

INTERNATIONAL
STANDARD

ISO/IEC/
IEEE
8802-1Q

First edition
2016-03-15

AMENDMENT 7
2019-02

**Information technology —
Telecommunications and information
exchange between systems — Local
and metropolitan area networks —
Specific requirements —**

**Part 1Q:
Bridges and bridged networks**

**AMENDMENT 7: Cyclic queuing and
forwarding**

*Technologies de l'information — Télécommunications et échange
d'information entre systèmes — Réseaux locaux et métropolitains —
Exigences spécifiques —*

Partie 1Q: Ponts et réseaux pontés

AMENDEMENT 7: Mise en file d'attente et transfert par cycle



Reference number
ISO/IEC/IEEE 8802-1Q:2016/Amd.7:2019(E)

© IEEE 2017

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019



COPYRIGHT PROTECTED DOCUMENT

© IEEE 2017

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO or IEEE at the respective address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Institute of Electrical and Electronics Engineers, Inc
3 Park Avenue, New York
NY 10016-5997, USA

Email: stds.ipr@ieee.org
Website: www.ieee.org

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted (see www.iso.org/directives).

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

ISO/IEC/IEEE 8802-1Q:2016/Amd.7 was prepared by the LAN/MAN of the IEEE Computer Society (as IEEE Std 802.1Qch-2017) and drafted in accordance with its editorial rules. It was adopted, under the "fast-track procedure" defined in the Partner Standards Development Organization cooperation agreement between ISO and IEEE, by Joint Technical Committee ISO/IEC JTC 1, *Information technology, Subcommittee SC6, Telecommunications and information exchange between systems*.

A list of all parts in the ISO/IEC/IEEE 8802 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019

IEEE Std 802.1Qch™-2017
(Amendment to
IEEE Std 802.1Q™-2014
as amended by
IEEE Std 802.1Qca™-2015,
IEEE Std 802.1Qcd™-2015,
IEEE Std 802.1Q-2014/Cor 1-2015,
IEEE Std 802.1Qbv™-2015,
IEEE Std 802.1Qbu™-2016,
IEEE Std 802.1Qbz™-2016, and
IEEE Std 802.1Qci™-2017)

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

Bridges and Bridged Networks—

Amendment 29: Cyclic Queuing and Forwarding

Sponsor

**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 18 May 2017

IEEE-SA Standards Board

STANDARDSISO.COM · Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019

Abstract: The use of traffic scheduling and per-stream filtering and policing to support cyclic queuing and forwarding are described in this amendment to IEEE Std 802.1Q-2014.

Keywords: Bridged Local Area Networks, cyclic queuing and forwarding (CQF), IEEE 802®, IEEE 802.1Q™, IEEE Std 802.1Qbu™, IEEE 802.1Qbv™, IEEE 802.1Qch™, IEEE 802.1Qci™, local area networks (LANs), MAC Bridges, metropolitan area networks, scheduled traffic, Virtual Bridged Local Area Networks (virtual LANs)

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2017 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 28 June 2017. Printed in the United States of America.

IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

Print: ISBN 978-1-5044-4095-0 STD22629
PDF: ISBN 978-1-5044-4096-7 STDPD22629

IEEE prohibits discrimination, harassment, and bullying.

For more information, visit <http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading “Important Notices and Disclaimers Concerning IEEE Standards Documents.” They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/IPR/disclaimers.html>.

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (“IEEE-SA”) Standards Board. IEEE (“the Institute”) develops its standards through a consensus development process, approved by the American National Standards Institute (“ANSI”), which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed through scientific, academic, and industry-based technical working groups. Volunteers in IEEE working groups are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied “AS IS” and “WITH ALL FAULTS.”

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE-SA Website at <http://ieeexplore.ieee.org/> or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE's standards development process, visit the IEEE-SA Website at <http://standards.ieee.org>.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: <http://standards.ieee.org/findstds/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at <http://standards.ieee.org/about/sasb/patcom/patents.html>. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

At the time of approval of this standard, the IEEE 802.1 Working Group had the following membership:

Glenn Parsons, Chair
John Messenger, Vice Chair
János Farkas, Chair, Time-Sensitive Networking Task Group
Tony Jeffree, Editor

SeoYoung Baek	Patrick Heffernan	Karen Randall
Shenghua Bao	Marc Holness	Maximilian Riegel
Jens Bierschenk	Tony Jeffree	Jessy Rouyer
Steinar Bjornstad	Michael Johas Teener	Eero Ryyty
Christian Boiger	Hal Keen	Soheil Samii
Paul Bottorff	Stephan Kehrer	Behcet Sarikaya
David Chen	Philippe Klein	Frank Schewe
Feng Chen	Jouni Korhonen	Michael Seaman
Weiyang Cheng	Yizhou Li	Johannes Specht
Rodney Cummings	Christophe Mangin	Patricia Thaler
Norman Finn	Tom McBeath	Paul Unbehagen
Mickael Fontaine	James McIntosh	Hao Wang
Geoffrey Garner	Robert Moskowitz	Karl Weber
Eric W. Gray	Tero Mustala	Brian Weis
Craig Gunther	Hiroki Nakano	Jordon Woods
Marina Gutierrez	Bob Noseworthy	Nader Zein
Stephen Haddock	Donald R. Pannell	Helge Zinner
Mark Hantel	Walter Pienciak	Juan Carlos Zuniga
	Michael Potts	

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

Thomas Alexander	Mark Hantel	Matthew Mora
Butch Anton	Marco Hernandez	Henry Muysshondt
Stefan Aust	Guido Hiertz	Michael Newman
Gordon Bechtel	Werner Hoelzl	Charles Ngethe
Steinar Bjornstad	Rita Horner	Satoshi Obara
Christian Boiger	Noriyuki Ikeuchi	Glenn Parsons
Nancy Bravin	Osamu Ishida	Bansi Patel
William Byrd	Atsushi Ito	Adee Ran
Juan Carreon	Raj Jain	Alon Regev
Keith Chow	Tony Jeffree	Robert Robinson
Charles Cook	SangKwon Jeong	Benjamin Rolfe
Rodney Cummings	Peter Jones	Dan Romascanu
Eugene Dai	Jeritt Kent	Osman Sakr
Patrick Diamond	Stuart Kerry	Frank Schewe
Sourav Dutta	Yongbum Kim	Michael Seaman
Marc Emmelmann	Jeff Koftinoff	Thomas Starai
János Farkas	Jouni Korhonen	Walter Struppler
Norman Finn	Bruce Kraemer	Patrik Sundstrom
Michael Fischer	John Lemon	Steven Tilden
Yukihiro Fujimoto	Joseph Levy	Mark-Rene Uchida
Devon Gayle	Jon Lewis	Prabodh Varshney
Eric W. Gray	Arthur H. Light	George Vlantis
Randall Groves	Elvis Maculuba	Karl Weber
Craig Gunther	Arthur Marris	Andreas Wolf
Stephen Haddock	Charles Moorwood	Oren Yuen
Marek Hajduczenia		Zhen Zhou

When the IEEE-SA Standards Board approved this standard on 18 May 2017, it had the following membership:

Jean-Philippe Faure, *Chair*
Gary Hoffman, *Vice Chair*
John D. Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Chuck Adams
Masayuki Ariyoshi
Ted Burse
Stephen Dukes
Doug Edwards
J. Travis Griffith
Michael Janezic

Thomas Koshy
Joseph L. Koepfinger*
Kevin Lu
Daleep Mohla
Damir Novosel
Ronald C. Petersen
Annette D. Reilly

Robby Robson
Dorothy Stanley
Adrian Stephens
Mehmet Ulema
Phil Wennblom
Howard Wolfman
Yu Yuan

*Member Emeritus

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019

Introduction

This introduction is not part of IEEE Std 802.1Qch-2017, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment 29: Cyclic Queuing and Forwarding.

This amendment to IEEE Std 802.1Q-2014 describes the use of traffic scheduling and per-stream filtering and policing to support cyclic queuing and forwarding.

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
445 Hoes Lane
Piscataway, NJ 08854-4141
USA

Contents

2. Normative references	12
4. Abbreviations	13
5. Conformance	14
5.4 VLAN Bridge component requirements.....	14
5.13 MAC Bridge component requirements.....	14
5.28 End station requirements—Cyclic queuing and forwarding.....	14
Annex A (normative) PICS proforma—Bridge implementations	16
A.5 Major capabilities	16
A.14 Bridge management	16
A.24 Management Information Base (MIB)	16
A.44 Scheduled traffic	17
A.45 Per-stream filtering and policing	17
Annex B (normative) PICS proforma—End station implementations	18
B.5 Major capabilities	18
B.15 Scheduled traffic	18
B.16 Per-stream filtering and policing	19
Annex T (informative) Cyclic queuing and forwarding	20
T.1 Overview of CQF.....	20
T.2 An approach to CQF implementation.....	21
T.3 Use of per-stream filtering and policing for CQF.....	22
T.4 Use of traffic scheduling for CQF.....	23
T.5 Timing considerations.....	24
Annex U (informative) Bibliography.....	28

List of figures

Figure T-1	Example PSFP configuration for QCF.....	23
Figure T-2	Traffic scheduling example for CQF	24
Figure T-3	Example PSFP configuration with two values of T	25
Figure T-4	Traffic scheduling example with two values of T.....	25
Figure T-5	Interleaving example—factor of 2	26

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019

IEEE Standard for
Local and metropolitan area networks—

Bridges and Bridged Networks—

Amendment 29: Cyclic Queuing and Forwarding

(This amendment is based on IEEE Std 802.1Q™-2014 as amended by IEEE Std 802.1Qca™-2015, IEEE Std 802.1Qcd™-2015, IEEE Std 802.1Q-2014/Cor 1-2015, IEEE Std 802.1Qbv™-2015, IEEE Std 802.1Qbu™-2016, IEEE Std 802.1Qbz™-2016, and IEEE Std 802.1Qbci™-2017)

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

The editing instructions are shown in **bold italic**. Four editing instructions are used: change, delete, insert, and replace. **Change** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). **Delete** removes existing material. **Insert** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. **Replace** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.¹

¹Notes in text, tables, and figures are given for information only, and do not contain requirements needed to implement the standard.

2. Normative references

Insert the following references in alphanumeric order:

IEEE Std 802.1Qbv™, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment 25: Enhancements for Scheduled Traffic.

IEEE Std 802.1Qci™, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment 28: Per-Stream Filtering and Policing.

NOTE—IEEE Std 802.1Qbv and IEEE Std 802.1Qci are both amendments to IEEE Std 802.1Q-2014, as is this standard. This NOTE and the references to IEEE Std 802.1Qbv and IEEE P802.1Qci will be removed when this standard is incorporated into the IEEE 802.1Q base standard in the next revision.

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/Amd7:2019

4. Abbreviations

Insert the following abbreviation in alphanumeric order:

CQF cyclic queuing and forwarding

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019

5. Conformance

5.4 VLAN Bridge component requirements

5.4.1 VLAN Bridge component options

Insert new subclause 5.4.1.9 as shown, renumbering as necessary:

5.4.1.9 Cyclic queuing and forwarding (CQF) requirements

A VLAN Bridge component implementation that conforms to the provisions of this standard for CQF (see Annex T) shall

- a) Support the enhancements for scheduled traffic as specified in 8.6.8.4.
- b) Support the state machines for scheduled traffic as specified in 8.6.9.
- c) Support the state machines for stream gate control as specified in 8.6.10.
- d) Support the management entities for scheduled traffic as specified in 12.29.
- e) Support the requirements for per-stream filtering and policing (PSFP) as stated in 5.4.1.8.
- f) Support the management entities for PSFP as specified in 12.31.

NOTE—The enhancements for scheduled traffic are defined in IEEE Std 802.1Qbv, and PSFP is defined in IEEE Std 802.1Qci, both of which are amendments to IEEE Std 802.1Q-2014, as is this standard. This NOTE will be removed when this standard is incorporated into the IEEE 802.1Q base standard in the next revision.

5.13 MAC Bridge component requirements

5.13.1 MAC Bridge component options

Insert new subclause 5.13.1.2 as shown, renumbering as necessary:

5.13.1.2 Cyclic queuing and forwarding requirements

A MAC Bridge component implementation that conforms to the provisions of this standard for CQF (see Annex T) shall

- a) Support the enhancements for scheduled traffic as specified in 8.6.8.4.
- b) Support the state machines for scheduled traffic as specified in 8.6.9.
- c) Support the state machines for stream gate control as specified in 8.6.10.
- d) Support the management entities for scheduled traffic as specified in 12.29.
- e) Support the requirements for PSFP as stated in 5.13.1.1.
- f) Support the management entities for PSFP as specified in 12.31.

Insert the following new subclause at the end of Clause 5, renumbering as necessary:

5.28 End station requirements—Cyclic queuing and forwarding

An end station implementation that conforms to the provisions of this standard for CQF (see Annex T) shall

- a) Support the enhancements for scheduled traffic as specified in 8.6.8.4.
- b) Support the state machines for scheduled traffic as specified in 8.6.9.
- c) Support the state machines for stream gate control as specified in 8.6.10.

IEEE Std 802.1Qch-2017
IEEE Standard for Local and Metropolitan Area Networks—Bridges and Bridged Networks—
Amendment 29: Cyclic Queuing and Forwarding

- d) Support the management entities for scheduled traffic as specified in 12.29.
- e) Support the requirements for PSFP as stated in 5.27.
- f) Support the management entities for PSFP as specified in 12.31.

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1Q:2016/AMD7:2019

Annex A

(normative)

PICS proforma—Bridge implementations²

A.5 Major capabilities

Insert the following row at the end of Table A.5:

CQF	Does the implementation support cyclic queuing and forwarding?	O	5.4.1.9, 5.13.1.2	Yes <input type="checkbox"/>	No <input type="checkbox"/>
-----	----------------------------------------------------------------	---	-------------------	------------------------------	-----------------------------

A.14 Bridge management

Change MGT-248 and MGT-249 in Table A.14 as shown:

Item	Feature	Status	References	Support
MGT-248	Does the implementation support the management entities defined in 12.29?	<u>SCHED OR</u> CQF: M	5.4.1 item ad), <u>5.4.1.9 item c).</u> <u>5.13.1.2 item c).</u> 12.29	Yes <input type="checkbox"/> N/A <input type="checkbox"/>
MGT-249	Does the implementation support the management entities defined in 12.31?	<u>PSFP OR</u> CQF: M	<u>5.4.1.9 item e).</u> <u>5.13.1.2 item e).</u> 8.6.5.1, 8.6.6.1, 8.6.10, 12.31	Yes <input type="checkbox"/> N/A <input type="checkbox"/>

A.24 Management Information Base (MIB)

Change MIB-42 and MIB-43 in Table A.24 as shown:

Item	Feature	Status	References	Support
MIB-42	Is the IEEE8021-ST-MIB module fully supported (per its MODULE-COMPLIANCE)?	MIB AND <u>(SCHED OR</u> CQF): O	5.4.1 item ad), <u>5.4.1.9 item c).</u> <u>5.13.1.2 item c).</u> 12.29, 17.7.22	Yes <input type="checkbox"/> N/A <input type="checkbox"/> No <input type="checkbox"/>
MIB-43	Is the IEEE8021-PSFP-MIB module fully supported (per its MODULE-COMPLIANCE)?	<u>PSFP OR</u> CQF: O	<u>5.4.1.9 item e).</u> <u>5.13.1.2 item e).</u> 8.6.5.1, 8.6.6.1, 8.6.10, 12.31, 17.7.24	Yes <input type="checkbox"/> N/A <input type="checkbox"/>

²Copyright 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.

Change Table A.44 as shown:

A.44 Scheduled traffic

Item	Feature	Status	References	Support
	If <u>neither</u> scheduled traffic (SCHED in Table A.5) <u>nor cyclic queuing and forwarding (COF in Table A.5)</u> is not <u>are</u> supported, mark N/A and ignore the remainder of this table.		5.4.1, 5.13.1, 8.6.8, 8.6.9, 12.29, 17.7.22	N/A []
SCHED1	Support the state machines and associated definitions as specified in 8.6.9	SCHED <u>OR</u> <u>COF</u> :M	5.4.1, 5.13.1, 8.6.8, 8.6.9	Yes [] N/A []
SCHED2	Does the implementation support the management entities defined in 12.29?	SCHED <u>OR</u> <u>COF</u> :M	5.4.1 item ad), <u>5.4.1.9 item c)</u> , <u>5.13.1.2 item c)</u> , 12.29	Yes [] N/A []
SCHED3	Is the IEEE8021-ST-MIB module fully supported (per its MODULE-COMPLIANCE)?	MIB AND (SCHED <u>OR</u> <u>COF</u>):O	5.4.1 item ad), <u>5.4.1.9 item c)</u> , <u>5.13.1.2 item c)</u> , 12.29, 17.7.22	Yes [] N/A [] No []

Change Table A.45 as shown:

A.45 Per-stream filtering and policing

Item	Feature	Status	References	Support
	If <u>neither</u> per-stream filtering and policing (PSFP in Table A.5) <u>nor cyclic queuing and forwarding (COF in Table A.5)</u> is not <u>are</u> supported, mark N/A and ignore the remainder of this table.		<u>5.4.1.9</u> , <u>5.13.1.2</u> , 8.6.5.1, 8.6.6.1, 8.6.10, 12.31, 17.7.24	N/A []
PSFP1	Does the implementation support the state machines and associated definitions as specified in 8.6.10?	PSFP <u>OR</u> <u>COF</u> :M	<u>5.4.1.9 item b)</u> , <u>5.13.1.2 item b)</u> , 8.6.5, 8.6.10	Yes [] N/A []
PSFP2	Does the implementation support the management entities defined in 12.31?	PSFP <u>OR</u> <u>COF</u> :M	<u>5.4.1.9 item e)</u> , <u>5.13.1.2 item e)</u> , 8.6.5.1, 8.6.6.1, 8.6.10, 12.31	Yes [] N/A []
PSFP3	Is the IEEE8021-PSFP-MIB module fully supported (per its MODULE-COMPLIANCE)?	MIB AND (PSFP <u>OR</u> <u>COF</u>):O	<u>5.4.1.9 item e)</u> , <u>5.13.1.2 item e)</u> , 12.31, 17.7.24	Yes [] N/A [] No []

Annex B

(normative)

PICS proforma—End station implementations³

B.5 Major capabilities

Insert the following row at the end of Table B.5:

CQF	Does the implementation support cyclic queuing and forwarding?	O	5.25, 5.28	Yes []	No []
-----	----------------------------------------------------------------	---	------------	---------	--------

Change Table B.15 as shown:

B.15 Scheduled traffic

Item	Feature	Status	References	Support
	If neither scheduled traffic (SCHED in Table B.5) nor cyclic queuing and forwarding (COF in Table B.5) is not are supported, mark N/A and ignore the remainder of this table.		5.4.1, 5.13.1, 5.25, 5.28, 8.6.8, 8.6.9, 12.29, 17.7.22	N/A []
SCHED1	Support the state machines and associated definitions as specified in 8.6.9	SCHED OR CQE:M	5.4.1, 5.13.1, 5.28 item b), 8.6.8, 8.6.9	Yes [] N/A []
SCHED2	Does the implementation support the management entities defined in 12.29?	SCHED OR CQE:M	5.4.1 item ad) 5.28 item c), 12.29	Yes [] N/A []
SCHED3	Is the IEEE8021-ST-MIB module fully supported (per its MODULE-COMPLIANCE)?	MIB AND (SCHED OR CQE):O	5.4.1 item ad) 5.28 item c), 12.29, 17.7.22	Yes [] N/A [] No []

³Copyright 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.

Change Table B.16 as shown:

B.16 Per-stream filtering and policing

Item	Feature	Status	References	Support
	If <u>neither</u> per-stream filtering and policing (PSFP in Table B.5) <u>nor</u> cyclic queuing and forwarding (COF in Table B.5) <u>is not</u> are supported, mark N/A and ignore the remainder of this table.		<u>5.28 items d) and e)</u> , 8.6.5.1, 8.6.6.1, 8.6.10, 12.31, 17.7.24	N/A []
PSFP1	Does the implementation support the state machines and associated definitions as specified in 8.6.10?	PSFP <u>OR</u> COF:M	<u>5.28 items b) and d)</u> , 8.6.5, 8.6.10	Yes [] N/A []
PSFP2	Does the implementation support the management entities defined in 12.31?	PSFP <u>OR</u> COF:M	<u>5.28 item e)</u> , 8.6.5.1, 8.6.6.1, 8.6.10, 12.31	Yes [] N/A []
PSFP3	Is the IEEE8021-PSFP-MIB module fully supported (per its MODULE-COMPLIANCE)?	MIB AND (PSFP <u>OR</u> COF):O	12.31, 17.7.24	Yes [] N/A [] No []

Annex T

(informative)

Cyclic queuing and forwarding⁴

T.1 Overview of CQF

Cyclic queuing and forwarding (CQF) is a method of traffic shaping that can deliver deterministic, and easily calculated, latency for time-sensitive traffic streams. As the name implies, the principle underlying CQF is that stream traffic is transmitted and queued for transmission along a network path in a cyclic manner. Time is divided into numbered time intervals i , $i+1$, $i+2$, ... $i+N$, each of duration d . Frames transmitted by a Bridge, *Alice*, during time interval i are received by a downstream Bridge, *Bob*, during time interval i and are transmitted onwards by *Bob* towards Bridge *Charlie* during time interval $i+1$, and so on. A starting assumption is that, for a given traffic class, all Bridges and all end stations connected to a given bridge have a common understanding (to a known accuracy) of the start time of cycle i , and the cycle duration, d .

Frames transmitted by *Alice* during interval i are transmitted by *Bob* in interval $i+1$; the maximum possible delay experienced by a given frame is from the beginning of i to the end of $i+1$, or twice d . Similarly, the minimum possible delay experienced is from the end of i to the beginning of $i+1$, which is zero. More generally, the maximum delay experienced by a given frame is

$$(h+1) \times d$$

and the minimum delay experienced by a given frame is

$$(h-1) \times d$$

where h is the number of hops.

This illustrates the attraction of CQF as a technique for handling time-sensitive traffic; the latency introduced as a frame transits the network is completely described by the cycle time and the number of hops, and is unaffected by any other topology considerations, including interference from other non time-sensitive traffic. This only holds, however, if frames are kept to their allotted cycles; if, for example, some of the frames that were expected to be received by *Bob* during cycle i do not appear until cycle $i+1$ has started, then the stated assumptions about maximum latency calculation no longer hold. Careful choice of cycle times, alignment of cycle times among the Bridges in the network, and the timing of first and last transmissions within a cycle are required in order to ensure that the desired latency bounds are achieved.

Any delays through a particular intermediate relay (for example, *Bob*) do not affect the end-to-end delay so long as *Bob*'s performance does not affect the correct assignment of frames to time intervals.

Since one of the goals for the handling of time-sensitive streams is zero frame loss (assuming that no unrecognizable non-conformant traffic is present), it is prudent to assume that reception is continuous—a frame received by a downstream system will always be assigned to one interval or another. This places most of the burden of correct interval assignment on the transmitting system; frames should not be transmitted if incorrect interval assignment is possible upon reception. It is therefore necessary to define the anticipated (and accommodated) errors in reception assignment with respect to the point in interval time, t ,

⁴In early discussions, CQF was known as the “Peristaltic Shaper” [B52].

where interval $i-1$ becomes interval i . A relay (such as *Bob*) can of course choose when to start reception assignment to i in relation to t ; it is assumed that *Bob's* intent is that the earliest frame to be assigned to i is the first whose very last octet (or other frame transmission encoding symbol) is still on the transmission medium (or other definable external event to what is considered to be *Bob* reference point) at t , thus placing any accommodation of known implementation dependent delays within *Bob* under *Bob's* control.

While *Bob* attempts to start i reception with a frame coming off the medium at t , and may factor known and repeatable internal delays into the way he goes about that intent, his actual start time depends on:

- a) The error in *Bob's* time sync (i.e., the error in his determination as to when t actually occurs).
- b) The maximum deviation (jitter) in *Bob's* use of that time.
- c) Additional delays that *Bob* does not account for, such as delays in selecting the output queue to be used for i .

Alice has to stop transmitting frames for $i-1$ before t , by a time that is the sum of *Bob's* possible early start of i as a consequence of a) through c), and the following:

- d) The error in *Alice's* time sync (i.e., the error in her determination as to when t occurs).
- e) The maximum deviation (jitter) in *Alice's* use of that time.
- f) The time between *Alice* deciding to commit a frame for transmission and the appearance of the last octet/symbol “on the medium” at *Alice's* end.
- g) The length of “the medium” in transmission time, i.e., the time for the last octet/symbol to leave *Alice* and reach *Bob*, including any consideration of the effect of interfering frames or fragments.

The description of CQF in terms of a number of consecutive intervals (as opposed to their support by “odd/even” queues, as discussed in T.2 onwards) gives easy answers to what to do with traffic still queued when its selected transmission interval has expired—discard it, or mark it down (discard eligible or priority change) and generate an alarm. In an environment where the stream bandwidth is allocated appropriately (i.e., the bandwidth allocated per time interval is less than can be received/transmitted in the chosen interval duration), this will be a rare occurrence, the traffic that follows will be conformant, and the overall system performance will be recoverable.

The discussion so far has assumed that all link speeds are the same; however, the situation becomes more complicated when links of different speeds are considered. One typical arrangement might comprise low speed links at the start and end of the path (network periphery to periphery), another with the high speed towards one end (periphery to core or vice versa). Taking the first of these, and placing *Alice* at the first transition from slow to fast, *Bob* as her fast neighbor, *Charlie* as his fast neighbor, and *Donald* at the transition from fast to slow, the important thing (treating the fast core of the network as a CQF black box) is that all conformant traffic received by *Alice* in interval i (say) is transmitted by *Donald* in a later interval $i+n$. A number of internal arrangements might be made between *Alice*, *Bob*, *Charlie*, and *Donald* to make this happen and would be valid from an external CQF perspective. It is also possible to consider fractional n , where n is still > 1 , as *Alice* may need to collect the entirety of any slow cycle before transmitting that in a more compressed burst into the rest of the fast network. More complex possibilities are equivalent to redefining the slow cycle time. Some of the less elaborate possibilities for the use of links of different speeds are discussed in T.5.

T.2 An approach to CQF implementation

In essence, the approach involves the use of two transmission queues and a cycle timer. During even numbered cycles (intervals), queue 1 accumulates received frames from the Bridge's reception Ports (and does not transmit them), while queue 2 transmits any queued frames from the previous odd-numbered cycle (and does not receive any frames). During odd-numbered cycles, queue 2 accumulates received frames from the Bridge's reception Ports (and does not transmit them), while queue 1 transmits any queued frames from

the previous even-numbered cycle (and does not receive any frames). With appropriate choice of receive and transmit cycle times (see T.5), such that, for any given stream, the cycle is at least long enough to accommodate all of the time-sensitive traffic that will need to be transmitted on the Bridge Port during the class measurement interval for that stream (see 34.6.1, also known as the observation interval in IEEE Std 802.1BA™ [B51]), plus a maximum-sized interfering frame (or frame fragment, if preemption is supported), then all of the stream's traffic will be accumulated during the cycle time in queues that are in receive mode, and it will all be transmitted during the cycle time when the queues switch to transmit mode.

CQF is implemented by configuring a combination of the stream gate control mechanisms defined for per-stream filtering and policing (PSFP, IEEE Std 802.1Qci) and the traffic scheduling mechanisms defined in 8.6.8.4 and 8.6.9 of IEEE Std 802.1Qbv. Per-stream filtering is used to direct received frames to one of a pair of outbound queues on a timed basis, determined by the cycle time of the per-stream filter, and traffic scheduling is used to ensure that frames are transmitted from the appropriate queue using the same cycle time, as described in the rest of this annex.

T.3 Use of per-stream filtering and policing for CQF

The first step in establishing the filtering and queuing structures needed for CQF is to set up one or more stream filters (8.6.5.1.1) and a stream gate instance (8.6.5.1.2) that will be receiving incoming time-sensitive frames. The stream filter(s) are configured so that all time-sensitive frames received on a given Port are directed to the same stream gate instance; in turn, the stream gate instance is configured so that the internal priority value (IPV) associated with the time-sensitive frames will direct them to one of two outbound queues on a timed basis. The use of the IPV allows this direction of frames to outbound queues to be independent of the received priority, and also does not affect the priority associated with the frame on transmission.

T.3.1 Stream filter configuration

The simplest stream filter configuration would be achieved where the same priority is used for all time-sensitive frames (and this priority is not used for any other frames); for example, the default priority assigned to SR class A (see Clause 34) could be used, in which case, the priority associated with the time-sensitive frames would be 3. The parameters that would define the stream filter for the time-sensitive frames would then be as follows:

- a) The *stream_identifier specification* would take the wild-card value.
- b) The *priority specification* would take the priority value 3.
- c) The *stream_gate_instance identifier* would take the value of the instance identifier for the stream gate (T.3.2).
- d) In the simplest case, there would be no filter specifications; however, these could be added as appropriate, for example if the maximum SDU size for the time-sensitive traffic is bounded at a value less than the maximum SDU size for the medium.

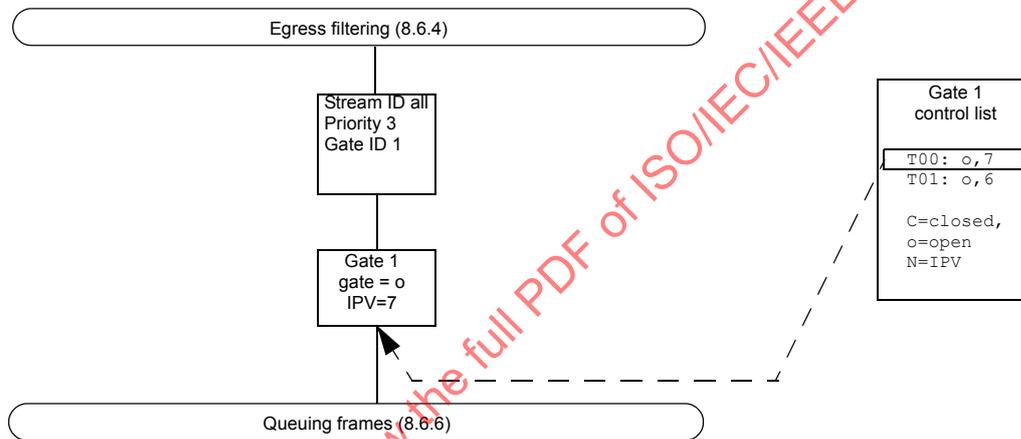
This stream filter specification results in all frames that carry a priority value of 3 being submitted to the stream gate. As the operation of PSFP is such that received frames that do not match a stream filter are handled as if PSFP is not implemented, there is no need for further stream filter specifications to handle frames that carry priorities other than 3 unless there are other filtering or gating decisions that need to be taken for such frames.

T.3.2 Stream gate configuration

The *stream gate instance* (8.6.5.1.1) needed to support the stream filter described in T.3.1 has a *stream gate control list* that contains two entries, each containing a SetGateAndIPS operation, with parameters as follows:

- 1) StreamGateState = *open*, IPV = 7, TimeInterval = T
- 2) StreamGateState = *open*, IPV = 6, TimeInterval = T

This control list has the effect of directing any traffic that passes the stream filter specified in T.3.1 to one of two different outbound queues (assuming that the outbound Ports support 8 queues, and that the default assignments for priorities to traffic classes follows the recommendation shown in Table 34-1); in the first time interval T, traffic is directed to queue 7, in the second time interval T, to queue 6, in the third time interval to queue 7, in the fourth time interval, to queue 6, and so on. The choice of time interval T is discussed in T.5; the cycle time (OperCycleTime, see 8.6.9.4.20) for the stream gate state machines would need to be set to 2T in order to accommodate the sum of the time intervals for the two gate operations. See Figure T-1



T.4 Use of traffic scheduling for CQF

The traffic scheduling support needed on each outbound Port in order to support the PSFP configuration described in T.3 is to execute a gate control list that will set the GateState to *open* for queue 6 and *closed* for queue 7 for a TimeInterval of T, and then set the GateState to *open* for queue 7 and *closed* for queue 6 for a TimeInterval of T, repeating ad infinitum. If there are no other traffic scheduling considerations, this can be achieved with a gate control list that contains just two SetGateStates gate operations, with parameters as follows:

- 1) GateState: 0, 1, 2, 3, 4, 5, 6 *open*, 7 *closed*, TimeInterval = T
- 2) GateState: 0, 1, 2, 3, 4, 5, 7 *open*, 6 *closed*, TimeInterval = T

This sequence of gate operations has the effect that during the initial time period T, the GateState for queue 7 is closed while queue 7 is being filled, and queue 6 is open to allow any queued frames to be transmitted; during the second time period T, the GateState for queue 6 is closed while queue 6 is being filled, and queue 7 is open to allow any queued frames to be transmitted. The gates for all other queues are open. The choice of time interval T is discussed in T.5; the cycle time (OperCycleTime; see 8.6.9.4.20) for the