Local and metropolitan area networks—

Cut-Through Forwarding Bridges and Bridged Networks

Unapproved draft, prepared by the
Time-Sensitive Networking (TSN) Task Group of IEEE 802.1

Sponsored by the
LAN/MAN Standards Committee
of the
IEEE Computer Society

DRAFT STATUS:
Editor's first draft.

This and the following cover pages are not part of the draft. They provide revision and other information for IEEE 802.1 Working Group members and participants in the IEEE Standards Association ballot process, and will be updated as convenient. New participants: Please read these cover pages, they contain information that should help you contribute effectively to this standards development project. Blank pages allow for the addition of cross-references to changed text without forcing renumbering of all pages in the draft. Pages are numbered from 1 (including cover pages) for the convenience of reviewers whose PDF viewers do not easily accommodate different numbering sequences. Pages will of course be renumbered prior to publication.

The text proper of this draft begins with the Title page.

Editors' Foreword

<<Throughout this document, all notes such as this one, presented between angle braces, are temporary notes inserted by the Editors for a variety of purposes. Certain text is also highlighted to attract the attention of reviewers. These notes and highlights, the temporary Annex Z (if present) containing some discussion of issues, the Editors' Foreword and Introduction to the current draft, and the preceding cover pages, will be removed prior to Sponsor Ballot and publication and are not part of the normative text. The records of participants in the development of the standard will be added at an appropriate time. >>

Participation in 802.1 standards development

All participants in the standardization activities of IEEE 802.1 should be aware of the Working Group Policies and Procedures, and the fact that they have obligations under the IEEE Patent Policy, the IEEE Standards Association (SA) Copyright Policy, and the IEEE SA Participation Policy. For information on these policies see 1.ieee802.org/rules/ and the slides presented at the beginning of each of our Working Group and Task Group meeting.

As part of our IEEE 802® process, the text of the PAR (Project Authorization Request) and CSD (Criteria for Standards Development) of each project is reviewed regularly to ensure their continued validity. The PAR is summarized in these cover pages and a links are provided to the full text of both PAR and CSD. A vote of "Approve" on this draft is also an affirmation that the PAR and CSD for this project are still valid.

Comments on this draft are encouraged. NOTE: All issues related to IEEE standards presentation style, formatting, spelling, etc. are routinely handled between the 802.1 Editor and the IEEE Staff Editors prior to publication, after balloting and the process of achieving agreement on the technical content of the standard is complete. Readers are urged to devote their valuable time and energy only to comments that materially affect either the technical content of the document or the clarity of that technical content. Comments should not simply state what is wrong, but also what might be done to fix the problem.

Full participation in the work of IEEE 802.1 requires attendance at IEEE 802 meetings. Information on 802.1 activities, working papers, and email distribution lists etc. can be found on the 802.1 Website:

http://ieee802.org/1/

Use of the email distribution list is not presently restricted to 802.1 members, and the working group has a policy of considering comments from all who are interested and willing to contribute to the development of the draft. Individuals not attending meetings have helped to identify sources of misunderstanding and ambiguity in past projects. The email lists exist primarily to allow the members of the working group to develop standards, and are not a general forum. All contributors to the work of 802.1 should familiarize themselves with the IEEE patent policy and anyone using the email distribution list will be assumed to have done so. Information can be found at http://standards.ieee.org/db/patents/

Comments on this draft may be sent to the 802.1 email exploder, to the Editor, or to the Chairs of the 802.1 Working Group and Time-Sensitive Networking (TSN) Task Group.

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As part of our IEEE 802 process, the text of the PAR and CSD (Criteria for Standards Development, formerly referred to as the 5 Criteria or 5C's) is reviewed on a regular basis in order to ensure their continued validity. A vote of “Approve” on this draft is also an affirmation by the balloter that the PAR is still valid.

Draft development

During the early stages of draft development, 802.1 editors have a responsibility to attempt to craft technically coherent drafts from the resolutions of ballot comments and from the other discussions that take place in the working group meetings. Preparation of drafts often exposes inconsistencies in editor’s instructions or exposes the need to make choices between approaches that were not fully apparent in the meeting. Choices and requests by the editors’ for contributions on specific issues will be found in the editors’ Introduction to the current draft and at appropriate points in the draft.

The ballot comments received on each draft, and the editors’ proposed and final disposition of comments on working group drafts, are part of the audit trail of the development of the standard and are available, along with all the revisions of the draft on the 802.1 website (for address see above).

During the early stages of draft development the proposed text can be moved around a great deal, and even minor rearrangement can lead to a lot of ‘change’, not all of which is noteworthy from the point of the reviewer, so the use of automatic change bars is not very effective. In early drafts change bars may be omitted or applied manually, with a view to drawing the readers attention to the most significant areas of change. Readers interested in viewing every change are encouraged to use Adobe Acrobat to compare the document with their selected prior draft. Note that the FrameMaker change bar feature is useless when it comes to indicating changes to Figures.

iPAR (Project Authorization Request) and CSD

Extracts from the PAR, as approved by IEEE NesCom 3rd December 2020:

https://development.standards.ieee.org/myproject-web/public/view.html#pardetail/9744

and the CSD (Criteria for Standards Development):

https://mentor.ieee.org/802-ec/dcn/23/ec-23-0076-00-ACSD-p802-1du.pdf

follow.

PAR Scope:

This standard specifies Cut-Through Forwarding (CTF) Bridges based on the IEEE 802.1Q Bridge architecture, including protocols, procedures, and managed objects. CTF Bridges interconnect individual local area networks (LANs) using different or identical media access control (MAC) methods with and without support for CTF. This standard also details the usage of CTF Bridges in Bridged networks.

PAR Purpose:

This standard enables lower latency communication compared to what is achievable without CTF and reduces the dependency of end-to-end latency on frame length, while allowing interoperable interconnection of individual LANs with and without support for CTF.

PAR Need for the Project:

The lower latency achievable in Bridged networks with CTF enables the applicability of bridging in certain applications, including use cases in industrial automation, professional audio-video and data centers. This project addresses the unmet needs of these applications for interoperable equipment that has lower latency.

CSD broad market potential [extract]

Proprietary implementations of Cut-Through Forwarding (CTF) are already widely used in industrial automation installations and data center networks. Standardizing CTF can be an enabling technology for a wide range of professional audio-video applications.

Existing proprietary implementations by Bridge vendors support CTF, but interoperability is limited. Standardizing CTF is an opportunity for deployment of IEEE 802 technology in existing and new use cases in industrial automation systems, data centers, and professional audio-video applications.

Additional material:
https://mentor.ieee.org/802.1/dcn/21/1-21-0037-00-ICne-ieee-802-tutorial-cut-through-forwarding-ctf-among-ethernet-networks.pdf

CSD compatability [extract]

The project will comply with IEEE Std 802, IEEE Std 802.1AC, and IEEE Std 802.1Q.

Introduction to the current draft

This introduction is not part of the draft, and will be revised for SA ballot. A set of cover pages will be retained for use during SA ballot.

This is an initial draft by the Editor for P802.1DU, and not for balloting. A subsequent draft for balloting may contain changes, additions and removals in various areas.

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P802.1DU/D0.0
July 12, 2023

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Unapproved draft, prepared by the

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Sponsored by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

IEEE Standards Activities Department
445 Hoes Lane
Piscataway, NJ 08854, USA

Abstract: This standard specifies Cut-Trhough Forwarding Bridges and Bridged networks.

Keywords: Cut-Through Forwarding, Store and Forward, Bridged Network, IEEE 802.1AC™, IEEE 802.1Q™, IEEE 802.1CB™, Local Area Network, LAN, virtual LAN, VLAN Bridge

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1. Available at: https://development.standards.ieee.org/myproject-web/public/view.html#landing.
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4. Available at: https://standards.ieee.org/standard/index.html.
5. Available at: https://standards.ieee.org/about/sasb/patcom/materials.html.

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Participants

<<The following lists will be updated in the usual way prior to publication>>

At the time this standard was completed, the IEEE 802.1 working group had the following membership:

Glenn Parsons, *Chair*
Jessy Rouyer, *Vice Chair*
Janos Farkas, *Security Task Group Chair*
Johannes Specht, *Editor*

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

A.N. Other

<<The above lists will be updated in the usual way prior to publication>>

When the IEEE-SA Standards Board approved this standard on <dd> <month> <year>, it had the following membership:

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Vice-Chair
Past Chair
Secretary

*Member Emeritus

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Introduction

This introduction is not part of IEEE Std 802.1DP-20XX, IEEE Standard for Local and metropolitan area networks—Cut-Through Forwarding Bridges and Bridged Networks

This standard specifies profiles of IEEE 802.1 Time-Sensitive Networking (TSN) and IEEE 802.1 Security standards for aerospace onboard Bridged IEEE 802.3 Ethernet networks.

This standard was first published as IEEE Std 802.1DP-20XX.

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

Secretary, IEEE-SA Standards Board
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USA

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Draft Standard for Local and Metropolitan Networks —

Cut-Through Forwarding Bridges and Bridged Networks

1. Overview

1.1 Scope

This standard specifies Cut-Through Forwarding (CTF) Bridges based on the IEEE 802.1Q Bridge architecture, including protocols, procedures, and managed objects. CTF Bridges interconnect individual local area networks (LANs) using different or identical media access control (MAC) methods with and without support for CTF. This standard also details the usage of CTF Bridges in Bridged networks.

1.2 Purpose

This standard enables lower latency communication compared to what is achievable without CTF and reduces the dependency of end-to-end latency on frame length, while allowing interoperable interconnection of individual LANs with and without support for CTF.

1.3 Introduction

The standardization of Ethernet communication technology in IEEE Std 802.3™, specifying transmission over the physical media of individual Local Area Networks (LANs), and in IEEE Std 802.1Q™, specifying Bridges that interconnect IEEE 802® LANs,[1] has facilitated widespread deployment of networks that connect significantly more end stations, with significantly greater bandwidth, and at significantly reduced cost compared to prior technology. All these metrics have been improved by several orders of magnitude—reducing costs through the multi-vendor provision of common components (Bridges, end station interfaces, integrated circuit and circuit designs, connectors, and software) for a wide range of network applications.

The use of Ethernet communication technology in networks with high-reliability and deterministic latency requirements is further supported by Time-Sensitive Networking (TSN) provisions in IEEE Std 802.1Q, IEEE Std 802.1AS, IEEE Std 802.1CB, and the security provisions in IEEE Std 802.1AE and IEEE Std 802.1X. The provisions in these standards can be used in various ways, and include options that address different network requirements and parameters that vary by network and application scale. Network design, time to deploy, and component development, selection, validation, and configuration for a particular network can all benefit from consistent choices, across similar networks and network applications, of the provisions, parameters, and options specified in the relevant standards.

This standard specifies provisions for CTF in Bridges and Bridged networks, consistent with the aforesaid IEEE 802 standards in form a separate IEEE 802.1 base standard, allowing the aforesaid IEEE 802 standards to remain unaltered. It specifies Bridges with support for CTF based on the existing Bridge architecture of IEEE Std 802.1Q, maintains the traditional MAC demarcation between IEEE 802.1 and other IEEE 802 working groups, provides support for mixes of Store and Forward (S&F) and CTF MAC methods, and provides connectivity in networks comprising Bridges with and without support for CTF.

To this end, this standard

a) Specifies the architecture of Bridges with support for CTF (CTF Bridges).
b) Establishes modeling principles for specification of CTF.
c) Defines interfaces for supporting a broad variety of Internal Sublayer Service (ISS) providers that support CTF, including MAC methods with support for CTF.
d) Selects and extends existing functionality of IEEE Std 802.1Q, IEEE Std 802.1CB and IEEE Std 802.1AC supporting CTF.

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e) Establishes compatibility with functionality from IEEE Std 802.1Q, IEEE Std 802.1CB and IEEE Std 802.1AC not supporting CTF.

f) Provides management means for controlling CTF in Bridges.

<<Editor’s Note: Extend as appropriate>>

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in the 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.

ANSI X3.159, American National Standards for Information Systems—Programming Language—C.[2]

IEEE Std 802®, IEEE Standard for Local and metropolitan area networks: Overview and Architecture.[3,4]

IEEE Std 802d™-2017, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture—Amendment 1: Allocation of Uniform Resource Name (URN) Values in IEEE 802® Standards.

IEEE Std 802.1AB™, IEEE Standard for Local and metropolitan area networks—Station and Media Access Control Connectivity Discovery.

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

IEEE Std 802.1AE™, IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Security.

IEEE Std 802.1AS™, IEEE Standard for Local and metropolitan area networks—Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks.

IEEE Std 802.1AX™, IEEE Standard for Local and metropolitan area networks—Link Aggregation.

IEEE Std 802.1CB™, IEEE Standard for Local and metropolitan area networks—Frame Replication and Elimination for Reliability.

IEEE Std 802.1Q™, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks.

IEEE Std 802.1X™, IEEE Standards for Local and metropolitan area networks—Port Based Network Access Control.

IEEE Std 802.3™, IEEE Standard for Ethernet.

IETF RFC 2119 (BCP 14), Key Words for Use in RFCs to Indicate Requirement Levels, March 1997.[5]

IETF RFC 4122, A Universally Unique IDentifier (UUID) URN Namespace, July 2005.

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

IETF RFC 8343, A YANG Data Model for Interface Management, March 2018.

[2] ANSI publications are available from the American National Standards Institute (https://www.ansi.org/).
[3] IEEE publications are available from The Institute of Electrical and Electronics Engineers (https://standards.ieee.org/).
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[5] IETF documents (i.e., RFCs) are available from the Internet Engineering Task Force (https://tools.ietf.org/html/).

ISO/IEC 7498-1, Information processing systems — Open Systems Interconnection — Basic Reference Model—Part 1: The Basic Model.[6]

ITU-T Recommendation G.8013/Y.1731, Operation, administration and maintenance (OAM) functions and mechanisms for Ethernet-based Networks.

MEF Technical Specification 10.3 (MEF 10.3), Ethernet Service Attributes Phase 3, October 2013.

[6] ISO and ISO/IEC documents are available from the International Organization for Standardization (https://www.iso.org/). ISO/IEC publications are also available in the United States from Global Engineering Documents (https://global.ihs.com/). Electronic copies are available in the United States from the American National Standards Institute (https://www.ansi.org/)

3. Definitions

The definitions shown in this place-holder clause serve as examples. The proposed structure serves to point out where definitions have been taken from the referenced standards - and to make the point that these definitions should not be modified by the profile (although notes—which are non-normative—can be used uired or not. The selection of definitions from each of the profiled standards are merely illustrative at this point. This 'Editor comment' text should be revised when the selections have actually been reviewed and revised. Initially it is unlikely to be clear as to whether particular definitions will be required or not. To avoid the effort of removing definitions in one draft only to bring them back in a following draft, the Conditional Tag 'Delete' can be used so the definition does not appear when View>Show/Hide Conditional Text has 'How as per Expression' with Expression 'Final text'. Any definitions that are completely unused (i.e. the term does no appear in any other clause) need to removed before SA ballot. Not all terms need to appear in this clause, terms are defined by their use.

Each of the definitions uses a simple paragraph style 'Definition' which is particular to this clause. Definitions are not numbered (the numbering of definitions in IEEE 802.1Q is a style mistake). The term to be defined (and the following ':') are bolded using Format>Style>Bold (i.e. run-in heads are not used). Definitions should not (as per the IEEE Standards Style Manual) contain cross-references to other clauses (or to each other), as they should (whenever possible) be written to have broad applicability with a view to possible inclusion in the *IEEE Standards Dictionary Online*. If references are *really* necessary, a NOTE can be added after the relevant definition. Other clauses in this standard should not be peppered with cross-references to this clause, as requiring frequent diversions to look up terms is not a service to the reader. When a term is first introduced (in a section of text, such as a Clause, or a set of Clauses) that a reader with particular interests can be reasonably be expected to read and comprehend at one time) it, and its use, should be explained. That explanation may require more than a brief definition, as definitions are typically written by those who are already familiar with the concepts involved. The definitions have been included from the other standards, rather just referenced because readers simply do not follow references to other documents. While there may be some pressure to only cross-reference in the final standard, we should at least know what we are talking about while this profile is being developed.

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.[7]

The following terms are specific to this standard:

customer: The purchaser of a service instance from a service provider.

NOTE—Certain terms in this profile, including customer and <t.b.d>, reflect common business relationships that exist among the users of equipment implemented in conformance with this standard.

customer equipment: See note above.

This standard makes use of the following term defined in IEEE Std 802:[8]

end station: A functional unit in an IEEE 802® network that acts as a source of, and/or destination for, link layer data traffic carried on the network.

NOTE—An end station (or end station functionality in an intermediate system, e.g., in a Bridge) is characterized by the use of an individual MAC address assigned to that end station as the source address of frames originating from that end station and reception of frames with that destination MAC address.

This standard makes use of the following terms defined in IEEE Std 802.1Q:[9]

[7] *IEEE Standards Dictionary Online* is available at https://dictionary.ieee.org.
[8] This definition is from IEEE Std 802-2014. Notes to definitions are particular to this standard.
[9] These definitions are from IEEE Std 802.1Q-2022. Notes to definitions are particular to this standard.

base time: A time from which future cycles of gate close and open events are calculated.

Bridge: A system that includes Media Access Control (MAC) Bridge or Virtual Local Area Network (VLAN) Bridge component functionality.

Bridge Port: A Service Access Point (SAP) that provides the Enhanced Internal Sublayer Service (EISS) to the Media Access Control (MAC) Relay Entity of a Virtual Local Area Network (VLAN) Bridge component, or that provides the Internal Sublayer Service (ISS) to the MAC Relay Entity of a MAC Bridge, and the interface stack that supports that SAP.

Bridged Network: A concatenation of individual IEEE 802 Local Area Networks (LANs) interconnected by Bridges.

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

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.

congruent: (A) An adjective to describe two or more paths that coincide at all points when superimposed. (B) An adjective to describe a set of trees specifying paths that coincide at all points when superimposed, for all Virtual Local Area Networks (VLANs).

NOTE—See also: reverse path congruent, unicast multicast congruent, downstream congruent, and symmetric.

Connectivity Fault Management (CFM): Management capabilities for detecting, verifying, and isolating connectivity failures in Virtual Bridged Networks.

Customer Virtual Local Area Network (C-VLAN): A Virtual Local Area Network (VLAN) identified by a C-VLAN Identifier (C-VID).

NOTE—The use of ‘Customer’ in the context of VLAN identification is not to be confused with any business relationships or role responsibilities in the context of this standard or its use.

Customer Virtual Local Area Network (C-VLAN) Bridge: A system comprising a single C-VLAN component.

Customer Virtual Local Area Network (C-VLAN) component: A Virtual Local Area Network (VLAN) Bridge component with each Port supported by an instance of the Enhanced Internal Sublayer Service (EISS) that can recognize, insert, and remove C-VLAN tags (C-TAGs).

Customer Virtual Local Area Network [C-VLAN] Identifier (C-VID): A Virtual Local Area Network (VLAN) Identifier (VID) conveyed in a C-VLAN tag (C-TAG).

Customer Virtual Local Area Network [C-VLAN] tag (C-TAG): A Virtual Local Area Network (VLAN) tag with a Tag Protocol Identification value allocated for “802.1Q Tag Protocol EtherType.”

downstream congruent: A phrase to describe the path for a given frame relayed by a first Bridge when that path passes through a second Bridge and is thereafter the same as the path for any other frame (assigned to the same Virtual Local Area Network (VLAN) and destined to the same station) relayed by the second Bridge.

Expedited traffic: Traffic that requires preferential treatment as a consequence of jitter, latency, or throughput constraints or as a consequence of management policy.

flow hash: An arbitrary value that serves to distinguish flows that may be subject to different treatment in a Bridged network, for example, flows subject to independent treatment by Equal Cost Multiple Paths (ECMP).

Frame: A unit of data transmission on an IEEE 802 Local Area Network (LAN) that conveys a Media Access Control (MAC) Protocol Data Unit (MPDU).

gate-close event: An event that occurs when the transmission gate associated with a queue transitions from the Open state to the Closed state, disconnecting the transmission selection function of the forwarding process from the queue and preventing it from selecting frames from that queue.

gate-open event: An event that occurs when the transmission gate associated with a queue transitions from the Closed state to the Open state, connecting the transmission selection function of the forwarding process to a queue and allowing it to select frames from that queue.

gating cycle: The period of time over which the sequence of operations in a gate control list repeats.

IEEE 802 Local Area Network [LAN] (IEEE 802 LAN): LAN technologies that provide a Media Access Control (MAC) Service equivalent to the MAC Service defined in IEEE Std 802.1AC. IEEE 802 LANs include IEEE 802.3 (Ethernet) and IEEE 802.11 (Wireless) LANs.

NOTE—The term "Local Area Network" and the abbreviation LAN are used exclusively to refer to an individual LAN specified by a MAC technology, without the inclusion of Bridges. This precise use of terminology within this specification allows a Bridged Network to be distinguished from an individual LAN that has been Bridged to other LANs in the network (a Bridged LAN). In more general usage, such precise terminology is not required, as it is an explicit goal of IEEE Std 802.1Q that Bridges are transparent to the users of the MAC Service.

Independent Virtual Local Area Network [VLAN] Learning (IVL): Configuration and operation of the Learning Process and the Filtering Database (FDB) such that, for a given set of VLAN Identifiers (VIDs), if a given individual Media Access Control (MAC) Address is learned in association with one VID, that learned information is not used in forwarding decisions taken for that address relative to any other VID in the given set.

Layer Management Interface (LMI): An interface used for carrying management controls, counters, status parameters, or event indications that are not communicated to an entity's peers.

NOTE—This is not one of the Service Access Points (SAPs) defined in this standard.

Media Access Control (MAC) Bridge: A Bridge that does not recognize Virtual Local Area Network (VLAN) tagged frames.

Multicast:

a) A group Media Access Control (MAC) address (noun).
b) To transmit a frame using a group MAC address as the destination address (verb).
c) Containing a group MAC address as the destination address (adjective).

Multiple Stream Registration Protocol (MSRP): A protocol designed to provide quality of service (QoS) for streams in Bridged networks by reserving resources within each Bridge along the streams' paths.

Operations, Administration, and Maintenance (OAM): A group of network management functions that provide network fault indication, performance information, and data and diagnosis functions.

packet: A protocol data unit, comprising data, addressing, and protocol identification information, sent by an instance of an identified class of protocol entities and transmitted in one or more frames (e.g., an IPv6 packet).

policing: A process of monitoring network traffic and deliberately dropping frames that are in excess of previously defined criteria.

Port: A Service Access Point (SAP) and the interface stack supporting that SAP.

preemption: The suspension of the transmission of a preemptible frame to allow one or more express frames to be transmitted before transmission of the preemptible frame is resumed.

Priority-tagged frame: A tagged frame whose tag header carries priority information but carries no Virtual Local Area Network (VLAN) identification information.

Service Access Point (SAP): The point at which a service is offered.

NOTE—In this standard, any given SAP provides access to either the Internal Sublayer Service (ISS, IEEE Std 802.1AC) or the Enhanced Internal Sublayer Service (EISS, IEEE Std 802.1Q). The abbreviation SAP (without a preceding ISS or EISS is used) where the nature of the service is clear.

service instance: A set of Service Access Points (SAPs) such that a Data.Request primitive presented to one SAP can result in a Data.Indication primitive occurring at one or more of the other SAPs in that set.

Shared Virtual Local Area Network [VLAN] Learning (SVL): Configuration and operation of the Learning Process and the Filtering Database (FDB) such that, for a given set of VLANs, if an individual Media Access Control (MAC) Address is learned in one VLAN, that learned information is used in forwarding decisions taken for that address relative to all other VLANs in the given set.

shim: A protocol entity that uses the same service as it provides.

NOTE—Shims in this standard make use of the specified or referenced in this standard make use of the Internal Sublayer Service (ISS) or the Enhanced Internal Sublayer Service (EISS). They secure the ISS, enhance privacy, or provided multiplexing over separate instances of the ISS.

Stream: A unidirectional flow of data (e.g., audio and/or video) from a Talker to one or more Listeners.

StreamID: A 64-bit field that uniquely identifies a stream.

symmetric: An adjective to describe paths, trees, or sets of trees. Symmetric algorithms are used to create a set of trees that are *reverse path congruent* with respect to sources and destinations. Symmetric algorithms are used to create a set of trees that are *unicast multicast congruent* with respect to a given source. *See also:* reverse path congruent and unicast multicast congruent.

Tag header: A header that allows priority information, and optionally, Virtual Local Area Network (VLAN) identification information, to be associated with a frame.

Tagged frame: A frame that contains a tag header immediately following the Source MAC Address field of the frame.

Talker: The end station that is the source or producer of a stream.

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

time-sensitive stream: A stream of data frames that are required to be delivered with a bounded latency.

traffic class: A classification used to expedite transmission of frames generated by critical or time-sensitive services.

transmission gate: A gate that connects or disconnects the transmission selection function of the forwarding process from the queue, allowing or preventing it from selecting frames from that queue. The gate has two states, Open and Closed.

unicast:

a) An individual Media Access Control (MAC) address (noun).
b) To transmit a frame using an individual MAC address as the destination address (verb).
c) Containing an individual MAC address as the destination address (adjective).

unicast multicast congruent: A phrase to describe the path taken by a unicast frame to a given destination when that path is the same as the path taken by any multicast frame [assigned to the same Virtual Local Area Network (VLAN)] from that source to the same destination.

Untagged frame: A frame that does not contain a tag header immediately following the Source MAC Address field of the frame.

Virtual Bridged Network: A concatenation of individual IEEE 802 Local Area Networks (LANs) interconnected by Bridges, including Virtual Local Area Network (VLAN) Bridges.

Virtual Local Area Network (VLAN): The closure of a set of Media Access Control (MAC) Service Access Points (MSAPs) such that a data request in one MSAP in the set is expected to result in a data indication in another MSAP in the set.

Virtual Local Area Network (VLAN) Bridge: A system comprising a single VLAN Bridge component implemented in accordance with Clause 5 of IEEE Std 802.1Q-2021.

Virtual Local Area Network (VLAN) Bridge component: The media access method-independent functionality supporting an instance of the Enhanced Internal Sublayer Service (EISS) at each Bridge Port that can recognize, insert, and remove VLAN tags, and the functionality that relays frames between Bridge Ports.

Virtual Local Area Network (VLAN) Bridged Network: A Virtual Bridged Network.

Virtual Local Area Network (VLAN) tagged frame: A tagged frame whose tag header carries both VLAN identification and priority information.

This standard makes use of the following terms defined in IEEE Std 802.1AE:[10]

access priority: The priority that a client of the MAC Service or MAC Internal Sublayer Service (ISS) associates with a given transmit request.

NOTE—From the point of view of a **shim**, the priority associated with each transmit request received from its client is the **user priority** for that request and the priority associated with the corresponding transmit request that it makes of the underlying service is the **access priority**.

express frame: A frame that a protocol entity identifies as a candidate for early transmission using **preemption** capabilities.

NOTE—Not all protocol entities that forward a given frame need identify that frame as an express frame or a preemptable frame. Preemption is specified in IEEE Std 802.3.

preemptable frame: A frame that a protocol entity identifies as a candidate for suspension by **preemption** capabilities, so as to allow the earlier transmission of an **express frame**.

preemption: The temporary suspension of the transmission (or encoding for transmission) of a **preemptable frame** to allow the earlier transmission of an **express frame**.

NOTE—The preemption capabilities specified by IEEE Std 802.3 can be used to expedite the transmission of an **express frame** that becomes available for transmission after transmission of a **preemptable frame** has begun.

Privacy Channel: A sequence of frames with the same MAC source and destination addresses each conveying a single MAC Privacy Protocol Data Unit (MPPDU), with the sequence conveying a sequence of entire or fragmented user data frames and padding.

Privacy Frame: A frame that conveys a single MAC Privacy Protocol Data Unit (MPPDU) that includes a single, unfragmented, user data frame followed by zero or more octets of padding.

Private Port: The access point used to provide the privacy protected secure MAC Service to a client of a MAC Privacy protection Entity (PrY).

[10] These definitions are from IEEE Std 802.1AE-2018 as amended by IEEE Std 802.1AEdk-202X. Notes to definitions are particular to this standard.

traffic: A sequence of frames forwarded in a network.

This standard makes use of the following terms defined in IEEE Std 802.1AS:[11]

accuracy: The mean of the time or frequency error between the clock under test and a reference clock over an ensemble of measurements (see IEEE Std 1588-2019).

clock: A physical device that is capable of providing a measurement of the passage of time since a defined epoch.

gPTP communication path: A segment of a generalized precision time protocol (gPTP) domain that enables direct communication between two PTP Instances.

local clock: A free-running clock, embedded in a respective entity (e.g., PTP Instance, CSN node), that provides a common time to that entity relative to an arbitrary epoch.

residence time: The duration of the time interval between the receipt of a time-synchronization event message by a PTP Instance and the sending of the next subsequent time-synchronization event message on another PTP Port of that PTP Instance. Residence time can be different for different PTP Ports. The term residence time applies only to the case where syncLocked is TRUE.

synchronized clocks: Absent relativistic effects, two clocks are synchronized to a specified uncertainty if they have the same epoch and their measurements of the time of a single event at an arbitrary time differ by no more than that uncertainty.

syntonized clocks: Absent relativistic effects, two clocks are syntonized to a specified uncertainty if the duration of a second is the same on both, which means the time as measured by each advances at the same rate within the specified uncertainty. The two clocks might or might not share the same epoch.

timestamp measurement plane: The plane at which timestamps are captured. If the timestamp measurement plane is different from the reference plane, the timestamp is corrected for ingressLatency and/ or egressLatency. See: reference plane.

[11] These definitions are from IEEE Std 802-2014. Notes to definitions are particular to this standard.

4. Abbreviations and acronyms

The following abbreviations and acronyms are used in this standard:

CTF	Cut-Through Forwarding
ISS	Internal Sublayer Service
EISS	Enhanced Internal Sublayer Service
MAC	Medium Access Control
S&F	Store and Forward

<<Editor’s Note: Extended as appropriate>>

5. Conformance

5.1 Overview

This clause specifies mandatory and optional capabilities provided by conformant implementations this standard. An implementation can:

a) Compose all or part of the functionality of a CTF Bridge
b) Provide, as specified by this standard, one or more instances of the MAC Service to other functional entities whose specification is outside the scope of this standard.
c) Provide, as specified by this standard, one or more instance of the Internal Sublayer Service (ISS) to other implementations or instances of the same implementation that conform to this standard.

<<Editor's Note: Items a), b) and c) were taken from 802.1Q-2022 as starting point with smaller modifications for P802.1DU. As of now, there are contributions on required differences for CTF in end stations (compared to end stations as already specified).>>

5.2 Requirements terminology

For consistency with existing IEEE and IEEE 802.1™ standards, requirements are expressed using the following terminology: [12]

a) ***Shall*** is used for mandatory requirements.
b) ***May*** is used to describe implementation or administrative choices ("may" means "is permitted to," and hence, "may" and "may not" mean precisely the same thing).
c) ***Should*** is used for recommended choices (the behaviors described by "should" and "should not" are both permissible but not equally desirable choices).

Protocol Implementation Conformance Statements (PICS) reflect the occurrences of the words "shall," "may," and "should" within the standard.

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

5.3 Protocol Conformance Statement (PCS)

A claim of conformance specifies implementation of a specific CTF Bridge, a C-VLAN component with support for CTF, or a VLAN-unaware MAC Bridge component with support for CTF as specified in this standard.

<<Editor's Note: Extending beyond the aforesaid needs to be discussed.>>

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 relevant

[12] Originally derived from ISO/IEC style requirements, and consistent with the terminology specified in the ISO/IEC Directives Part 2:2021, Clause 7 (http://www.iec.ch/members_experts/refdocs).

PCS proforma provided in Annex A for that specific Bridge component or station together with the Protocol Implementation Conformance Statements (PICS) for the herein referenced protocols and procedures from other IEEE 802.1 standards.

5.4 CTF Bridge requirements

5.4.1 VLAN unaware conformance

<<Editor’s Note: Placeholder>>

5.4.2 VLAN aware conformance

<<Editor’s Note: Placeholder>>

5.5 CTF Bridge options

5.5.1 VLAN unaware conformance

<<Editor’s Note: Placeholder>>

5.5.2 VLAN aware conformance

<<Editor’s Note: Placeholder>>

<<Editor’s Note: The above are structural placeholders. The intended content is a combination of references to conformance in existing 802.1 Stds and references within P802.1DU for additional functionality. Contents are planned for a later stage (i.e., once there is certain consensus on the technical operation.>>

Further major items that may (or may not) be part of the conformance clause are the following (for consideration/discussion):

1) ISS provider conformance (outer interfaces) with and without support for CTF

2) Conformant networks

>>

6. Architecture

This standard specifies the operation Bridges, similar to IEEE Std 802.1Q [B1]. For differentiation between Bridges with support for CTF in the present standard, and Bridges according to IEEE Std 802.1Q, term *CTF Bridge* is used in this standard to refer to the former, whereas term *S&F Bridge* is used in this standard to refer to the latter.

Similar to S&F Bridges, CTF Bridges may or may not support Virtual Local Area Networks (VLANs), and therefore terms VLAN-aware and VLAN-unaware are used to distinguish between Bridges with and without support for VLANs.

The architecture of CTF Bridges is shown in Figure 6-1in a compact form, and is aligned with that of S&F Bridges (see also Figure 8-2, Figure 8-3, Figure 8-4, ff. of IEEE Std 802.1Q).

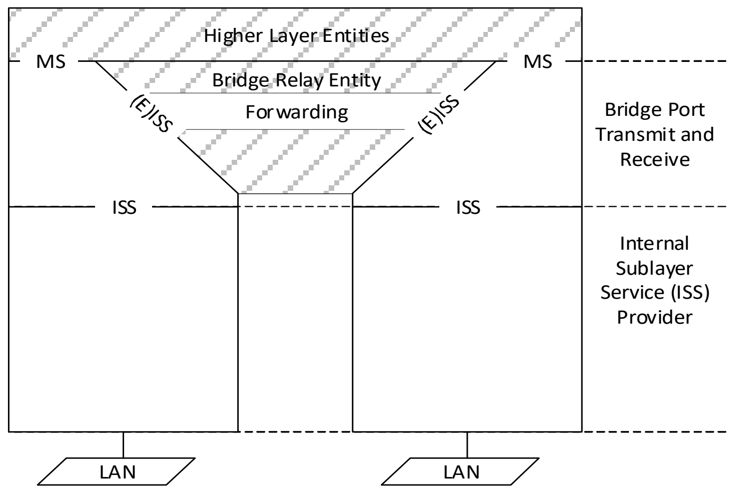

Figure 6-1—Architecture of a Cut-Through Forwarding (CTF) Bridge.

This architecture includes the following elements:

a) Higher layer entities using the MAC Service (MS) via the MAC Service interface defined in clause 14 of IEEE Std 802.1AC [B2].
b) Two or more Internal Sublayer Service (ISS) providers (Clause 8).
c) Bridge Port transmit and receive operations (Clause 9) per Bridge port that transform and transfer service primitive invocations between the Bridge relay entity, higher layer entities and the generalized serial convergence operations.
d) A Bridge relay entity (Clause 10) that relays frames between different Bridge Ports.

This standard excludes several details on higher layer entities above the MAC service interface and elements of the Bridge relay entity other than the forwarding process:

e) For frames to and from higher layer entities, the Bridge port transmit and receive operations of a CTF Bridge establish the behavior of S&F Bridge at the MAC service interface ([sec:Bridge-Port-Connectivity]), allowing higher layer entities to operate according to the behavior specified in IEEE 802.1 Standards unaltered.
f) The forwarding process of a CTF Bridges (re-)establishes the behavior of S&F Bridges at interaction points with other elements of the Bridge relay entity.

NOTE 1—Examples for higher layer entities are Spanning Tree Protocols and Multiple Registration Protocols, supported by LLC entities above the MAC service interface [see also item c) in 8.2 and item b) in 8.3 of IEEE Std 802.1Q].

NOTE 2—An example element of the Bridge relay entity other than the forwarding process is the learning process [see also item c) in 8.2 and item b) in 8.3 of IEEE Std 802.1Q].

ISS providers according to the present standard can support CTF or not. Bridges according to the present standard comprise at least one ISS provider with support for CTF. Bridges that comprise no ISS provider with support for CTF are specified in IEEE Std 802.1Q.

7. Modeling principles

7.1 Overview

This clause (Clause 7) specifies principles for accurate temporal modeling of elements of a CTF Bridge.

7.2 Frame types

If necessary, distinct terms for are used for frames for describing their current state, as follows:

a) **frame under reception:** A frame that is being serially received from LAN for which reception began bit did not finish.

b) **received frame:** A frame that was serially received from a LAN that finished reception.

c) **frame under transmission:** A frame that is being serially transmitted to a LAN for which transmission began bit did not finish.

d) **transmitted frame:** A frame that was serially transmitted to a LAN that finished transmission.

7.3 Modeling of service primitives

All invocations of service primitives in this standard are atomic. That is, each invocation is non-decomposable (see also 7.2 of IEEE Std 802.1AC and [B4]). Semantics of the ISS (8.4) and EISS (9.4) in terms of service primitives, their parameters, etc. is refined in this standard for the CTF operation, allowing for accurate description of operations within a CTF Bridge. This refined model comprises the following:

e) The parameters of a service primitive are explicitly modeled as bit arrays.

f) The values of parameters during invocations of a service primitive are passed according to a call-by-reference scheme.

g) A service primitive provides two attributes, 'start and 'end. These attributes are used in subsequent descriptions to indicate the temporal start and the end of the indication, respectively.

NOTE—The concept of attributes is inspired by the Very High Speed Integrated Circuits Hardware Description Language, VHDL [B5], which provides predefined attributes (e.g., 'transaction) that allow modeling over multiple VHDL simulation cycles at the same instant of simulated time.

In a series of sequential processing stages (e.g., a sub-process of the forwarding process in 10.1), this model allows later processing stages to access contents in service primitive parameters that are incrementally added by an earlier processing stage. The 'start and ‘end attributes can, but are not required to, be in temporal relationship with the duration of frames on the physical layer.

7.4 Parameter-based modeling

At higher processing stages, service primitives of frames and processing of these frames themselves is modeled at parameter level accuracy. The purpose of this model is to

h) provide means for compact description of temporal control (7.5) in and across processing stages,

i) enable re-use of existing transformation rules from IEEE 802.1 Stds, and

j) avoid low level details that would not provide any value to the clarity of descriptions.

The parameter-based modeling uses the resolution of symbolic and/or numeric parameters instead of bit arrays (7.3). A parameter is said to be complete at the earliest instant of time at which the minimal information is available to unambiguously determine the parameter's value within the specified valid value range of such parameter. The minimal information may be

k) a coherent sequence of bits in a frame (e.g., eight subsequent bits forming an octet),

l) the result of composition and/or computation across bits located at various locations in a frame,
m) frame information not encoded in particular bits (e.g., frame length),
n) based on out-of-band information, or
o) combinations of the aforesaid.

As an example, the vlan_identifier parameter of EM_UNITDATA.indication (9.4) invocations can be derived from a subset of underlying bits of the associated SDU parameter of M_UNITDATA.indication invocations (8.4) that are located in a VLAN Tag (9.6 of IEEE Std 802.1Q) according to the specification of the Support for the EISS defined in item e) in 6.9.1 of IEEE Std 802.1Q or originate from out-of-band information like a configured per-Port PVID parameter [item d) in 6.9, item f) in 6.9.1 and 12.10.1.2 of IEEE Std 802.1Q]. If the VLAN tag is required to unambiguously determine the vlan_identifier parameter, the parameter is complete when all bits of the VID parameter in the VLAN Tag where received. Most of the data transformations between bits in a frame, frame parameters and potential out-of-band information is already unambiguously specified in the relevant IEEE 802.1 Standards. This standard omits repetition of already specified transformations and instead just refers to the relevant transformations in existing IEEE 802.1 Standards.

NOTE—The bits and potential out-of-band information form the minimal information, and exclude any redundant information, most prominently the (in-band) redundant encoding of the VID parameter in the frame's FCS parameter.

7.5 Temporal control

7.5.1 Processing stalls

Parameter-based modeling is used for convenient formulation of temporal control statements in processing stages. A processing stage (7.3) may stall further processing of a frame under reception, including (but not limited to) passing this frame to a subsequent processing stage, until one or more parameters are complete (7.4), subject to the implicit discarding due to late errors (7.5.2). Most processing stalls are given due to the data dependencies already specified in IEEE 802.1 Standards (e.g., Ingress Filtering as part of the forwarding process in 8.6.2 of IEEE Std 802.1Q depends on the availability of a frame's VID, which therefore implicitly requires completion of the vlan_identifier parameter of EM_UNITDATA.indication invocations), however, explicit modeling of processing stalls may be expressed by formulations in natural language.

Example formulations:

p) *"Processing **stalls** pending the **vlan_identifier** parameter."*
q) *"Further execution in a CTF Bridge is **stalled** pending the **destination address** of a frame under reception prior to the filtering database lookup of the destination ports."*

A processing stall does not become effective if all associated parameters of a frame are complete at the point where the processing stall is defined.

7.5.2 Late errors

In a sequence of processing stages, an earlier processing stage may discover an error in a frame under reception and then notify all subsequent (not antecedent) processing stages, which may then implement error handling upon this such notification. This is termed as a late error, which is raised by the earlier processing stage and associated with a particular frame under reception. If any of the subsequent stage stalls processing pending one or more parameters of the associated frame under reception when the error is raised, the frame is discarded in the subsequent stage and thereby neither further processed nor passed to any other following processing stage.

7.5.3 Fall-backs to S&F

The descriptions of the processing stages use fall back to S&F as a modeling shortcut to summarize the following sequence:

r) Processing of a frame under reception stalls pending the frame's end of reception, which is a shortcut by itself for stalling processing pending all parameters of a frame under reception, including the FCS.

s) Dependent on whether or not a late error was indicated by an earlier processing stage for that frame while processing stalls, processing continues or the frame is discarded:
   1) **Late error indicated:** The frame is discarded prior to any further processing by any stage.
   2) **No Late error indicated:** Processing of the frame continues through subsequent processing steps and stages according to the standardized behavior of an S&F Bridge.

7.5.4 Instantaneous operations

In absence of processing stalls, processing stages in this standard perform their operations instantaneously. It is clear that idealistic instantaneous operations, in terms of 0-delay at an infinite high resolution, are not possible in real world implementations. Physics, design decisions and design constraints introduce additional delays in such implementations. The model is not intended to upper limit such delays. It is there for describing data dependencies, late error handling and the resulting externally visible behavior. Additional delays (e.g., real world implementations starting transmissions on a physical medium later than the model) are not described by the model, but could be determined by observation/measurement and are available as management parameters (11.3).

8. Internal Sublayer Service (ISS) providers

8.1 Overview

<<Editor’s Note: Placeholder for an overview of this clause>>

8.2 ISS providers without support for CTF

<<Editor’s Note: Placeholder for ISS providers wihtout support for CTF, including (nut not limited to) 802 MACs without support for CTF.>>

8.3 ISS providers with support for CTF

<<Editor’s Note: Text to be added. The intent is to connect M_LATEERROR primitives with M_UNITDATA primitives via frame_handle, itself a sub-parameter of M_UNITDATA.connection_identifier. An reception side, frame_handle is passed on M_UNITDATA.indication’begin, M_LATEERROR.indication may appear between M_UNITDATA.indication’begin and M_UNITDATA.indication’end to indicate a late error. On the transmission side, M_LATERROR.request may be issued between M_UNITDATA.request’begin and M_UNITDATA.request’end to request late error handling by the ISS provider for frames under transmission identified via frame_handle..>>

```
M_UNITDATA.indication          (
                               destination_address,
                               source_address,
                               mac_service_data_unit,
                               priority,
                               drop_eligible,
                               frame_check_sequence,
                               service_access_point_identifier,
                               connection_identifier
                               )
```

```
M_UNITDATA.request             (
                               destination_address,
                               source_address,
                               mac_service_data_unit,
                               priority,
                               drop_eligible,
                               frame_check_sequence,
                               service_access_point_identifier,
                               connection_identifier
                               )
```

NOTE—The service primitives from IEEE Std 802.1AC are repeated in this standard for reference only.

ISS providers with support for CTF should support M_LATEERROR.indication and M_LATEERROR.request service primitives. Each invocation of M_LATEERROR.indication corresponds to the detection of a late error during the receipt of frame from a LAN. The M_LATEERROR.request is invoked to request late error handling for a frame under transmission by the ISS provider.

```
M_LATEERROR.indication      (
                            frame_handle
                            )

M_LATEERROR.request         (
                            frame_handle
                            )
```

8.4 Service primitives and parameters

8.4.1 Unit-data primitives

```
M_CONTROL.request           (
                            destination_address,
                            opcode,
                            request_operand_list
                            )

M_CONTROL.indication        (
                            opcode,
                            request_operand_list
                            )
```

The semantics of these service primitives is defined separately for ISS providers without for CTF (8.5) and ISS provider with support for CTF (8.6).

8.4.2 Late error primitives

8.5 Semantic definitions for ISS providers without support for CTF

<<Editor’s Note: Placeholder>>

8.6 Semantic definitions for ISS providers with support for CTF

<<Editor’s Note: Placeholder>>

9. Bridge port transmit and receive operations

9.1 Overview

The architecture of the Bridge Port transmit and receive operations in CTF Bridges is based on the architecture found in S&F Bridges with additions for CTF. The architecture in CTF Bridges is shown in Figure 9-1 and Figure 9-2 for VLAN-unaware and VLAN-aware CTF Bridges, respectively.

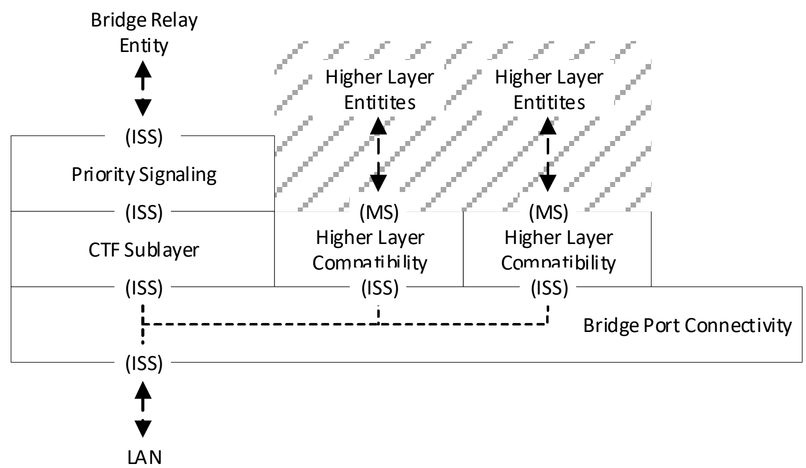

Figure 9-1—Bridge Port Transmit and Receive (VLAN-unaware).

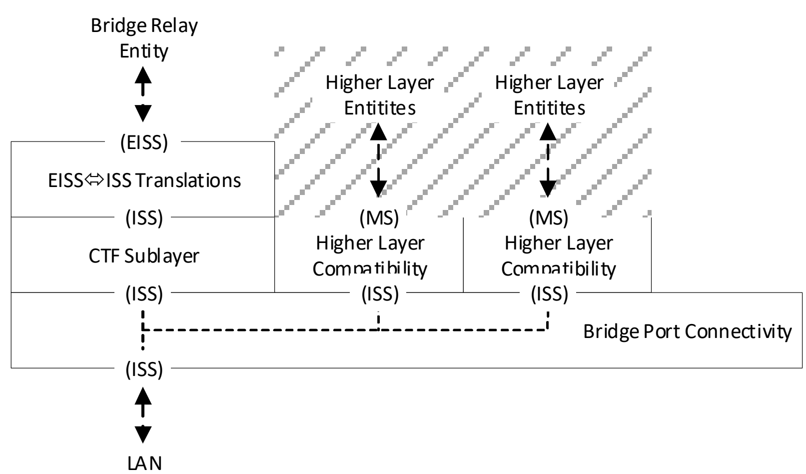

Figure 9-2—Bridge Port Transmit and Receive (VLAN-aware).

The elements contained are as follows:

a) Bridges Port Connectivity (9.2) between the access points of the ISS.
b) Priority Signaling in VLAN-unaware CTF Bridges (9.3).
c) Translations between ISS and EISS in VLAN-aware CTF Bridges (9.4).
d) Higher Layer Compatibility (9.5).
e) CTF Sublayer (9.6).

9.2 Bridge port connectivity

Bridge Port connectivity in CTF Bridges is as specified for S&F Bridges specified in 8.5.1 of IEEE Std 802.1Q with the additional definitions as follows.

For frames under reception originating from the LAN, a copy of such frames for each upper access point is created prior to passing each copy towards the respective upper access point. Frames from the upper access points towards the LAN are passed instantaneously. The multiplexing rules towards the LAN are identical to those of S&F Bridges with the addition that frames under reception originating from the Bridge relay entity are treated as received frames.

9.3 Priority signaling

9.3.1 Receive path operations

VLAN-unaware CTF Bridges may or may not implement a shim for support of the ISS with signaled priority to determine values of the drop_eligible and priority parameters (8.4) from frames destined towards the Bridge relay entity that contain a C-Tag (Customer VLAN Tag) or S-Tag (Service VLAN Tag or Backbone VLAN Tag).

If the shim is not implemented, frames under reception are passed towards the Bridge relay entity instantaneously. If the shim is implemented, that shim is as specified in 6.20 IEEE Std 802.1Qwith additional definitions for frames under reception as follows.

Frames under reception are stalled pending the initial four octets of the mac_service_data_unit parameter. If the first two octets indicate a C-Tag [#Std8021Q, Table 9-1], the priority and drop_eligible parameters are decoded from the Tag's Control Information [#Std8021Q, 9.6] in the subsequent two octets prior to passing the frame towards the Bridge relay entity instantaneously. For any other VLAN Tag (Table 9-1 of IEEE Std 802.1Q), processing falls back to S&F. In absence of any VLAN Tag, the frame is passed towards the Bridge relay entity instantaneously.

For frames under reception, the invocation of M_UNITDATA.indication (M_UNITDATA.indication'start) towards the Bridge relay entity starts when the frame is passed to the Bridge relay entity according to the aforesaid definitions, and ends when the originating invocation of M_UNITDATA.indication ends (M_UNITDATA.indication'end).

NOTE—This definition is intended to support the understanding of temporal relationships (e.g., distinction between *frame under reception* and *received frame*).

9.3.2 Transmit path operations

All frames originating from the Bridge relay entity are passed towards Bridge Port connectivity (9.2) instantaneously.

9.4 Translations between Internal Sublayer Service (ISS) and Enhanced Internal Sublayer Service (EISS)

9.4.1 Receive path operations

The translations from ISS to EISS can extract and decode C-Tags from the mac_service_data_unit parameter and discard tagged or untagged frames dependent on management parameters. The operations are as specified in 9.6.1 of IEEE Std 802.1Q, with the following additional definitions for frames under reception.

Frames under reception are stalled pending the initial four octets of the mac_service_data_unit parameter. The frame is then discarded according to the rules specified in 6.9.1 of IEEE Std 802.1Q, or further processed as follows:

f) If the first two octets indicate a C-Tag (Table 9-1 of IEEE Std 802.1Q), the vlan_identifier, priority and drop_eligible parameters are decoded from the Tag's Control Information (9.6 of IEEE Std 802.1Q) in the subsequent two octets, the first four octets are removed from mac_service_data_unit parameter, and the frame is passed towards the Bridge relay entity instantaneously in this order.
g) If the first two octets indicate a VLAN Tag other than a C-Tag, processing falls back to S&F.
h) In all other cases, the frame is passed towards the Bridge relay entity instantaneously.

For frames under reception, the invocation of EM_UNITDATA.indication (EM_UNITDATA.indication'start) towards the Bridge relay entity starts when the frame is passed to the Bridge relay entity according to the aforesaid definitions, and ends when the originating invocation of M_UNITDATA.indication ends (EM_UNITDATA.indication'end).

9.4.2 Transmit path operations

The translations from EISS to ISS on the transmit path of S&F Bridges can discard, encode and insert C-Tags into the mac_service_data_unit parameter. The operations are as specified in 9.6.2 of IEEE Std 802.1Q.

NOTE—Modifications of the mac_service_data_unit parameter in accordance with ISO/IEC 11802-5, IETF RFC 1042 (1988) and IETF RFC 1390 (9.6.2 of IEEE Std 802.1Q) are incorporated into the queuing decision logic (10.12).

9.5 Higher layer compatibility

Higher layer compatibility ensures that only frames with consistent FCS are passed via the MAC Service Interface to higher layer entities. Therefore, a CTF Bridge falls back to S&F prior to passing copies of frames under reception towards higher layer entities and performs the translation between the service primitives of the ISS and the MAC Service as defined in Clause 14 of IEEE Std 802.1 AC.

9.6 Cut-Through Forwarding (CTF) sublayer

9.6.1 Receive path operations

For frames under reception destined towards the Bridge relay, the CTF sublayer can emit late errors and fall back to S&F based on the CTFReceptionEnable parameter (11.2.4) and dependent on whether or not the ISS provider associated with the Bridge Port supports CTF or not.

If CTFReceptionEnable is FALSE and the associated ISS provider supports CTF, processing of a frame under reception is stalled pending all parameters of this frame, including the FCS. If the frame's FCS is consistent, the frame is passed towards the Bridge relay instantaneously and discarded otherwise.

If CTFReceptionEnable is TRUE and the associated ISS provider supports CTF, a frame under reception is towards the relay (9.3 and 9.4) instantaneously.

The CTF sublayer maintains reference to frames under reception after passing these frames towards the Bridge relay. If a frame's FCS is inconsistent, all of the following operations are performed:

i) A late error associated with this frame is raised.
j) A frame error counter is increased (9.6.3).

9.6.2 Transmit path operations

The transmit path of the CTF sublayer passes frames from the Bridge relay entity towards the LAN instantaneously. For any frame that is a under transmission AND a frame under reception (i.e., Cut-Through), the transmit path operations of the CTF sublayer maintains reference to such frames and marks (9.6.3) each of these frames if a late error has been raised by an earlier stage. Such earlier stages include the CTF sublayer receive path (9.6.1) and other processing stages in the Bridge relay entity (Clause 10).

<<Editor’s Note: Truncating frames under transmission is not part of this version of this document.>>

9.6.3 Inconsistent frame handling

<<Editor’s Note: The text in this clause needs to be revised to use the M_LATEERROR primitives.>>

Handling of inconsistent frames can increase diagnostic error counters on the receive path (9.6.1), CTFReceptionDiscoveredErrors (11.4.1) and CTFReceptionUndiscoveredErrors (11.4.2), as follows:

- — If the frame has been marked by an upstream Bridge and this mark was identified as such, CTFReceptionDiscoveredErrors is increased.
- — In all other cases, CTFReceptionUndiscoveredErrors is increased.

Marking inconsistent frames on the transmit path (9.6.2) assigns a externally visible indicator to such frames, usually at the end of serial transmission. In existing implementations of CTF Bridges, the marking mechanism varies. For example, an implementation may apply a modified FCS determined as follows:

k) Calculate a consistent FCS for the frame.
l) Modify the calculated consistent FCS in a deterministic manner. Examples:
   1) a) Exchange bits of the FCS at known positions.
   2) b) Invert bits of the FCS known positions.
   3) c) Perform an XOR operation between the FCS and a known constant value.
m) Replace the frame_check_sequence parameter of the associated M_UNITDATA.request invocation with the modified FCS.

Proper interpretation of a marked frames by a receiving CTF Bridge requires that the sending CTF Bridge upstream is aware of the same marking mechanism. For example, if an sending Bridge marks inconsistent frames by inverting all FCS bits, and the receiving Bridge expects (`FCS` **`XOR`** `C1-F4-80-21`), the receiving Bridge will increase CTFReceptionUndiscoveredErrors instead of CTFReceptionDiscoveredErrors even though the frame was marked by the sending Bridge.

10. Bridge relay operations

10.1 Overview

The structure of the Bridge relay entity of CTF Bridges is aligned with that of an S&F Bridge. Additional definitions for supporting frames under reception for Cut-Through exist primarily in the forwarding process (see also Clause 6).

The structure of the forwarding process in CTF Bridges, in terms of processing stages passed by frames, is likewise aligned with that of S&F Bridges. It comprises processing stages symmetrical to those found in S&F Bridges (8.6 and Figure 8-12 of IEEE Std 8021Q) with incorporated processing stages for FRER (8.1 and Figure 8-2 of IEEE Std 802.1CB). The given subset is intended to provide the minimum for having stream_handle and sequence_number parameters. The forwarding process of a CTF Bridge, additional elements in the Bridge relay and indicated interactions between them are shown in Figure 10-1.

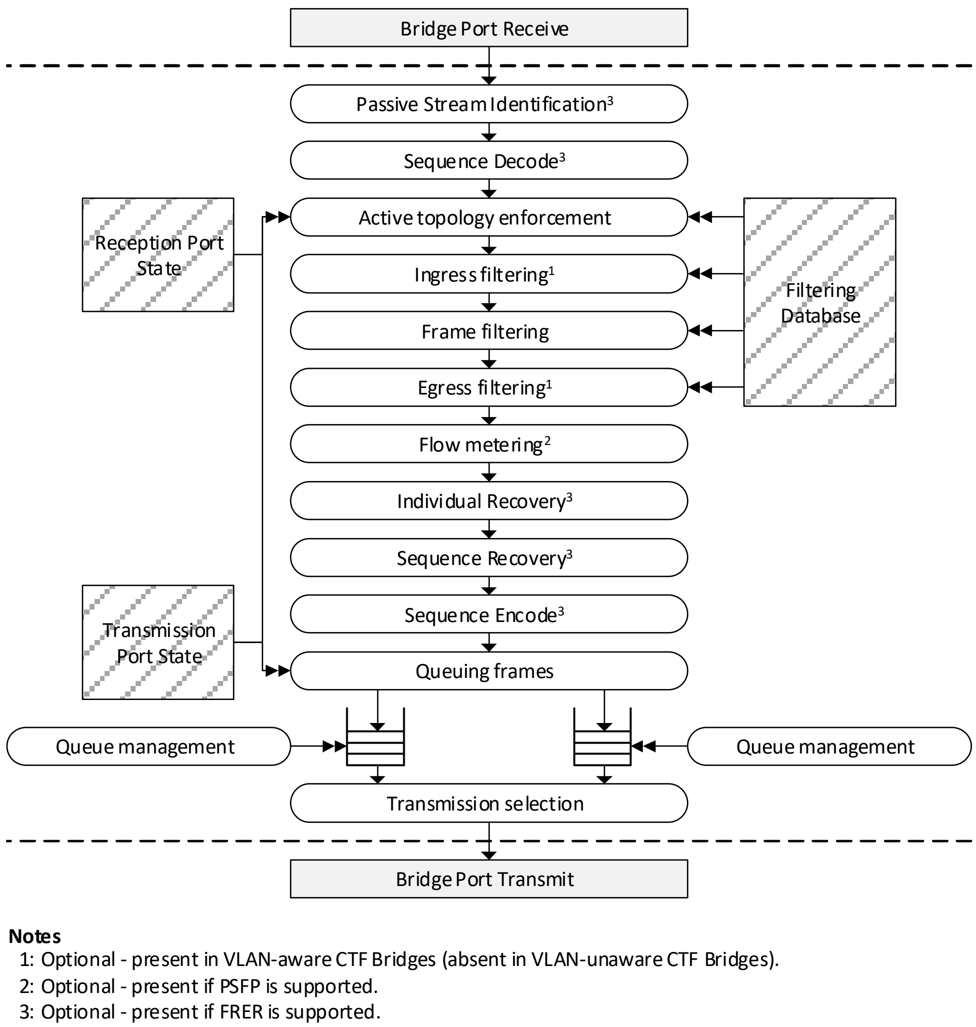

Figure 10-1—Forwarding process of a CTF Bridge.

The processing stages and their subsections are as follows:

a) Passive Stream Identification (10.2)

b) Sequence Decode (10.3)
c) Active topology enforcement (10.4)
d) Ingress filtering (10.5)
e) Frame filtering (10.6)
f) Egress filtering (10.7)
g) Flow classification and metering (10.8)
h) Individual recovery (10.9)
i) Sequence recovery (10.10)
j) Sequence encode (10.11)
k) Queuing frames (10.12), and associated additional definitions for queue management (10.13)
l) Transmission selection (10.14)

The sections of the processing stages are written in a manner that avoids replicating contents of the corresponding sections in the published IEEE 802.1 standards. The sections provide reference to the corresponding section(s) in the published standards, followed by additional definitions for processing frames under reception. While the emphasis is on processing frames under reception, the stages are equally capable for processing received frames.

<<Editor's Note: The FRER stages used in this version limit to a subset of those described in IEEE Std 802.1CB when the FRER functions are integrated into the forwarding process. For example, active stream identification is not present.>>

10.2 Passive stream identification

The passive stream identification stage can determine a stream_handle parameter and associate it with a frame. The operation of this stage is as specified in 6.2, 6.4, 6.5, 8.1 and Figure 8-2 of IEEE Std 802.1CB with the additional definitions for frames under reception described in the following.

Whether or not a frame under reception can be subject to passive stream identification is dependent on the associated management parameters (Clause 9 of IEEE Std 802.1CB). If it can be precluded that the frame is not subject to passive stream identification, the frame is forwarded to the next processing stage (10.3) instantaneously. If this cannot be precluded, processing of the frame stalls pending the necessary parameters of the frame (source_address, destination_address, vlan_identifier, msdu octets, etc.) that are required to determine the following:

m) 1. Whether or not one or more stream stream identification function instance matches the frame, and
n) 2. in case of multiple matching stream identification function instance, to the resolve ambiguity as defined in IEEE Std 802.1CB.

NOTE—An example for precluding that a frame is not subject to passice stream identification is an empty stream identity table (9.1 of IEEE Std 802.1CB).

The exact set of parameters required to satisfy the aforesaid conditions is dependent on the stream identification function instances that are actually set in the stream identity table (9.1 of IEEE Std 802.1CB) and the parameters of the underlying stream identification functions (Clause 6 of IEEE Std 802.1CB). If a stream identification function instance matches, a stream_handle parameter is associated to the frame before the frame is passed to the next processing stage instantaneously.

10.3 Sequence decode

The sequence decode stage is not present in CTF Bridges without support for FRER. The stage can extract redundancy tags (7.8 of IEEE Std 802.1CB) from frames, decode therein contained sequence_number parameters (item b) in 6.1 of IEEE Std 802.1CB), and assign these parameters to frames. The operation of this stage is as specified in 7.6 of IEEE Std 802.1CB with the additional definitions for frames under reception described in the following.

<<Editor's Note: Consideration of tags other than R-Tag is excluded in this version.>>

If a frame under reception has no associated stream_handle parameter (10.2), the frame is passed to the next processing stage (10.4) instantaneously. If a frame under reception has an associated stream_handle parameter, processing stalls pending the initial six octets in the mac_service_data_unit parameter. If the first two octets indicate an R-Tag (Table 7-1 of IEEE Std 802.1CB), the sequence_number parameter is decoded from the 5th and 6th octet, the first six octets are removed from the mac_service_data_unit parameter, and the frame is passed to the next processing stage instantaneously.

10.4 Active topology enforcement

10.4.1 Overview

The active topology enforcement stage can determine if frames from reception Ports are submitted to learning, and determines the initial set of potential transmission Ports for each frame. Both operations are as specified in 8.6.1 of IEEE Std 802.1Q in CTF Bridges, with the additions described in the following for learning (10.4.2) and the initial set of potential transmission Ports (10.4.3) separately.

<<Editor's Note: To my surprise, I could not find a statement in 8.4 or 8.6.1 of IEEE Std 802.1Q indicating that frames would be discarded by active topology enforcement if the forwarding control in 8.6.1 is FALSE.>>

10.4.2 Learning

Learning is based on the source_address (VLAN-unaware and VLAN-aware CTF Bridges) and VID (VLAN-aware CTF Bridges) parameters of frames for adding dynamic entries in the forwarding database (FDB) as specified in 8.7 of IEEE Std 802.1Q. The parameters are submitted to learning only if the following conditions are satisfied:

o) A frame under reception associated with the parameters reached the end of reception.
p) This frame's FCS is consistent.
q) All conditions of an S&F Bridge for using the parameters for learning are satisfied (8.4 and 8.6.1 of IEEE Std 802.1Q).

10.4.3 Initial set of potential transmission ports

The initial set of potential transmission Ports is determined by CTF Bridges as specified in 8.6.1 of IEEE Std 802.1Q.

10.5 Ingress filtering

The ingress filtering stage is not present in VLAN-unaware CTF Bridges. The stage discards frames originating from reception Ports based on per frame VID parameters, if present. The conditions under which a frame is discarded by a CTF Bridge are identical to those specified in 8.6.2 of IEEE Std 802.1Q. Non-discarded frames are passed to the next processing stage (10.6) instantaneously.

10.6 Frame filtering

The frame filtering stage reduces the set of potential transmission Ports (10.4) associated with a frame based on the destination_address (VLAN-unaware and VLAN-aware CTF Bridges) and VID (VLAN-aware CTF Bridges) parameters, entries in the FDB and management parameters. The operation of this stage is as specified in 8.6.3 of IEEE Std 802.1Q with the additional definitions for frames under reception as follows.

<<Editor’s Note: flow_hash [item c) in 8.6.3 of IEEE Std 802.1Q] is not considered in this version of this document.>>

In VLAN-aware CTF Bridges, an FDB query is performed for each frame under reception instantaneously. In VLAN-unaware CTF Bridges, processing stalls pending a frame's destination_address parameter before performing an FDB query for this frame (8.8.9 of IEEE Std 802.1Q). Dependent on a query's result by the FDB, processing of the frame under reception falls back to S&F or passes the frame to the next stage instantaneously as follows:

— Whenever the query evaluation by the FDB results in flooding (i.e., query evaluation hits an “ELSE Forward” branch in 8.8.9 of IEEE Std 802.1Q), processing of the frame falls back to S&F.
— In all other cases, a frame under reception is passed to the next processing stage instantaneously.

NOTE—The fall-back to S&F is intended to reduce the cases for circulation of inconsistent frames in topological loops, assuming that the performance benefits of CTF in presence of flooding are negligible in most use-cases.

10.7 Egress filtering

The egress filtering stage is only present in VLAN-aware CTF Bridges. The stage reduces the set of potential transmission Ports (10.4) associated with a frame based on this frame's VID parameter. The rules under which transmission Ports are removed from this set are identical to those specified in 8.6.4 of IEEE Std 802.1Q.

10.8 Flow classification and metering

10.8.1 Overview

The flow classification and metering stage can can apply flow classification and metering to frames that are received on a Bridge Port and have one or more potential transmission ports. The stage is structured into multiple internal (sub)stages in CTF Bridges, identical to the structure specified in 8.6.5 of IEEE Std 802.1Q. The internal stages and their relationships are shown in Figure 10-2.

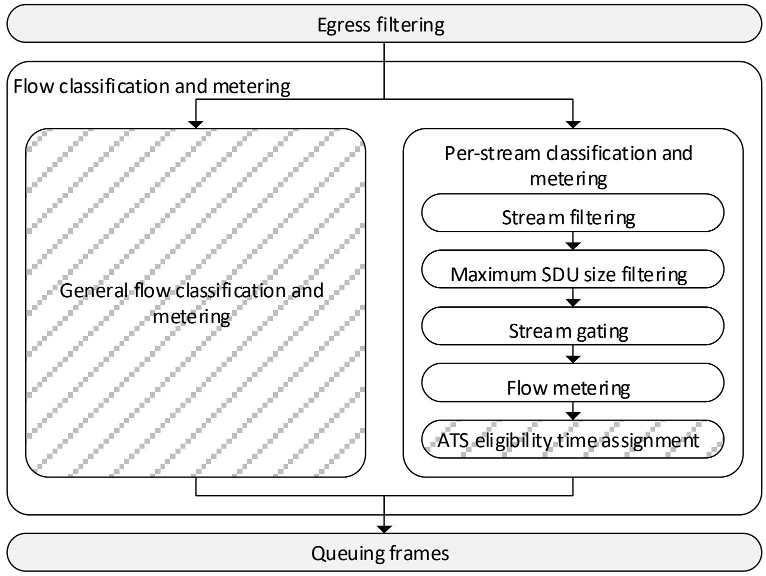

Figure 10-2—Flow classification and metering.

Support for frames under reception is provided by CTF Bridges for the following internal stages:

r) Stream filtering
s) Maximum SDU size filtering
t) Stream gating
u) Flow metering

Processing in CTF Bridges falls back to S&F immediately if a frame under reception reaches any other internal stage prior to being processed by this stage.

The operation of stages with support for frames under reception is described in 10.8.2, 10.8.3, 10.8.4 and 10.8.5. All of these stages process frames under reception instantaneously (i.e., stall-free operation).

10.8.2 Stream filtering

The operation of stream filtering for frames under reception is as specified in 8.6.5.3 of IEEE Std 802.1Q.

10.8.3 Maximum SDU size filtering

The operation of maximum SDU size filtering for frames under reception is as specified in 8.6.5.3.1 of IEEE Std 802.1Q with the following additional definitions for frames under reception.

When a frame under reception reaches maximum SDU size filtering, an initial number of octets of this frame is already received. This number of octets is used by maximum SDU size filtering for the decision on whether or not this frame is passed to a subsequent processing stage or discarded. If a frame under reception already passed frame maximum SDU size filtering and the associated maximum SDU size limit is exceeded prior to the frame's end of reception, a late error for that frame is indicated for handling by subsequent processing stages in a CTF Bridge.

10.8.4 Stream gating

The operation of stream gates for frames under reception is as specified in 8.6.5.4 of IEEE Std 802.1Q with the following additional definitions for frames under reception.

When frame under reception reaches a stream gate, this frame is only passed to the next processing stage if the gate is in an open state. The frame is discard otherwise prior to being passed to the next processing stage. If a stream If a stream gate closes prior to the end of the frame under reception, a late error for this frame is indicated immediately for handling by subsequent processing stages in a CTF Bridge.

10.8.5 Flow metering

The operation of stream gates for frames under reception is as specified in 8.6.5.5 of IEEE Std 802.1Q with the following additional definitions for frames under reception.

When a frame under reception reaches flow metering, an initial number of octets of this frame is already received. This number of octets is used by the associated flow meter for the decision on whether or not this frame is passed to a subsequent processing stage or discarded. If a frame under reception already passed flow metering and the limit of the flow meter is subsequently exceeded prior to the frame's end of reception, a late error for this frame is indicated for handling by subsequent processing stages in a CTF Bridge.

10.9 Individual recovery

The individual recovery stage is not present in CTF Bridges without support for FRER. If present, the stage can associate frames belonging to individual Member streams (7.4.2 of IEEE Std 802.1CB) with therefore configured instances of the Base recovery function (7.4.3 of IEEE Std 802.1CB), which then discard frames with repeating sequence_number parameters (10.3) on a per Member stream resolution. The operation of the individual recovery stage is as specified in 7.5 of IEEE Std 802.1CB, with the following additions for CTF Bridges.

If frames under reception are associated with a Base recovery function for individual recovery, processing falls back to S&F prior to performing individual recovery.

NOTE—Falling back to S&F ensures that individual recovery does not falsely discard a frame with correct sequence_number parameter (and consistent FCS) after accepting a frame with incorrect but identical sequence_number (and inconsistent FCS) earlier. The same rationale applies in 10.10.

10.10 Sequence recovery

The sequence recovery stage is not present in CTF Bridges without support for FRER. If present, the stage can associate frames belonging to sets of Member streams with therefore configured instances of the Base recovery function (7.4.3 of IEEE Std 802.1CB), which then remove frames with repeating sequence_number parameters [item b) in 6.1 of IEEE Std 802.1CB] on a per Member stream set resolution. The operation of the sequence recovery stage is as specified in IEEE Std 802.1CB (7.4.2 of IEEE Std 802.1CB), with the following additions for CTF Bridges.

If frames under reception are associated with a Base recovery function for sequence recovery, processing falls back to S&F prior to performing sequence recovery.

10.11 Sequence encode

The sequence recovery stage is not present in CTF Bridges without support for FRER. If it is present, the stage can encode and insert R-Tags into the mac_service_data_unit parameter based on the sequence_number parameter associated with these frames. The operation of the sequence encode stage for frames under reception is as specified in 7.6 and 7.8 of IEEE Std 802.1CB.

10.12 Queuing frames

The queuing frames stage queues each received frame to a per-traffic class queue of each remaining potential transmission Port associated with the frame (10.4, 10.6 and 10.7). The stage operates as specified in 8.6.6 of IEEE Std 802.1Q with the following additional definitions for frames under reception.

Before a frame under reception is queued, a per-queue copy of a frame is created before queuing and considered separately according to the following algorithm:

```
IF
        (the associated CTFTransmissionEnable parameter [11.2.2] is FALSE)
        OR
        (the associated transmission selection algorithm is not strict priority [8.6.8.1 of IEEE Std 802.1Q])
THEN
        Processing falls back to S&F before queuing the frame instantaneously.
ELSE IF
        (the associated CTFTransmissionEnable parameter is TRUE)
        AND
        (CTFInconsistencyCondition is TRUE)
THEN
        The frame is discarded before queuing.
ELSE
        The frame is queued instantaneously.
END IF

CTFInconsistencyCondition :=
        (transmission link speed of the frame > reception link speed of the frame)
        OR
        (mac_service_data_unit modification required in accordance with
        ISO/IEC 11802-5, IETF RFC 1042 (1988) and IETF RFC 1390)
```

<<Editor's Note: TBD: Put a reference after (CTFInconsistencyCondition) - AND modification of the mac_service_data_unit according to 6.9.2 of 802.1Q cannot be precluded>>

10.13 Queue management

The rules for removing frames from 8.6.7 of IEEE Std 802.1Q remain unaltered in CTF Bridges.

In addition, CTF Bridges may remove a frame from a queue if all of the following conditions are satisfied:

v) The frame was queued while it was under reception.

w) A processing stage before queuing (10.12) raised a late error for that frame.

x) The end of reception of the frame was reached before the frame was selected for transmission (10.14).

NOTE—Erroneous frames removed according to this additional rule will not become visible on the LAN of an associated transmission Port, because such frames can be removed before being selected by transmission selection.

10.14 Transmission selection

Transmission selection determines whether frames in per traffic class queues are available for transmission, determines transmission ordering and transmission times of queued frames, de-queues frames for transmission and initiates transmission. Transmission selection in CTF Bridges is as specified in 8.6.8 of IEEE Std 802.1Q.

11. Management parameters

11.1 Overview

The management parameters for CTF fall into three categories:

a) Control Parameters (11.2)
b) Timing Parameters (11.3)
c) Error Counters (11.4)

The control parameters allow to (i) determine whether CTF is supported on a per Port and per Port per Traffic Class resolution, and if CTF is supported, to (ii) enable and disable CTF on these resolutions. These parameters are available in reception Ports and transmission Ports. For a pair of Bridge ports, frames can only be subject to the CTF operation if CTF is supported and enabled on both Ports.

The timing parameters expose the delays experienced by frames passing from a particular reception Port to another transmission Port. These parameters are primarily intended for automated network and traffic configuration, for example, by a Centralized Network Controller (CNC) using the associated mechanisms from Clause 46 of IEEE Std 802.1Q.

The error counters expose information on frames that were subject to the CTF operation in a Bridge, even though such frames have consistency errors (i.e., a frame check sequence inconsistent with the remaining contents of that frame) during reception by this Bridge. These counters are primarily intended for manual diagnostic purposes to support identifying erroneous links or stations, for example, by a human network administrator.

11.2 Control parameters

11.2.1 CTFTransmissionSupported

A Boolean read-only parameter that indicates whether CTF on transmission is supported (TRUE) or not (FALSE). There is one CTFTransmissionSupported parameter for each traffic class of each transmission Port.

11.2.2 CTFTransmissionEnable

A Boolean parameter to enable (TRUE) and disable (FALSE) CTF on transmission. There is one CTFTransmissionEnable parameter for each traffic class of each transmission Port. The default value of the CTFTransmissionEnable parameter is FALSE for all traffic classes of all transmission Ports. It is an error if a CTFTransmissionEnable is set to TRUE if the associated CTF Transmission Supported parameter is FALSE.

11.2.3 CTFReceptionSupported

A Boolean read-only parameter that indicates whether CTF on reception is supported (TRUE) or not (FALSE). There is one CTFReceptionSupported parameter for each reception Port.

11.2.4 CTFReceptionEnable

A Boolean parameter to enable (TRUE) and disable (FALSE) CTF on reception. There is one CTFReceptionEnable parameter for each reception Port. The default value of the CTFReceptionEnable parameter is FALSE for all reception Ports.It is an error if a CTFReceptionEnable is set to TRUE if the associated CTFReceptionSupported parameter is FALSE.

11.3 Timing parameters

11.3.1 CTFDelayMin and CTFDelayMax

A pair of unsigned integer read-only parameters, in units of nanoseconds, describing the delay range for frames that are subject to the CTF operation and encounter zero delay for transmission selection (8.6.8 of IEEE Std 802.1Q). 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). There is one pair of CTFDelayMin and CTFDelayMax parameters per reception Port per transmission Port traffic class pair.

<<Editor’s Note: This version does not contain parameters for frame truncation.>>

11.4 Error counters

11.4.1 CTFReceptionDiscoveredErrors

An integer counter, counting the number of received frames with discovered consistency errors. There is one CTFReceptionDiscoveredErrors parameter for each reception Port. A frame with discovered consistency errors has been identified as such by a Bridge on the upstream path from which the frame originates and marked by that an implementation-dependent marking mechanism. The value of the counter always increases by one

d) if
    1) the upstream Bridge that applied the marking,
    2) all Bridges on the path of that Bridge to the reception Port associated with the CTFReceptionDiscoveredErrors counter and
    3) the receiving Bridge of which the reception Port is a part of are different instances of the same Bridge implementation, and

e) the underlying marking mechanism is identical for all these instances if multiple marking mechanisms are supported by these instances.

If any condition d)1), d)2), d)3) and e) is unsatisfied, CTFReceptionUndiscoveredErrors may be increased instead of CTFReceptionDiscoveredErrors.

NOTE—It is assumed that there is a variety of options for implementing a frame marking mechanism. For example, by using physical layer symbols (1.121 through 1.126 of [B7]) or special frame check sequences (p.54 of [B6]) The current description in this standard permits any marking mechanism, but the associated error counters are only consistent in networks with homogeneous implementation instances, and may be inconsistent in heterogeneous networks. However, term (CTFReceptionDiscoveredErrors + CTFReceptionUndiscoveredErrors) on a reception Port should be identical in several heterogeneous networks. A human network administrator may be able to localize erroneous links or stations solely by considering this term along multiple reception Ports across a network instead of its constituents.

11.4.2 CTFReceptionUndiscoveredErrors

An integer counter, counting the number of received frames with undiscovered consistency errors. There is one CTFReceptionUndiscoveredErrors parameter for each reception Port. This counter is increased by one if a frame with consistency errors is received at the associated reception Port and CTFReceptionDiscoveredErrors is not increased.

12. YANG

12.1 YANG framework

<<Editor’s Note: Placeholder>>

12.2 Structure of the YANG modules

<<Editor’s Note: Placeholder>>

12.3 Security considerations

<<Editor’s Note: Placeholder>>

12.4 YANG schema tree definitions

<<Editor’s Note: Placeholder>>

12.5 YANG modules

<<Editor’s Note: Placeholder>>

13. Cut-Through Forwarding (CTF) in Bridged networks

<<Editor’s Note: Placeholder for:

- Describing forwarding to unintended ports and or traffic classes of frames under reception due to header corruption,

- Qualitative analysis of the impact,

- Mitigations, and

- Recommendations for networks.

>>

Annex A

(normative)

PICS proforma—Cut-Through Forwarding (CTF) Bridges[13]

<<Editor's Note: The remaining contents of Annex A are as found in the FrameMaker template and will be adjusted in a later stage (i.e., do not review/comment now).

A.1 Introduction

The supplier of a protocol implementation that is claimed to conform to this standard shall complete the following Protocol Implementation Conformance Statement (PICS) proforma.

A completed PICS proforma is the PICS for the implementation in question. The PICS is a statement of which capabilities and options of the protocol have been implemented. The PICS can have a number of uses, including use

a) By the protocol implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight.
b) By the supplier and acquirer—or potential acquirer—of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma.
c) By the user—or potential user—of the implementation, as a basis for initially checking the possibility of interworking with another implementation (note that, while interworking can never be guaranteed, failure to interwork can often be predicted from incompatible PICSs).
d) By a protocol tester, as the basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.

A.2 Abbreviations and special symbols

A.2.1 Status symbols

M	mandatory
O	optional
O.n	optional, but support of at least one of the group of options labeled by the same numeral n is required
X	prohibited
pred:	conditional-item symbol, including predicate identification: see A.3.4
¬	logical negation, applied to a conditional item's predicate

A.2.2 General abbreviations

N/A	not applicable
PICS	Protocol Implementation Conformance Statement

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

A.3 Instructions for completing the PICS proforma

A.3.1 General structure of the PICS proforma

The first part of the PICS proforma, implementation identification and protocol summary, is to be completed as indicated with the information necessary to identify fully both the supplier and the implementation.

The main part of the PICS proforma is a fixed-format questionnaire, divided into several subclauses, each containing a number of individual items. Answers to the questionnaire items are to be provided in the rightmost column, either by simply marking an answer to indicate a restricted choice (usually Yes or No) or by entering a value or a set or range of values. (Note that there are some items where two or more choices from a set of possible answers can apply; all relevant choices are to be marked.)

Each item is identified by an item reference in the first column. The second column contains the question to be answered; the third column records the status of the item—whether support is mandatory, optional, or conditional: see also A.3.4. The fourth column contains the reference or references to the material that specifies the item in the main body of this standard, and the fifth column provides the space for the answers.

A supplier may also provide (or be required to provide) further information, categorized as either Additional Information or Exception Information. When present, each kind of further information is to be provided in a further subclause of items labeled Ai or Xi, respectively, for cross-referencing purposes, where i is any unambiguous identification for the item (e.g., simply a numeral). There are no other restrictions on its format and presentation.

A completed PICS proforma, including any Additional Information and Exception Information, is the Protocol Implementation Conformation Statement for the implementation in question.

NOTE—Where an implementation is capable of being configured in more than one way, a single PICS may be able to describe all such configurations. However, the supplier has the choice of providing more than one PICS, each covering some subset of the implementation's configuration capabilities, in case that makes for easier and clearer presentation of the information.

A.3.2 Additional information

Items of Additional Information allow a supplier to provide further information intended to assist the interpretation of the PICS. It is not intended or expected that a large quantity will be supplied, and a PICS can be considered complete without any such information. Examples might be an outline of the ways in which a (single) implementation can be set up to operate in a variety of environments and configurations, or information about aspects of the implementation that are outside the scope of this standard but that have a bearing on the answers to some items.

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

A.3.3 Exception information

It may occasionally happen that a supplier will wish to answer an item with mandatory status (after any conditions have been applied) in a way that conflicts with the indicated requirement. No preprinted answer will be found in the Support column for this item. Instead, the supplier shall write the missing answer into the Support column, together with an *Xi* reference to an item of Exception Information, and shall provide the appropriate rationale in the Exception item itself.

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

NOTE—A possible reason for the situation described previously is that a defect in this standard has been reported, a correction for which is expected to change the requirement not met by the implementation.

A.3.4 Conditional status

A.3.4.1 Conditional items

The PICS proforma contains a number of conditional items. These are items for which both the applicability of the item itself, and its status if it does apply—mandatory or optional—are dependent on whether certain other items are supported.

Where a group of items is subject to the same condition for applicability, a separate preliminary question about the condition appears at the head of the group, with an instruction to skip to a later point in the questionnaire if the "Not Applicable" answer is selected. Otherwise, individual conditional items are indicated by a conditional symbol in the Status column.

A conditional symbol is of the form "**pred:** S" where **pred** is a predicate as described in A.3.4.2 below, and S is a status symbol, M or O.

If the value of the predicate is true (see A.3.4.2), the conditional item is applicable, and its status is indicated by the status symbol following the predicate: The answer column is to be marked in the usual way. If the value of the predicate is false, the "Not Applicable" (N/A) answer is to be marked.

A.3.4.2 Predicates

A predicate is one of the following:

a) An item-reference for an item in the PICS proforma: The value of the predicate is true if the item is marked as supported and is false otherwise.
b) A predicate-name, for a predicate defined as a boolean expression constructed by combining item-references using the boolean operator OR: The value of the predicate is true if one or more of the items is marked as supported.
c) The logical negation symbol "¬" prefixed to an item-reference or predicate-name: The value of the predicate is true if the value of the predicate formed by omitting the "¬" symbol is false, and vice versa.

Each item whose reference is used in a predicate or predicate definition, or in a preliminary question for grouped conditional items, is indicated by an asterisk in the Item column.

A.4 PICS proforma—Cut-Through Forwarding (CTF) Bridges

A.4.1 Implementation identification

Supplier	
Contact point for queries about the PICS	
Implementation Name(s) and Version(s)	
Other information necessary for full identification, e.g., name(s) and version(s) of machines and/or operating system names	
NOTE 1—Only the first three items are required for all implementations; other information may be completed as appropriate in meeting the requirement for full identification. NOTE 2—The terms “Name” and “Version” should be interpreted appropriately to correspond with a supplier’s terminology (e.g., Type, Series, Model).	

A.4.2 Protocol summary

Identification of protocol specification	<tbs>
Identification of amendments and corrigenda to the PICS proforma that have been completed as part of the PICS	Amd. : Corr. : Amd. : Corr. :
Have any Exception items been required? (See A.3.3: the answer “Yes” means that the implementation is not conformant).	No [ ] Yes [ ]

Date of Statement	

Annex B

(informative)

Bibliography

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

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Annex Z

(informative)

Commentary