)	no	no	Yes	Yes
IP source address ⁶	[CB] 6.7	Yes ⁷	no	Yes	no
IP destination address ⁶	[CB] 6.7	Yes ⁷	no	Yes	no
IP differentiated services code point ⁶	[CB] 6.7	Yes ⁷	no	Yes	no
IP next protocol ⁶	[CB] 6.7	Yes ⁷	no	Yes	no
IP transport source port number ⁶	[CB] 6.7	Yes ⁷	no	Yes	no
IP transport destination port number ⁶	[CB] 6.7	Yes ⁷	no	Yes	no

- 1 Parameter is used by an IEEE 802.1Q Bridge to determine the set of transmission ports to which the frame is to be forwarded.
- 2 Parameter can be used by an IEEE 802.1Q Bridge for GFQoS purposes, without flow classification and metering (7.2.1).
- 3 Parameter can be used to identify a particular stream or set of streams for GFQoS purposes using flow classification and metering (7.2.1).
- 4 Parameter can be modified by GFQoS.
- 5 “Frame size” is not a separate parameter in [AC] 11.1; it is an implied characteristic of the mac_service_data_unit parameter.
- 6 These parameters are specified in IETF RFCs, including [B5], [B6], [B11], [B9], [B8], and [B10]. Their use in the context of this standard is described in [CB] 6.7.
- 7 In IEEE Std 802.1Q, this parameter is part of the mac_service_data_unit, and is not used by an IEEE Std 802.1Q Bridge for selecting output ports. A Bridge can use these parameters, via [CB] 6, for stream identification.

- 1 The use of the mac_service_data_unit for GFQoS purposes is not limited to VLAN tagging and removal.
- 2 Stream identification based on the examination of the mac_service_data_unit is not precluded, just as
- 3 forwarding based on the mac_service_data_unit is not precluded. (See, e.g. [Q] 6.12 Protocol VLAN
- 4 classification.)

7.3 Requirements for GFQoS functions

7.3.1 Transmission by priority

- 7 IEEE Std 802.1Q provides eight levels of priority and two levels of drop eligibility to be assigned to a frame.
- 8 These parameters can be carried in a VLAN tag or by other means specified by certain media (e.g. some
- 9 specified by IEEE Std 802.11). This standard considers the reception, manipulation, and transmission of
- 10 priority and drop eligibility values to be specific to Bridges, and does not address these functions.
- 11 This does not mean that priority is irrelevant to this standard. [Q] 8.6.6 specifies the Internal Priority Value
- 12 (IPV). The Stream Gate function [Q] 8.6.5.4 can assign an IPV to a frame. This IPV overrides the priority in
- 13 determining in which of the output queues that frame is placed when assigned to a port for transmission. One
- 14 queue can serve more than one IPV/priority value. Frames with a given IPV/priority are always assigned to
- 15 the same queue.

1 Although the allowed range for the IPV parameter is not specified explicitly in IEEE Std 802.1Q, the
2 managed objects specified in that standard effectively limit an implementation to eight classes of service,
3 and thus eight output queues per port. In practice, Bridges (and many other devices) use a number of
4 methods to assign a frame an IPV/priority, and thus to an output queue, including the recognition of
5 particular layer 2 or layer 3 protocols, IP DIFFSERV code points, etc. This standard does not restrict such
6 behavior by forwarding systems.

7 Strict priority is the basis of all IEEE Std 802.1Q QoS functions, and therefore of GFQoS. *The queues on a*
8 *port are served strictly according to priority, no matter what GFQoS techniques are applied.* However, any
9 given queue can be made eligible or not eligible for the priority competition, according to Stream Gates,
10 shaper state machines, priority flow control, and a number of mechanisms. Thus, a low-priority queue can
11 transmit frames, even if higher-priority queues are not empty, but only if those higher-priority queues are all
12 rendered ineligible for transmission by some GFQoS mechanism. If no GFQoS functions are enabled, strict
13 priority remains to control the queues.

14 A GFQoS system shall support transmission selection by strict priority ([Q] 8.6.8.1).

15 7.3.2 Enhanced Internal Sublayer Service

16 A GFQoS system may support the Enhanced Internal Sublayer Service (EISS), which is described in
17 [Q] 6.8, [Q] 6.9, and supported by [Q] 9. A GFQoS system that supports the EISS shall:

- 18 a) Implement the EISS as specified in [Q] 6.8.
- 19 b) Implement the support of the EISS as specified in [Q] 6.9, with the following exceptions:
 - 20 1) The GFQoS system may implement the Acceptable Frame Types parameter.
 - 21 2) The GFQoS system may implement the PVID and VID Set and/or the default PVID.
 - 22 3) The GFQoS system may implement the VID translation table and/or the Egress VID translation
 - 23 table.
 - 24 4) The GFQoS system may discard a frame as described in item b) of [Q] 6.9.1.
 - 25 5) The GFQoS system may provide only a fixed Priority Code Point Encoding Table ([Q] 6.9.3)
 - 26 that leaves the priority and drop_eligible parameters unchanged
 - 27 6) The GFQoS system may provide priority regeneration [Q] 6.9.4.
- 28 c) Support either a C-TAG or an S-TAG on each port, as specified in [Q] 6.9 and supported by [Q] 9.
- 29 d) Conform to the format and encoding in [Q] 9 for tags supported by the GFQoS system.

30 NOTE 1—This standard is concerned solely with QoS issues. The use of the EISS priority and drop_eligible parameters
31 are of obvious relevance to QoS. The EISS vlan_identifier field is of concern only for stream identification purposes, not
32 for forwarding purposes.

33 NOTE 2—The option for support of the EISS is specified so that the vlan_identifier of a received frame can be
34 determined in exactly the same manner as an IEEE Std 802.1Q VLAN-aware Bridge, including, for example, the port
35 VLAN identifier (PVID, [Q] 6.9). Alternatively, in this standard, VLAN tags (or other tags) can be accessed as part of
36 the mac_service_data_unit parameter (see 7.2.5), without implementing the EISS.

37 7.3.3 Credit-Based Shaper

38 A GFQoS system that supports the Credit-Based Shaper shall:

- 39 a) Implement the Credit-Based Shaper as described in [Q] 8.6.8.2.

40 NOTE—IEEE Std 802.1Q specifies nwf.

1 **7.3.4 Frame preemption**

2 A GFQoS forwarding system that supports frame preemption shall:

- 3 a) Implement frame preemption as described in [Q] 6.7.2,
- 4 b) Conform to those portions of [Q] 6.7.1 and [Q] 8.6.8 that are specified as requirements for frame
- 5 preemption.

6

1 8. Managed Objects

2 Managed objects and the MIB modules to access them, for all of the GFQoS functions in this standard, are
3 specified in IEEE Std 802.1Q, and in IEEE Std 802.1CB-2017. The managed objects and MIB modules in
4 IEEE Std 802.1CB-2017 are directly applicable to this standard, because they are not tied to the IEEE
5 802.1Q Bridge functions. Some of the managed objects in IEEE Std 802.1Q, however, are tied to IEEE Std
6 802.1Q Bridge functionality, and to Bridge Ports ([Q] 8.2), in particular.

7 See Clause 9 for YANG modules for managing the IEEE Std 802.1Q managed objects relevant to GFQoS in
8 a manner independent of the Bridge functionality specified in IEEE Std 802.1Q. This standard does not
9 specify any MIB modules.

9. YANG Data Model

This clause specifies YANG data modules that provide control and status monitoring of systems and system components that implement the functionality specified in this standard. These data modules are based on the set of managed objects and their functionality specified in Clause 8.

This clause:

- a) Introduces the YANG framework that governs the naming and hierarchy of configuration and operational data structures in the data modules, and the modeling of network interfaces (9.1),
- b) Describes each of the data modules and its relationship to the operational processes and managed objects specified in the other clauses of this standard (9.2),
- c) Describes the structure of the data modules (9.3),
- d) Reviews security considerations (9.4),
- e) Provides a schema tree as an overview of the YANG module (9.5),
- f) Specifies the YANG modules (9.6).

9.1 YANG framework

In order to make certain YANG modules that control features in IEEE Std 802.1Q and its amendments easy to incorporate into both IEEE 802.1Q Bridges and IEEE 802.1Q end stations, those YANG modules are defined in pairs, one pair for each feature. One module of each pair defines groupings that control the feature. The other module augments either a Bridge component or a Bridge Port with that first module's groupings. This standard takes advantage of this structure. The modules defined in this clause use the modules that control IEEE 802.1Q features required for GFQoS to augment systems and/or interfaces, instead of Bridge components and/or Bridge Ports.

9.2 IEEE 802.1DC YANG modules

Table 9-1 shows the modules, specified in IEEE Std 802.1Q-2022 and its amendments, that can be used to control GFQoS functions in GFQoS systems. As shown in 9.3, these modules can be adapted for use in GFQoS systems by means of YANG augment statements.

Table 9-1—YANG modules specified IEEE Std 802.1Q-2022 and amendments, and relevant to GFQoS systems

Function	Module name	Specified in ¹
Scheduled Transmission	ieee802-dot1q-sched	[Qcw] 48.6.17
Asynchronous Traffic Shaping	ieee802-dot1q-ats ieee802-dot1q-stream-filters-gates	[Qcz] 48.6.18 [Qcz] 48.6.14
Frame preemption	ieee802-dot1q-preemption	[Qcw] 48.6.19
Per-Stream Filtering and Policing	ieee802-dot1q-psfp	[Qcw] 48.6.21
Credit-Based Shaper	ieee802-dot1q-cbsa	[Qdx] 48.6.24

¹ See 1.6 “Reference conventions”.

1 9.3 Structure of the YANG modules

2 The YANG modules specified by this standard use the YANG modules summarized in Table 9-2.

Table 9-2—Summary of GFQoS functions and their YANG modules

Module	References	Managed functionality	Notes
		Basic function- ality 6.2.1	No YANG modules are provided for basic functionality; there are no managed objects to control that are independent of the functions of an IEEE 802.1Q Bridge.
		Strict priority 6.2.2	No YANG modules are provided for strict priority; there are no managed objects to control that are independent of the functions of an IEEE 802.1Q Bridge.
ieee802-dot1dc-gfqos	9.6.3	EISS 6.2.3	The managed objects and YANG modules for managing the Extended Internal Sublayer Service (EISS) are specified in IEEE Std 802.1Q as part of the modules that control a Bridge component and a Bridge Port. These have been adapted for use by GFQoS systems in this standard (6.2.3).
		PFC 6.2.4	At the time of this writing, there is no published IEEE 802.1 standard for a YANG module to control Priority Flow Control.
ieee802-dot1dc-preemption-if	9.6.1	Frame preemption 6.2.5	Augments an interface using ieee802-dot1q-preemption [Qcw] 48.6.19
		FRER 6.2.6	Frame Replication and Elimination for Reliability (FRER) is managed by YANG modules specified in IEEE Std 802.1CB and its amendments.
		General flow classification and metering 6.2.7	No YANG modules are provided for general flow classification and metering; there are no managed objects specified by IEEE 802.1 to control this function.
ieee802-dot1dc-psfp-sys	9.6.2	PSFP 6.2.8	Augments a system using ieee802-dot1q-psfp [Qcw] 48.6.21
ieee802-dot1dc-gfqos	9.6.3	ETS 6.2.9	Enhanced Transmission Selection is managed using YANG modules specified in [Qcz] D.6.5.3, which are included by reference through ieee802-dot1dc-gfqos (9.6.3).
ieee802-dot1dc-sched-if	9.6.4	Scheduled traffic 6.2.10	Augments an interface using ieee802-dot1q-sched [Qcw] 48.6.17
ieee802-dot1dc-cbsa-if	9.6.5	CBS 6.2.11	Augments an interface using ieee802-dot1q-cbsa [Qdx] 48.6.24
		CQF 6.2.12	No YANG modules are provided specifically for cyclic queuing and forwarding. Control of CQF is accomplished by managing PSFP (6.2.8) and scheduled transmissions (6.2.10), as described in [Q] Annex T

Table 9-2—Summary of GFQoS functions and their YANG modules

Module	References	Managed functionality	Notes
ieee802-dot1dc-ats-if	9.6.6	ATS 6.2.13	Augments an interface using ieee802-dot1q-ats [Qcz] 48.6.18 and ieee802-dot1q-stream-filters-gates [Qcz] 48.6.14

9.4 Security considerations

See [Qcw] 48.4, [Qcz] 48.4, and [Qdx] 48.4 for a review of security considerations relevant to the IEEE 802.1DC YANG modules.

9.5 YANG Schema tree definitions

9.5.1 Tree diagram for ieee802-dot1dc-preemption-if

```

module: ieee802-dot1dc-preemption-if
augment /if:interfaces/if:interface:
  +---u q-preempt:preemption-parameters

```

9.5.2 Tree diagram for ieee802-dot1dc-psfp-sys

```

module: ieee802-dot1dc-psfp-sys
augment /sys:system:
  +---u q-psfp:psfp-parameters

```

9.5.3 Tree diagram for ieee802-dot1dc-gfqos

```

module: ieee802-dot1dc-gfqos
augment /if:interfaces/if:interface:
  +--rw gfqos-ifc
    +--rw pvid? dot1qtypes:vlan-index-type
  {eiss}?
    +--rw acceptable-frame? enumeration {eiss}?
    +--rw transmission-selection-algorithm-table
      | +--rw transmission-selection-algorithm-map* [traffic-class]
      |   +--rw traffic-class traffic-class-type
      |   +--rw transmission-selection-algorithm? identityref
    +--ro media-dependent-overhead? uint8
    +--ro statistics
      +--ro delay-exceeded-discards? yang:counter64
      +--ro mtu-exceeded-discards? yang:counter64
      +--ro frame-rx? yang:counter64
      +--ro octets-rx? yang:counter64
      +--ro frame-tx? yang:counter64
      +--ro octets-tx? yang:counter64
      +--ro discard-inbound? yang:counter64
      +--ro forward-outbound? yang:counter64

```

```

1      +---ro discard-lack-of-buffers?          yang:counter64
2      +---ro discard-transit-delay-exceeded?   yang:counter64
3      +---ro discard-on-error?                 yang:counter64
4      +---ro discard-on-ingress-filtering?     yang:counter64 {dot1q:ingress-
5 filtering}?
6

```

7 9.5.4 Tree diagram for ieee802-dot1dc-sched-if

```

8 module: ieee802-dot1dc-sched-if
9
10 augment /if:interfaces/if:interface:
11     +---u q-sched:sched-parameters
12

```

13 9.5.5 Tree diagram for ieee802-dot1dc-cbsa-if

```

14 module: ieee802-dot1dc-cbsa-if
15
16 augment /if:interfaces/if:interface:
17     +---u cbsa:cbsa-config
18

```

19 9.5.6 Tree diagram for ieee802-dot1dc-ats-if

```

20 module: ieee802-dot1dc-ats-if
21
22 augment /if:interfaces/if:interface:
23     +---u ats:ats-port-parameters
24 augment /sys:system:
25     +---u sfsg:sfsg-parameters
26

```

27 9.6 YANG modules^{6, 7, 8}

28 9.6.1 YANG module for Frame preemption

```

29 module ieee802-dot1dc-preemption-if {
30     yang-version "1.1";
31     namespace urn:ieee:std:802.1Q:yang:ieee802-dot1dc-preemption-if;
32     prefix preempt-if;
33
34     import ietf-interfaces {
35         prefix if;
36     }
37     import ieee802-dot1q-preemption {
38         prefix q-preempt;
39     }
40

```

6. 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.

7. 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/>.

8. 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.

```
1 organization
2   "Institute of Electrical and Electronics Engineers";
3 contact
4   "WG-URL: http://ieee802.org/1/
5     WG-EMail: stds-802-1-l@ieee.org
6       Contact: IEEE 802.1 Working Group Chair
7       Postal: C/O IEEE 802.1 Working Group
8       IEEE Standards Association
9         445 Hoes Lane
10        Piscataway
11        NJ 08854
12        USA
13
14   E-mail: stds-802-1-chairs@ieee.org";
15
16 description
17   "This module provides for management of General Frame Quality of
18   Service (GFQoS) systems that support Frame Preemption.
19
20   Copyright (C) IEEE (2024).
21
22   This version of this YANG module is part of IEEE Std 802.1DC;
23   see the standard itself for full legal notices.";
24
25 revision 2024-02-28 {
26   description
27     "Published as part of IEEE Std 802.1DC.
28
29     The following reference statement identifies each referenced
30     IEEE Standard as updated by applicable amendments.";
31
32   reference
33     "IEEE Std 802.1DC:
34     IEEE Std 802.1DC - Quality of Service Provision by
35     Network Systems.";
36 }
37
38 feature frame-preemption {
39   description
40     "Frame preemption supported.";
41   reference
42     "6.2.5 of IEEE Std 802.1DC";
43 }
44 augment "/if:interfaces/if:interface" {
45   if-feature "frame-preemption";
46   description
47     "Augment interface with Frame Preemption configuration.";
48   uses q-preempt:preemption-parameters;
49 }
50 }
51
```

1 9.6.2 YANG module for Per-Stream Filtering and Policing

```
2 module ieee802-dot1dc-psfp-sys {
3   yang-version "1.1";
4   namespace urn:ieee:std:802.1Q:yang:ieee802-dot1dc-psfp-sys;
5   prefix psfp-sys;
6
7   import ietf-system {
8     prefix sys;
9   }
10  import ieee802-dot1q-psfp {
11    prefix q-psfp;
12  }
13
14  organization
15    "Institute of Electrical and Electronics Engineers";
16  contact
17    "WG-URL: http://ieee802.org/1/
18    WG-EMail: stds-802-1-1@ieee.org
19    Contact: IEEE 802.1 Working Group Chair
20    Postal: C/O IEEE 802.1 Working Group
21    IEEE Standards Association
22    445 Hoes Lane
23    Piscataway
24    NJ 08854
25    USA
26
27    E-mail: stds-802-1-chairs@ieee.org";
28
29  description
30    "This module provides management of General Frame Quality of
31    Service (GFQoS) systems that support IEEE Std 802.1Q Per-
32    Stream Filtering and Policing (PSFP).
33
34    Copyright (C) IEEE (2024).
35
36    This version of this YANG module is part of IEEE Std 802.1DC;
37    see the standard itself for full legal notices.";
38
39  revision 2024-02-28 {
40    description
41      "Published as part of IEEE Std 802.1DC.
42
43      The following reference statement identifies each referenced
44      IEEE Standard as updated by applicable amendments.";
45
46    reference
47      "IEEE Std 802.1DC:
48      IEEE Std 802.1DC - Quality of Service Provision by
49      Network Systems.";
50  }
51
52  feature psfp {
53    description
```

```

1      "Per-Stream Filtering and Policing supported.";
2      reference
3      "6.2.8 of IEEE Std 802.1DC";
4  }
5
6  augment "/sys:system" {
7      description
8      "Augment system with Per-Stream Filtering and Policing
9      configuration";
10     uses q-psfp:psfp-parameters;
11 }
12 }
13

```

14 9.6.3 YANG module for GFQoS interface

```

15 module ieee802-dot1dc-gfqos {
16     yang-version "1.1";
17     namespace urn:ieee:std:802.1Q:yang:ieee802-dot1dc-gfqos;
18     prefix dot1dc;
19     import ietf-yang-types {
20         prefix yang;
21     }
22     import ietf-interfaces {
23         prefix if;
24     }
25     import ieee802-dot1q-types {
26         prefix dot1qtypes;
27     }
28     import ieee802-dot1q-bridge {
29         prefix dot1q;
30     }
31
32     organization
33     "Institute of Electrical and Electronics Engineers";
34     contact
35     "WG-URL: http://ieee802.org/1/
36     WG-EMail: stds-802-1-1@ieee.org
37     Contact: IEEE 802.1 Working Group Chair
38     Postal: C/O IEEE 802.1 Working Group
39     IEEE Standards Association
40     445 Hoes Lane
41     Piscataway
42     NJ 08854
43     USA
44
45     E-mail: stds-802-1-chairs@ieee.org";
46
47     description
48     "This module provides for management of General Frame Quality of
49     Service (GFQoS) systems that support Extended Internal Sublayer
50     Service (EISS).
51
52

```



```
1 Copyright (C) IEEE (2024).
2
3 This version of this YANG module is part of IEEE Std 802.1DC;
4 see the standard itself for full legal notices.";
5
6 revision 2024-02-28 {
7     description
8         "Published as part of IEEE Std 802.1DC.
9
10        The following reference statement identifies each referenced
11        IEEE Standard as updated by applicable amendments.";
12
13    reference
14        "IEEE Std 802.1DC:
15        IEEE Std 802.1DC - Quality of Service Provision by Network
16        Systems.
17        IEEE Std 802.1Q:
18        IEEE Std 802.1Q-2022 Bridges and Bridged Networks.";
19 }
20
21 feature eiss {
22     description
23         "Each GFQoS interface may support the Extended Internal Sublayer
24         Service (EISS). This is one useful method for dealing with VLAN
25         tags.";
26     reference
27         "7.3.2 of IEEE Std 802.1DC";
28 }
29 augment "/if:interfaces/if:interface" {
30     description
31         "Augment the interface model with the GFQoS interface";
32     container gfqos-ifc {
33         description
34             "GFQoS interface is an extension of the IETF Interfaces model
35             (IETF RFC 7223).";
36         leaf pvid {
37             if-feature "eiss";
38             type dot1qtypes:vlan-index-type;
39             default "1";
40             description
41                 "The port VID assigned to the interface.";
42             reference
43                 "12.10.1, item m) of 5.4 of IEEE Std 802.1Q";
44         }
45         leaf acceptable-frame {
46             if-feature "eiss";
47             type enumeration {
48                 enum admit-only-VLAN-tagged-frames {
49                     description
50                         "Admit only VLAN-tagged frames.";
51                 }
52                 enum admit-only-untagged-and-priority-tagged {
53                     description
54                         "Admit only untagged and priority-tagged frames.";
```

```

1      }
2      enum admit-all-frames {
3          description
4              "Admit all frames.";
5      }
6  }
7  default "admit-all-frames";
8  description
9      "To configure the Acceptable Frame Types parameter associated
10     with one or more GFQoS interfaces, only if EISS is supported";
11  reference
12     "12.10.1.3, 6.9 of IEEE Std 802.1Q";
13 }
14 container transmission-selection-algorithm-table {
15     description
16         "The Transmission Selection Algorithm Table for a given
17         interface assigns, for each traffic class that the interface
18         supports, the transmission selection algorithm that is to be
19         used to select frames for transmission from the corresponding
20         queue. Transmission Selection Algorithm Tables may be managed,
21         and allow the identification of vendor-specific transmission
22         selection algorithms. The transmission selection algorithms
23         are identified in the Transmission Selection Algorithm Table
24         by means of integer identifiers.";
25     reference
26         "12.20.2, 8.6.8 of IEEE Std 802.1Q";
27     uses dot1qtypes:transmission-selection-table-grouping;
28 }
29 leaf media-dependent-overhead {
30     type uint8;
31     units "octets";
32     config false;
33     description
34         "The portMediaDependentOverhead parameter provides the number
35         of additional octets for media-dependent framing. The overhead
36         includes all octets prior the first octet of the Destination
37         Address field and all octets after the last octet of the frame
38         check sequence.";
39     reference
40         "12.4.2 of IEEE Std 802.1Q";
41 }
42 container statistics {
43     config false;
44     description
45         "Container of operational state node information associated
46         with the GFQoS interface.";
47     uses dot1qtypes:bridge-port-statistics-grouping;
48     leaf discard-on-ingress-filtering {
49         if-feature "dot1q:ingress-filtering";
50         type yang:counter64;
51         description
52             "The number of frames that were discarded as a result of
53             Ingress Filtering being enabled.
54 
```

```

1         Discontinuities in the value of this counter can occur at
2         re-initialization of the management system, and at other
3         times as indicated by the value of 'discontinuity-time.'";
4     reference
5         "12.6.1.1.3 of IEEE Std 802.1Q";
6     }
7 }
8 }
9 }
10 }
11

```

9.6.4 YANG module for Scheduled Transmissions

```

13 module ieee802-dot1dc-sched-if {
14     yang-version "1.1";
15     namespace urn:ieee:std:802.1Q:yang:ieee802-dot1dc-sched-if;
16     prefix sched-if;
17
18     import ietf-interfaces {
19         prefix if;
20     }
21     import ieee802-dot1q-sched {
22         prefix q-sched;
23     }
24
25     organization
26         "Institute of Electrical and Electronics Engineers";
27     contact
28         "WG-URL: http://ieee802.org/1/
29         WG-EMail: stds-802-1-1@ieee.org
30         Contact: IEEE 802.1 Working Group Chair
31         Postal: C/O IEEE 802.1 Working Group
32         IEEE Standards Association
33             445 Hoes Lane
34             Piscataway
35             NJ 08854
36             USA
37
38         E-mail: stds-802-1-chairs@ieee.org";
39
40     description
41         "This module provides for management of General Frame Quality of
42         Service (GFQoS) systems that support Scheduled Traffic Enhancements.
43
44         Copyright (C) IEEE (2023).
45
46         This version of this YANG module is part of IEEE Std 802.1DC;
47         see the standard itself for full legal notices.";
48
49     revision 2023-05-16 {
50         description
51             "Published as part of IEEE Std 802.1DC.
52

```

```
1     The following reference statement identifies each referenced
2     IEEE Standard as updated by applicable amendments.";
3
4     reference
5         "IEEE Std 802.1DC:
6         IEEE Std 802.1DC - Quality of Service Provision by
7         Network Systems.";
8     }
9
10    augment "/if:interfaces/if:interface" {
11
12        description
13            "Augment interface with Scheduled Traffic configuration.";
14
15        uses q-sched:sched-parameters;
16    }
17 }
18
```

19 9.6.5 YANG module for Credit-Based Shaper

```
20 module ieee802-dot1dc-cbsa-if {
21     yang-version "1.1";
22     namespace urn:ieee:std:802.1Q:yang:ieee802-dot1dc-cbsa-if;
23     prefix cbsa-if;
24
25     import ietf-interfaces {
26         prefix if;
27     }
28     import ieee802-dot1q-cbsa {
29         prefix cbsa;
30     }
31
32     organization
33         "Institute of Electrical and Electronics Engineers";
34     contact
35         "WG-URL: http://ieee802.org/1/
36         WG-EMail: stds-802-1-1@ieee.org
37         Contact: IEEE 802.1 Working Group Chair
38         Postal: C/O IEEE 802.1 Working Group
39         IEEE Standards Association
40             445 Hoes Lane
41             Piscataway
42             NJ 08854
43             USA
44
45         E-mail: stds-802-1-chairs@ieee.org";
46
47     description
48         "This module provides for management of General Frame Quality of
49         Service (GFQoS) systems that support the Credit-Based Shaper
50         transmission selection algorithm.
51
52         Copyright (C) IEEE (2024).

```

```
1
2   This version of this YANG module is part of IEEE Std 802.1DC;
3   see the standard itself for full legal notices.";
4
5   revision 2024-02-27 {
6     description
7       "Published as part of IEEE Std 802.1DC.
8
9       The following reference statement identifies each referenced
10      IEEE Standard as updated by applicable amendments.";
11
12    reference
13      "IEEE Std 802.1DC:
14      IEEE Std 802.1DC - Quality of Service Provision by
15      Network Systems.";
16  }
17
18  augment "/if:interfaces/if:interface" {
19
20    description
21      "Augment interface with Credit-Based Shaper configuration.";
22
23    uses cbsa:cbsa-config;
24  }
25 }
26
```

27 9.6.6 YANG module for Asynchronous Traffic Shaping

```
28 module ieee802-dot1dc-ats-if {
29   yang-version "1.1";
30   namespace urn:ieee:std:802.1Q:yang:ieee802-dot1dc-ats-if;
31   prefix ats-if;
32   import ietf-system {
33     prefix sys;
34   }
35   import ietf-interfaces {
36     prefix if;
37   }
38   import ieee802-dot1q-ats {
39     prefix ats;
40   }
41   import ieee802-dot1q-stream-filters-gates {
42     prefix sfsg;
43   }
44
45   organization
46     "Institute of Electrical and Electronics Engineers";
47   contact
48     "WG-URL: http://ieee802.org/1/
49     WG-EMail: stds-802-1-1@ieee.org
50     Contact: IEEE 802.1 Working Group Chair
51     Postal: C/O IEEE 802.1 Working Group
52     IEEE Standards Association
```

```
1         445 Hoes Lane
2         Piscataway
3         NJ 08854
4         USA
5
6     E-mail: stds-802-1-chairs@ieee.org";
7
8     description
9         "This module provides management of 802.1Q General Frame Quality of
10        Service (GFQoS) systems that support Asynchronous Traffic Shaping
11        (ATS).
12
13        Copyright (C) IEEE (2024).
14
15        This version of this YANG module is part of IEEE Std 802.1DC;
16        see the standard itself for full legal notices.";
17
18    revision 2024-02-28 {
19        description
20            "Published as part of IEEE Std 802.1DC.
21
22            The following reference statement identifies each referenced
23            IEEE Standard as updated by applicable amendments.";
24
25        reference
26            "IEEE Std 802.1DC:
27            IEEE Std 802.1DC - Quality of Service Provision by
28            Network Systems.";
29    }
30
31    augment "/if:interfaces/if:interface" {
32        description
33            "Augments interfaces by ATS per-Port parameters.";
34        uses ats:ats-port-parameters;
35    }
36    augment "/sys:system" {
37        description
38            "Augments the system with ATS parameters.";
39        uses sfsg:sfsg-parameters {
40            augment "stream-filters/stream-filter-instance-table" {
41                description
42                    "Augments the system stream filter for ATS
43                    schedulers.";
44                uses ats:ats-parameters;
45                container scheduler {
46                    description
47                        "This container encapsulates ATS scheduler nodes.";
48                    leaf scheduler-ref {
49                        type leafref {
50                            path
51                                '..'+
52                                '/..' +
53                                '/schedulers'+
54                                '/scheduler-instance-table' +
```

```
1         '/scheduler-instance-id';
2     }
3     description
4         "A reference to the ATS scheduler associated with this
5         stream filter.";
6     }
7     leaf scheduler-enable {
8         type boolean;
9         default "false";
10        description
11            "If TRUE, this stream filter has an associated ATS
12            scheduler referenced by scheduler-ref. If FALSE, no ATS
13            scheduler is associated with this stream filter
14            (scheduler-ref is ignored).";
15    }
16 }
17 }
18 }
19 }
20 }
21
22
```

1 Annex A

2 (informative)

3 Protocol Implementation Conformance Statement (PICS) pro- 4 forma

5 A.1 Introduction⁹

6 The supplier of an implementation that is claimed to conform to this standard shall complete the following
7 protocol implementation conformance statement (PICS) proforma.

8 A completed PICS proforma is the PICS for the implementation in question. The PICS is a statement of
9 which capabilities and options of the protocol have been implemented. A PICS is included at the end of each
10 clause as appropriate. The PICS can be used for a variety of purposes by various parties, including the
11 following:

- 12 a) As a checklist by the protocol implementor, to reduce the risk of failure to conform to the standard
13 through oversight;
- 14 b) As a detailed indication of the capabilities of the implementation, stated relative to the common
15 basis for understanding provided by the standard PICS proforma, by the supplier and acquirer, or
16 potential acquirer, of the implementation;
- 17 c) As a basis for initially checking the possibility of interworking with another implementation by the
18 user, or potential user, of the implementation (note that, while interworking can never be guaranteed,
19 failure to interwork can often be predicted from incompatible PICS);
- 20 d) As the basis for selecting appropriate tests against which to assess the claim for conformance of the
21 implementation, by a protocol tester.

22 A.1.1 Abbreviations and special symbols

23 The following symbols are used in the PICS proforma:

24	M	mandatory field/function
25	!	negation
26	O	optional field/function
27	O.<n>	optional field/function, but at least one of the group of options labeled by
28		the same numeral <n> is required
29	O/<n>	optional field/function, but one and only one of the group of options
30		labeled by the same numeral <n> is required
31	X	prohibited field/function
32	<item>:	simple-predicate condition, dependent on the support marked for <item>
33	<item1>*<item2>:	AND-predicate condition, the requirement must be met if both optional
34		items are implemented
35	<item1>+<item2>:	OR-predicate condition, the requirement must be met if either of the
36		optional items are implemented

9. *Copyright release for PICS proformas:* Users of this standard may freely reproduce the PICS proforma in this subclause so that it can be used for its intended purpose and may further publish the completed PICS.

1 A.1.2 Instructions for completing the PICS proforma

2 The first part of the PICS proforma, Implementation Identification and Protocol Summary, is to be
3 completed as indicated with the information necessary to identify fully both the supplier and the
4 implementation.

5 The main part of the PICS proforma is a fixed-format questionnaire divided into subclauses, each containing
6 a group of items. Answers to the questionnaire items are to be provided in the right-most column, either by
7 simply marking an answer to indicate a restricted choice (usually Yes, No, or Not Applicable), or by entering
8 a value or a set or range of values. (Note that there are some items where two or more choices from a set of
9 possible answers can apply; all relevant choices are to be marked.)

10 Each item is identified by an item reference in the first column; the second column contains the question to
11 be answered; the third column contains the reference or references to the material that specifies the item in
12 the main body of the standard; the sixth column contains values and/or comments pertaining to the question
13 to be answered. The remaining columns record the status of the items—whether the support is mandatory,
14 optional or conditional—and provide the space for the answers.

15 The supplier may also provide, or be required to provide, further information, categorized as either
16 Additional Information or Exception Information. When present, each kind of further information is to be
17 provided in a further subclause of items labeled A<i> or X<i>, respectively, for cross-referencing purposes,
18 where <i> is any unambiguous identification for the item (e.g., simply a numeral); there are no other
19 restrictions on its format or presentation.

20 A completed PICS proforma, including any Additional Information and Exception Information, is the
21 protocol implementation conformance statement for the implementation in question.

22 Note that where an implementation is capable of being configured in more than one way, according to the
23 items listed under Major Capabilities/Options, a single PICS may be able to describe all such configurations.
24 However, the supplier has the choice of providing more than one PICS, each covering some subset of the
25 implementation's configuration capabilities, if that would make presentation of the information easier and
26 clearer.

27 A.1.3 Additional information

28 Items of Additional Information allow a supplier to provide further information intended to assist the
29 interpretation of the PICS. It is not intended or expected that a large quantity will be supplied, and the PICS
30 can be considered complete without any such information. Examples might be an outline of the ways in
31 which a (single) implementation can be set up to operate in a variety of environments and configurations; or
32 a brief rationale, based perhaps upon specific application needs, for the exclusion of functions that, although
33 optional, are nonetheless commonly present in implementations.

34 References to items of Additional Information may be entered next to any answer in the questionnaire, and
35 may be included in items of Exception Information.

36 A.1.4 Exceptional information

37 It may occasionally happen that a supplier will wish to answer an item with mandatory or prohibited status
38 (after any conditions have been applied) in a way that conflicts with the indicated requirement. No
39 preprinted answer will be found in the Support column for this; instead, the supplier is required to write into
40 the Support column an X<i> reference to an item of Exception Information, and to provide the appropriate
41 rationale in the Exception item itself.

1 An implementation for which an Exception item is required in this way does not conform to this standard.

2 Note that a possible reason for the situation described above is that a defect in the standard has been
3 reported, a correction for which is expected to change the requirement not met by the implementation.

4 **A.1.5 Conditional items**

5 The PICS proforma contains a number of conditional items. These are items for which both the applicability
6 of the item itself, and its status if it does apply—mandatory, optional, or prohibited—are dependent upon
7 whether or not certain other items are supported.

8 Individual conditional items are indicated by a conditional symbol of the form “<item>:<s>” in the Status
9 column, where “<item>” is an item reference that appears in the first column of the table for some other
10 item, and “<s>” is a status symbol, M (Mandatory), O (Optional), or X (Not Applicable).

11 If the item referred to by the conditional symbol is marked as supported, then 1) the conditional item is
12 applicable, 2) its status is given by “<s>”, and 3) the support column is to be completed in the usual way.
13 Otherwise, the conditional item is not relevant and the Not Applicable (N/A) answer is to be marked.

14 Each item whose reference is used in a conditional symbol is indicated by an asterisk in the Item column.

A.1.6 Identification

A.1.6.1 Implementation identification

Supplier (Note 1)	
Contact point for queries about the PICS (Note 1)	
Implementation Name(s) and Version(s) (Notes 1 and 3)	
Other information necessary for full identification—e.g., name(s) and version(s) of machines and/or operating system names (Note 2)	
<p>NOTE 1—Required for all implementations.</p> <p>NOTE 2—May be completed as appropriate in meeting the requirements for the identification.</p> <p>NOTE 3—The terms Name and Version should be interpreted appropriately to correspond with a supplier’s terminology (e.g., Type, Series, Model).</p>	

A.1.6.2 Protocol summary

Identification of protocol specification	P802.1DC/D3.2, Quality of Service Provision by Network Systems.
Identification of amendments and corrigenda to the PICS proforma that have been completed as part of the PICS	<p>Amd : _____ Cor: _____</p> <p>Amd : _____ Cor: _____</p>
Have any exceptions been noted? (See A.1.4. The answer, “Yes” means that the implementation does not conform to P802.1DC/D3.2.	Yes [] No []

1 A.2 PICS proforma for Quality of Service Provision by Network Systems

2 A.2.1 Major capabilities/options

Item	Feature	Subclause	Value/Comment	Status	Support
END	Is the system a GFQoS end system?	5.3, 5.5	At least one of END or RLY must be marked, “Yes.”	O.1	Yes [] No []
RLY	Is the system a GFQoS forwarding system?	5.3, 5.7		O.1	Yes [] No []
MC1	Does the system support the GFQoS provision model?	5.3:a, 7.2		M	Yes []
MC2	Does the system support the ISS?	5.3:b, [AC] 11.1		M	Yes []
MC3	Does the system support transmission by strict priority?	5.3:c		M	Yes []
MC4	Does the system support the EISS?	5.4:a, 7.3.2		O	Yes [] No []
MC5	Does the system support priority flow control?	5.4:b		O	Yes [] No []
MC6	Does the system support enhanced transmission selection?	5.4:c		O	Yes [] No []
MC7	Does the system support enhancements for scheduled traffic?	5.4:d		O	Yes [] No []
MC8	Does the system support management via YANG modules specified in Clause 9?	5.4:e, 9		O	Yes [] No []

3 A.2.2 GFQoS end system capabilities/options

Item	Feature	Subclause	Value/Comment	Status	Support
If item END is not supported, mark N/A and continue at the subsequent subclause.					N/A []
ES9	Does the system support CBS?	5.6:b		END: O	Yes [] No []
ES10	Does the system support PSFP?	5.6:c		END: O	Yes [] No []
ES11	Does the system support CQF?	5.6:e		END: O	Yes [] No []
ES12	Does the system support asynchronous traffic shaping?	5.6:d		END: O	Yes [] No []

Item	Feature	Subclause	Value/Comment	Status	Support
ES13	Does the system support IEEE Std 802.1CB-2017 Talker end system behaviors?	5.6:f		END: O	Yes [] No []
ES14	Does the system support IEEE Std 802.1CB-2017 Listener end system behaviors?	5.6:g		END: O	Yes [] No []
ES15	Does the system support frame preemption?	5.6:h		END: O	Yes [] No []

1 A.2.3 GFQoS forwarding system capabilities/options

Item	Feature	Subclause	Value/Comment	Status	Support
If item RLY is not supported, mark N/A and continue at the subsequent subclause.					N/A []
RS16	Does the system support CQF?	5.8:e		RLY: O	Yes [] No []
RS17	Does the system support CBS?	5.8:b		RLY: O	Yes [] No []
RS18	Does the system support general flow classification and metering?	5.8:h		RLY: O	Yes [] No []
RS19	Does the system support PSFP?	5.8:c		RLY: O	Yes [] No []
RS20	Does the system support asynchronous traffic shaping?	5.8:d		RLY: O	Yes [] No []
RS21	Does the system support IEEE Std 802.1CB-2017 relay system behaviors?	5.8:f		RLY: O	Yes [] No []
RS22	Does the system support frame preemption?	5.8:g		RLY: O	Yes [] No []

¹ **Annex B**

² (informative)

³ **Bibliography**

- ⁴ [B1] IEEE Std 802.3™, IEEE Standard for Ethernet.
- ⁵ [B2] IEEE Std 802.1AX, IEEE Standard for Local and metropolitan area networks—Link Aggregation.
- ⁶ [B3] IEEE Std 802.1AE, IEEE Standard for Local and Metropolitan Area Networks: Media Access
⁷ Control (MAC) Security.
- ⁸ [B4] IEEE Std 802.11, IEEE Standard for Information technology—Telecommunications and
⁹ information exchange between systems Local and metropolitan area networks—Specific
¹⁰ requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY)
¹¹ Specifications
- ¹² [B5] IETF RFC 768, User Datagram Protocol, Postel, J., August 1980.6
- ¹³ [B6] IETF RFC 791, Internet Protocol, Postel, J., Ed., September 1981.
- ¹⁴ [B7] IETF RFC 2205, Resource ReSerVation Protocol (RSVP)—Version 1 Functional Specification,
¹⁵ Braden, RT Ed., Zhang L, Berson S, Herzog S, Jamin S, September 1997
- ¹⁶ [B8] IETF RFC 2474, Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6
¹⁷ Headers, Nichols, K., et al., December 1998.
- ¹⁸ [B9] IETF RFC 8200 (STD 86), Internet Protocol, Version 6 (IPv6) Specification, Deering, S., Hinden, R.,
¹⁹ July 2017.
- ²⁰ [B10] IETF RFC 9260, Stream Control Transmission Protocol, Stewart, R., Tüxen, M., Nielsen, K., June
²¹ 2022.
- ²² [B11] IETF RFC 9293 (STD 7), Transmission Control Protocol, Eddy, W., Ed., August 2022.