

INTERNATIONAL
STANDARD

ISO/IEC/
IEEE
8802-1CM

First edition
2019-07

AMENDMENT 1
2021-10

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

Part 1CM:
**Time-sensitive networking for
fronthaul**

AMENDMENT 1: Enhancements to
fronthaul profiles to support new
fronthaul interface, synchronization, and
syntonization standards

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

Partie 1CM: Réseaux à temps critique pour fronthaul

*AMENDEMENT 1: Perfectionnement des profils fronthaul pour
la prise en charge de la nouvelle interface fronthaul, normes de
synchronisation et de recherche*



Reference number
ISO/IEC/IEEE 8802-1CM:2019/Amd.1:2021(E)

© IEEE 2020



COPYRIGHT PROTECTED DOCUMENT

© IEEE 2020

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 IEEE at the address below.

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.

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/IEC documents should be noted (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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) or the IEC list of patent declarations received (see patents.iec.ch).

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. In the IEC, see www.iec.ch/understanding-standards.

ISO/IEC/IEEE 8802-1CM:2019/Amd 1 was prepared by the LAN/MAN of the IEEE Computer Society (as IEEE Std 802.1CMde-2020) 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 SC 6, *Telecommunications and information exchange between systems*.

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

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 and www.iec.ch/national-committees.

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1CM:2019/AMD1:2021

IEEE Std 802.1CMde™-2020
(Amendment to IEEE Std 802.1CM™-2018)

IEEE Standard for
Local and metropolitan area networks—

Time-Sensitive Networking for Fronthaul

Amendment 1: Enhancements to Fronthaul Profiles to Support New Fronthaul Interface, Synchronization, and Syntonization Standards

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

Approved 4 June 2020
IEEE SA Standards Board

Abstract: Enhancements to fronthaul profiles are defined in this amendment to IEEE Std 802.1CM™-2018 in order to address new developments in fronthaul interface standards and in related synchronization and syntonization standards.

Keywords: amendment, bridged network, CPRI, eCPRI, F1, fronthaul, IEEE 802®, IEEE 802.1™, IEEE 802.1CM™, IEEE 802.1CMde™, synchronization, time-sensitive networking, TSN, Virtual Local Area Network, VLAN, VLAN Bridge

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

Copyright © 2020 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 16 October 2020. Printed in the United States of America.

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

PDF:	ISBN 978-1-5044-6814-5	STD24245
Print:	ISBN 978-1-5044-6815-2	STDPD24245

IEEE prohibits discrimination, harassment and bullying.

For more information, visit <https://www.ieee.org/about/corporate/governance/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 Standards documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page (<https://standards.ieee.org/ipr/disclaimers.html>), appear in all standards and may be found under the heading “Important Notices and Disclaimers Concerning IEEE Standards Documents.”

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

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through an accredited consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed by volunteers with scientific, academic, and industry-based expertise in technical working groups. Volunteers are not necessarily members of IEEE or IEEE SA, 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 does not warrant or represent the accuracy or completeness 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. In addition, IEEE does not warrant or represent that the use of the material contained in its standards is free from patent infringement. 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: THE NEED TO PROCURE 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 is 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, nor 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 the presenter's views should be considered the personal views of that individual rather than the formal position of IEEE, IEEE SA, the Standards Committee, or the Working Group.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE or IEEE SA. However, **IEEE does not provide interpretations, 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 evaluating comments or in revisions to an IEEE standard is welcome to join the relevant IEEE working group. You can indicate interest in a working group using the Interests tab in the Manage Profile & Interests area of the [IEEE SA myProject system](#). An IEEE Account is needed to access the application.

Comments on standards should be submitted using the [Contact Us](#) form.

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 constitute 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.

Data privacy

Users of IEEE Standards documents should evaluate the standards for considerations of data privacy and data ownership in the context of assessing and using the standards in compliance with applicable laws and regulations.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under US 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 licensing fees, 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; <https://www.copyright.com/>. 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 10 years. When a document is more than 10 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 [IEEE Xplore](#) or [contact IEEE](#). For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website.

Errata

Errata, if any, for all IEEE standards can be accessed on the [IEEE SA Website](#). Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in [IEEE Xplore](#). Users are encouraged to periodically check for errata.

Patents

IEEE Standards are developed in compliance with the [IEEE SA Patent Policy](#).

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 <https://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.

IMPORTANT NOTICE

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. IEEE Standards development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. 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.

Participants

At the time this amendment was submitted to the IEEE SA Standards Board for approval, 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*

Craig Gunther, *Vice Chair, Time-Sensitive Networking Task Group*

Astrit Ademaj	Satoko Itaya	Jessy Rouyer
Ralf Assmann	Yoshihiro Ito	Atsushi Sato
Jens Bierschenk	Michael Karl	Frank Schewe
Christian Boiger	Stephan Kehrer	Michael Seaman
Paul Bortorff	Randy Kelsey	Maik Seewald
Feng Chen	Hajime Koto	Johannes Specht
Weiyang Cheng	James Lawlis	Marius Stanica
Paul Congdon	Christophe Mangin	Guenther Steindl
Rodney Cummings	Scott Mansfield	Xinyuan Wang
Josef Dorr	Kenichi Maruhashi	Tongtong Wang
Hesham Elbakoury	Larry McMillan	Hao Wang
Thomas Enzinger	Tero Mustala	Karl Weber
Donald Fedyk	Roy Myers	Brian Weis
Norman Finn	Tomoki Ohsawa	Ludwig Winkel
Geoffrey Garner	Hiroshi Ohue	Jordon Woods
Marina Gutierrez	Donald Pannell	Takahiro Yamaura
Stephen Haddock	Michael Potts	Nader Zein
Mark Hantel	Wei Qiu	Helge Zinner
Marc Holness	Karen Randall	Harald Zweck
	Maximilian Riegel	

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

Thomas Alexander	Raj Jain	Alon Regev
Carol Ansley	SangKwon Jeong	Maximilian Riegel
Butch Anton	Lokesh Kabra	Robert Robinson
Greg Armstrong	Srinivas Kandala	Silvana Rodrigues
Christian Boiger	Randy Kelsey	Benjamin Rolfe
Vern Brethour	Stuart Kerry	Jessy Rouyer
Matthew Brown	Evgeny Khorov	Frank Schewe
Demetrio Bucaneg	Yongbum Kim	Veselin Skendzic
William Byrd	Hyeong Ho Lee	Thomas Starai
Paul Cardinal	Kang Lee	Walter Struppler
Juan Carreon	Jennifer Lemon	Bo Sun
Pin Chang	Joseph Levy	Karim Traore
Charles Cook	Arthur Marris	Richard Tse
Marc Emmelmann	Jeffery Masters	Mark-Rene Uchida
János Farkas	Michael Maytum	Dmitri Varsanofiev
Avraham Freedman	Richard Mellitz	John Vergis
Geoffrey Garner	Nick S. A. Nikjoo	George Vlantis
Joel Goergen	Satoshi Obara	Lisa Ward
Randall Groves	Glenn Parsons	Karl Weber
Craig Gunther	Bansi Patel	Stuart Whitehead
Stephen Haddock	Arumugam Paventhan	Scott Willy
Marco Hernandez	David Piehler	Andreas Wolf
Werner Hoelzl	Walter Pieniac	Chi Xu
Oliver Holland	Clinton Powell	Yu Yuan
Woojung Huh	R. K. Rannow	Oren Yuen
Atsushi Ito		Nader Zein

When the IEEE SA Standards Board approved this amendment on 4 June 2020, it had the following membership:

Gary Hoffman, Chair
Jon Walter Rosdahl, Vice Chair
John D. Kulick, Past Chair
Konstantinos Karachalios, Secretary

Ted Burse	David J. Law	Mehmet Ulema
Doug Edwards	Howard Li	Lei Wang
J. Travis Griffith	Dong Liu	Sha Wei
Grace Gu	Kevin Lu	Philip B. Winston
Guido R. Hiertz	Paul Nikolich	Daidi Zhong
Joseph L. Koepfinger*	Damir Novosel	Jingyi Zhou
	Dorothy Stanley	

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 802.1CMde-2020, IEEE Standard for local and metropolitan area networks—Time-Sensitive Networking for Fronthaul—Amendment 1: Enhancements to Fronthaul Profiles to Support New Fronthaul Interface, Synchronization, and Syntonization Standards.

This amendment to IEEE Std 802.1CM-2018 defines enhancements to fronthaul profiles in order to address new developments in fronthaul interface standards and in related synchronization and syntonization standards.

The 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 USA.

Acknowledgments

Permissions have been granted as follows:

Figure 11.1.1-1 of 3GPP™ TR 38.801 reprinted as Figure C-1 in this document with permission from 3GPP © 2017. 3GPP™ technical specifications (TSs) and technical reports (TRs) are the property of ARIB, ATIS, CCSA, ETSI, TSDSI, TTA and TTC who jointly own the copyright in them. They are subject to further modifications and are therefore provided to you “as is” for information purposes only. Further use is strictly prohibited.

Contents

1. Overview.....	10
1.3 Introduction.....	10
2. Normative references	11
3. Definitions	12
4. Acronyms and abbreviations	13
5. Conformance.....	14
5.3 Bridge requirements.....	14
5.4 Bridge options.....	14
5.6 End station options.....	15
6. Fronthaul.....	16
6.1 Radio access technology background.....	16
6.2 Class 1 requirements.....	16
6.3 Class 2 requirements.....	17
6.4 Synchronization requirements	19
7. Bridge and synchronization functions	23
7.3 Frame preemption.....	23
7.4 Network synchronization.....	23
8. Fronthaul profiles.....	25
8.1 Profile A.....	25
8.2 Profile B.....	26
9. Synchronization solutions.....	27
9.1 Solutions for Category A.....	27
Annex A (normative) PCS proforma—Time-sensitive networking for Fronthaul Profiles.....	28
Annex C (informative) Fronthaul interfaces.....	32
Annex D (informative) Bibliography	33

IEEE Standard for
Local and metropolitan area networks—

Time-Sensitive Networking for Fronthaul

Amendment 1: Enhancements to Fronthaul Profiles to Support New Fronthaul Interface, Synchronization, and Syntonization Standards

The amendment is based on IEEE Std 802.1CM-2018.

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

1. Overview

1.3 Introduction

Change the dashed list of the second paragraph in 1.3 as shown (text of footnote 3 remains unchanged):

- Virtual Local Area Network (VLAN) Bridge specification in IEEE Std 802.1QTM.³
- MAC service specifications in IEEE Std 802.1ACTM.
- MAC/PHY technology specifications in IEEE Std 802.3TM.
- Interspersing express traffic specification in IEEE Std 802.3~~bf~~TM.
- Frame preemption specification in IEEE Std 802.1Q.
- Time synchronization and Precision Time Protocol (PTP) specifications in IEEE Std 1588TM.
- Telecom profile specification in ITU-T G.8275.1, which is based on IEEE Std 1588.
- Synchronous Ethernet specification in ITU-T G.8261, G.8262, G.8262.1, and G.8264.

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

2. Normative references

Delete IEEE Std 802.3br™ (“IEEE ... Ethernet—Amendment 5:”) from the list of normative references in Clause 2.

Change the following references in Clause 2 as shown (text of footnote 7 remains unchanged):

ITU-T G.8262, Timing characteristics of a synchronous ~~Ethernet~~ equipment slave clock.

MEF 10:~~34~~, [Subscriber](#) Ethernet Service Attributes ~~Phase 3~~.⁷

Insert the following reference into Clause 2 in alphanumeric order:

ITU-T G.8262.1, Timing characteristics of an enhanced synchronous equipment slave clock.

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1CM:2019/Amd.1:2021

3. Definitions

Change the following definition and footnote in Clause 3 as shown:

Synchronous Ethernet: A method to distribute frequency synchronization over the Ethernet physical layer according to IEEE Std 802.3 and ITU-T Recommendations G.8261, G.8262, [G.8262.1](#), and G.8264.¹⁰

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1CM:2019/AMD1:2021

¹⁰ Synchronous Ethernet has been defined to be fully conformant to IEEE Std 802.3 as documented in the relevant ITU-T Recommendations (G.8261, G.8262, [G.8262.1](#), and G.8264).

4. Acronyms and abbreviations

Delete TAI (“Tems ... Time”) from the list of abbreviations in Clause 4.

Insert the following abbreviation into Clause 4 in alphanumeric order:

NR New Radio access technology (for 5G)

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1CM:2019/Amd1:2021

5. Conformance

5.3 Bridge requirements

5.3.1 Common bridge requirements

Change item p) in the lettered list of 5.3.1 as shown:

- p) Support flow metering (8.6.5 of IEEE Std 802.1Q-2018) with the token bucket bandwidth profile specified in MEF 10.34;

5.4 Bridge options

Change item a) in the lettered list in the introductory text of 5.4 as shown:

- a) Support MEF 10.34 token sharing for the token bucket bandwidth profile, which is used for flow metering [item p) in 5.3.1; 8.6.5 of IEEE Std 802.1Q-2018];

5.4.1 Bridge requirements for Profile B

Change item b) in the lettered list of 5.4.1 as shown:

- b) Support Frame Preemption, i.e.,
 - 1) Support item ad) in 5.4.1 of IEEE Std 802.1Q-2018 (see also 7.3);
 - 2) Support Interspersing Express Traffic (Clause 99 of IEEE Std 802.3br-2018, see also 7.3)¹³;
 - 3) ~~Support Frame Preemption and Interspersing Express Traffic on each port whose data rate is not higher than 10Gbps;~~
 - 3) ~~4) Support the configuration of 64-octet fragment size for Interspersing Express Traffic at each port for which Interspersing Express Traffic is enabled.~~

5.4.2 Bridge requirements for synchronization

Change items b) and c) in the lettered list of 5.4.2 as shown:

- b) Support the ITU-T G.8275.1 telecom profile (full timing support from the network) and one or more of the related clocks:
 - 1) ~~Support~~ Telecom-Boundary Clock (ITU-T G.8273.2) Class A, B, or C, or
 - 2) ~~Support~~ Telecom-Transparent Clock (ITU-T G.8273.3), or
 - 3) ~~Support~~ Primary Reference Time Clock or enhanced Primary Reference Time Clock, and Grandmaster functionality (ITU-T G.8272 or ITU-T G.8272.1);
- c) Support Synchronous Ethernet functions ~~(ITU-T G.8264)~~ including the Ethernet Synchronization Messaging Channel (ESMC) ~~(ITU-T G.8264)~~, and the related clock specification, i.e.,
 - 1) Synchronous Ethernet slave equipment clock (ITU-T G.8262), or
 - 2) Enhanced synchronous Ethernet equipment clock (ITU-T G.8262.1).

¹³At the time of publication of this standard, the relevant content of IEEE Std 802.3 was separately published as IEEE Std 802.3br™ 2016.

5.6 End station options

Change item b) in the lettered list in the introductory text of 5.6 as shown:

- b) Support Synchronous Ethernet functions ~~(ITU-T G.8264)~~ including the ESMC [\(ITU-T G.8264\)](#), and the related clock specification, i.e.,
 - 1) Synchronous Ethernet ~~slave~~[equipment](#) clock (ITU-T G.8262), or
 - 2) [Enhanced synchronous Ethernet equipment clock \(ITU-T G.8262.1\)](#).

5.6.1 End station requirements for time synchronization

Change the introductory text of item b) and the text of item b)1) in the lettered list of 5.6.1 as shown:

- b) Support ITU-T G.8275.1 telecom profile (full timing support from the network) and [the functionality of](#) one or more of the related clocks [that allow the requirements of 6.4 to be met](#), ~~i.e.,~~
 - 1) Support ~~Telecom~~ Time Slave Clock [functionality](#) ~~or Telecom Boundary Clock~~ (~~e.g.,~~ ITU-T G.8273.2), or

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-1CM:2019/Amd.1:2021

6. Fronthaul

Change the first item in the dashed list in the introductory text of Clause 6 as shown:

- Provides background information on aspects of the ~~Evolved Universal Terrestrial Radio Access (E-UTRA) (3GPP TS 36.211 [B3])~~ technology ~~ies~~ supported by the fronthaul standards that are closely related to this standard (6.1).

Change the title and text of 6.1 as shown:

6.1 ~~Evolved Universal Terrestrial Radio Access~~ technology background

The Evolved Universal Terrestrial Radio Access (E-UTRA) specifications (e.g., 3GPP TS 36.211 [B3]) and the New Radio (NR) access technology for 5G specifications (e.g., 3GPP TS 38.211 [B3b]) define precise time intervals for data transmission. ~~E-UTRA time intervals are defined as multiples of the basic time unit: $T_s = 1/(15000 \times 2048)$ s. E-UTRA and NR uses Orthogonal Frequency Division Multiplexing (OFDM) where an OFDM symbol is the smallest element of an E-UTRA or NR frame. NR supports a wider range of OFDM numerologies than E-UTRA. In either case, data transmission timing is based on t . The OFDM symbol time to carry data is $2048 \times T_s$. In addition, the full OFDM symbol time includes the time of the cyclic prefix (T_{cp}). In case of normal cyclic prefix, $T_{cp} = 160 \times T_s$ for the first symbol and $T_{cp} = 144 \times T_s$ for the following six symbols. In case of extended cyclic prefix, $T_{cp} = 512 \times T_s$ for each symbol.~~

The timing of packet transmission at an eRE/RE and an eREC/REC in a fronthaul interface supporting E-UTRA or NR is related to the given OFDM symbol times ~~explained above~~. A timing example is shown in Figure 38 in the eCPRI Interface Specification V2.0 [B5].

NOTE—Frame refers to Ethernet frame in this document. ~~OFDM E-UTRA frame~~ and NR frame refers to the ~~OFDM~~ frame structure specified by 3GPP standards (see 3GPP TS 36.211 [B3] and 3GPP TS 38.211 [B3b], respectively).

6.2 Class 1 requirements

6.2.3 IQ data requirements

6.2.3.1 Latency

Change 6.2.3.1 as shown:

The maximum end-to-end one-way latency is 100 μ s for IQ data between an edge port connected to an REC and another edge port connected to an RE. This maximum end-to-end latency includes the propagation delay of the links between the bridges of the fronthaul bridged network, and internal delays in these bridges. The end-to-end one-way latency is measured from the arrival/reception of the last ~~first~~ bit at the ingress edge port of the bridged network to the transmission of the last bit by the egress edge port of the bridged network (see Annex L.3 of IEEE Std 802.1Q-2018 8.8.1.5 in MEF 10.4).

NOTE 1—MEF 10.3 defines one-way frame delay from first bit to last bit (8.8.1 in MEF 10.3).

NOTE 2—No requirement on frame delay variation has been specified; see the CPRI functional decomposition requirements [B7].

6.3 Class 2 requirements

Change 6.3 as shown:

Class 2 refers to fronthaul interfaces where the functional decomposition of an E-UTRA BS (see 3GPP TS 36.104 [B1]) or an NR BS (see 3GPP TS 38.104 [B3a]) into eRE and eREC is inside the radio physical layer (PHY) as specified by the eCPRI Interface Specification [B5]. eCPRI bit rates corresponding to the same end-user data rates are smaller than Common Public Radio Interface Specification [B4] bit rates due to the flexible functional decomposition provided by eCPRI. In the case of Class 2, the eCPRI protocol is used between the eRE and the eREC, and they are connected by a bridged network as described in Clause 8.

6.3.1 eCPRI background

Change the first paragraph of 6.3.1 as shown (text of footnote 19 remains unchanged):

The eCPRI functional decomposition positions the split point inside the radio physical layer (PHY) when dividing a BS into eRE and eREC. The eCPRI Interface Specification [B5] functional split is more flexible than the Common Public Radio Interface Specification [B4] functional split. The fronthaul bridged network connects the eRE and the eREC regardless of the functional decomposition selected for a specific implementation. The intra-PHY splits introduced by eCPRI are called Split $\{I_D; I_{D'}; I_U\}$ (see 6.1.1 in the eCPRI Interface Specification V1.2.0 [B5]), which include multiple options.¹⁹

Change the last paragraph of 6.3.1 as shown:

When used for an E-UTRA or NR BS, eCPRI timing is related to the E-UTRA ~~OFDM~~ or NR frame structure and timing described in 6.1.

6.3.2 User Plane data requirements

Change the introductory text of 6.3.2 as shown:

This subclause describes Class 2 User Plane information flows and their requirements. The timing of the transmission of User Plane data by an eRE and an eREC is aligned with E-UTRA or NR OFDM timing (see 6.1), which is periodic. That is, the time windows when one or more packets of a User Plane data flow can be sent are aligned with the given OFDM timing. The traffic of a User Plane data flow carrying user data is correlated with the user data traffic of the corresponding UE (i.e., eRE and eREC exchange user data only when there is user data exchange between UE and BS). Thus, a User Plane data flow can have time windows with no packet. There is a maximum amount of data in a time window for a User Plane data flow. The requirements for User Plane data flows are described in the Requirements for the eCPRI Transport Network V1.2 [B6].

6.3.2.1 Latency

Change 6.3.2.1 as shown (including the addition of a new Table 6-1):

~~The maximum end-to-end one-way latency is 100 μ s for the majority of User Plane data between an edge port connected to an eREC and another edge port connected to an eRE. This User Plane (fast) data belongs to the high priority traffic class in~~ has the most stringent latency requirement according to Table 1 in the Requirements for the eCPRI Transport Network V1.2 [B6], where this data belongs to the 'High' traffic class. Four latency classes for this data are specified for different use cases in Table 1A in the Requirements for the eCPRI Transport Network V1.2 [B6], a subset of which is listed in Table 6-1. Each corresponds to the

maximum end-to-end one-way latency between an edge port connected to an eREC and another edge port connected to an eRE for a given use case. The value 100 μ s of the High100 latency class enables full E-UTRA and NR performance.

Table 6-1—Subset of latency classes for the ‘High’ traffic class

<u>Latency class</u>	<u>Maximum one-way latency</u>
<u>High100</u>	<u>100 μs</u>
<u>High200</u>	<u>200 μs</u>
<u>High500</u>	<u>500 μs</u>

NOTE 1—The High25 latency class for ultra-low latency performance in Table 1A in the Requirements for the eCPRI Transport Network V1.2 [B6] is primarily, but not only, for direct point-to-point fronthaul connections.

The maximum end-to-end latency includes the propagation delay of the links between the bridges of the fronthaul bridged network, and internal delays in these bridges. The end-to-end one-way latency is measured from the ~~arrival~~reception of the ~~last~~first bit at the ingress edge port of the bridged network to the transmission of the last bit by the egress edge port of the bridged network (see ~~Annex L.3 of IEEE Std 802.1Q-2018~~8.8.1.5 in MEF 10.4).

~~NOTE 1—MEF 10.3 defines one-way frame delay from first bit to last bit (8.8.1 in MEF 10.3).~~

NOTE 2—No requirement on frame delay variation has been specified; see the Requirements for the eCPRI Transport Network V1.2 [B6].

The latency requirement is not that strict for User Plane (slow) data, as shown in Table 1 in the Requirements for the eCPRI Transport Network V1.+2 [B6]. The maximum end-to-end one-way latency from edge port to edge port is 1 ms for User Plane (slow), which belongs to the medium priority traffic class in Table 1 in the Requirements for the eCPRI Transport Network V1.+2 [B6].

6.3.3 Control and Management Plane data requirements

6.3.3.1 Latency

Change 6.3.3.1 as shown:

According to the Requirements for the eCPRI Transport Network V1.2 [B6], C&M information flows are not as time-critical as the high-priority User Plane (fast) data flows ~~with 100 μ s latency budget~~ (6.3.2.1).

The maximum end-to-end one-way latency is 100 ms for the majority of C&M Plane data between an edge port connected to an eREC and another edge port connected to an eRE. This C&M Plane data belongs to the low-priority traffic class in Table 1 in the Requirements for the eCPRI Transport Network V1.+2 [B6].

The latency requirement is stricter for C&M Plane (fast) in Table 1 in the Requirements for the eCPRI Transport Network V1.+2 [B6]. The maximum end-to-end one-way latency from edge port to edge port is 1 ms for C&M Plane (fast), i.e., the same as for User Plane (slow) (see 6.3.2.1). Therefore, similarly to User Plane (slow), C&M Plane (fast) also belongs to the medium priority traffic class in Table 1 in the Requirements for the eCPRI Transport Network V1.+2 [B6].

6.3.3.2 Frame Loss Ratio

Change 6.3.3.2 as shown:

The maximum FLR that the majority of C&M Plane data flows can tolerate is 10^{-6} . This C&M Plane data belongs to the low-priority traffic class in Table 1 in the Requirements for the eCPRI Transport Network V1.4.2 [B6].

The FLR tolerance requirement is stricter for C&M Plane (fast) data flows in Table 1 in the Requirements for the eCPRI Transport Network V1.4.2 [B6], where C&M Plane (fast) belongs to the medium priority traffic class. The maximum tolerable FLR between edge ports of a fronthaul bridged network for a C&M Plane (fast) data flow is 10^{-7} , which is the same as for a User Plane data flow (6.3.2.2).

6.4 Synchronization requirements

6.4.1 Time synchronization requirements

Change 6.4.1 as shown (including the deletion of the original Table 6-1):

If the bridged network provides time synchronization, then the following timing accuracy requirements apply. ~~Three~~Four different Categories are defined and distinguished by the Requirements for the eCPRI Transport Network V1.2 [B6] with respect to time synchronization requirements; they are described in 6.4.1.1, 6.4.1.2, and 6.4.1.3, ~~and 6.4.1.4~~. Different timing Categories are applicable for different 3GPP features; an example is given for each Category.

Based on ITU-T G.8271.1, synchronization accuracy is specified here using maximum absolute TE ($\max|TE|$) values when the requirement is expressed with respect to an internationally recognized time reference [~~e.g., the Temps Atomique International (TAI)~~] or maximum absolute relative TE ($\max|TE|_{relative}$) values when the requirement is expressed between two reference points. The subclauses contained herein define the requirements at the input of the eRE/RE. Time ~~e~~Errors (TEs) introduced by the link connected to the eRE/RE are not part of the budget for eRE/RE internal Time Error ($|TE_{eRE/RE}|$) but are included in the $\max|TE|$ budget. The different TEs are illustrated in Figure 6-3.

Legend:

PRTC: Primary Reference Time Clock
eRE: eCPRI Radio Equipment
eREC: eCPRI Radio Equipment Control
RE: Radio Equipment
REC: Radio Equipment Control
TE: Time Error
UNI: User Network Interface

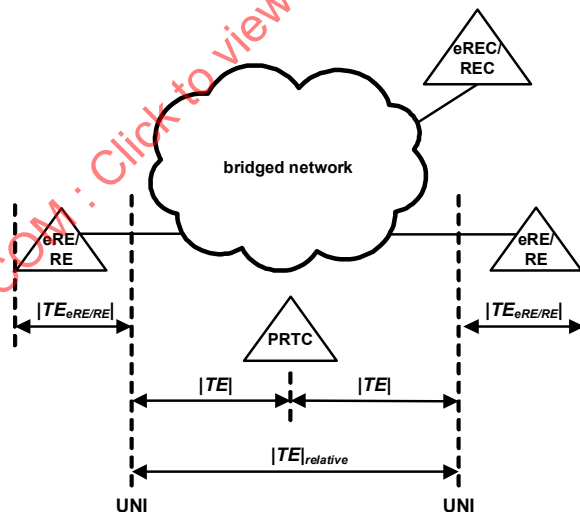


Figure 6-3—Time ~~e~~Errors

NOTE 1—Figure 6-3 is based on Figure 7 of the eCPRI transport requirements specification (Requirements for the eCPRI Transport Network V1.2 [B6]), which uses the User Network Interface (UNI) definition of MEF 10.34.

The following interface condition cases are distinguished:

- Case 1: The Telecom Time Slave Clock (T-TSC) is integrated in eRE/RE, i.e., PTP termination is in eRE/REs. Thus, the eRE/RE has two time budgets: eRE/RE internal TE and integrated T-TSC TE. Case 1 corresponds to deployment case 1 of Figure 7-1 of ITU-T G.8271.1 (10/2017) (illustrated in Figure 6-4). Case 1 includes two sub-cases:
 - Case 1.1: The performance of an integrated T-TSC requirements are the same as is assumed to be similar to that of a standalone T-TSC Class B as specified in ITU-T G.8273.2.
 - Case 1.2: Enhanced An integrated T-TSC requirements is assumed to contribute with a total maximum absolute TE of 15 ns. (See Note 5 in section 4.2 in the Requirements for the eCPRI Transport Network V1.2 [B6].)

NOTE 2—There is no specific requirement for the integrated T-TSC TE and eRE/RE internal TE in Case 1.1 and Case 1.2. The combined TE is what matters.

- Case 2: The T-TSC is not integrated in eRE/REs, i.e., PTP termination is in T-TSC at the edge port, and the phase/time reference is delivered from the T-TSC to the co-located eRE/REs via a phase/time synchronization distribution interface (e.g., 1 PPS and Time of Day). Case 2 corresponds to deployment case 2 of Figure 7-1 of ITU-T G.8271.1 (10/2017) (illustrated in Figure 6-4).

~~According to the Requirements for the eCPRI Transport Network [B6], the budget for eRE/RE internal Time Error ($TE_{eRE/RE}$) depends on the Case and the Category as shown in Table 6-1.~~

~~Table 6-1—Budget for eRE/RE internal absolute Time Error~~

	~~Category A+ (6.4.1.1)~~	~~Category A (6.4.1.2)~~	~~Category B (6.4.1.3)~~	~~Category C (6.4.1.4)~~
~~Case 1 (1.1 & 1.2)~~	~~N/A~~	~~20 ns~~	~~20 ns~~	~~20 ns~~
~~Case 2~~	~~22.5 ns~~	~~30 ns~~	~~30 ns~~	~~30 ns~~

~~Category A+ (6.4.1.1), Category A (6.4.1.2), and Category B (6.4.1.3) requirements are expressed as relative requirements between two points at the edge of the bridged network (instead of relative to a common clock reference). Category C (6.4.1.4) requirements are expressed as an absolute requirement at the edge of the bridged network as in ITU-T G.8271.1. Category C (6.4.1.4) network limits are not derived from 3GPP requirements, but network limits specified for reference point C in 7.3 of ITU-T G.8271.1 (10/2017) are used (see reference point C in Figure 6-4). Considerations on how to measure network limits on a packet-based interface (e.g., PTP) are provided in Appendix III of ITU-T G.8271.1 (10/2017). The ITU-T has defined individual clock specifications for time distribution to address Category C (6.4.1.4) requirements. Their use for other Categories is discussed in 7.4.~~

NOTE 23—eRE/RE clock specification is in scope of the specifications of CPRI Cooperation; it is out of the scope of ITU-T and out of the scope of this document. The budget of the bridged network is important for this document.

NOTE 34—ITU-T recommendations under development are expected to support the requirements of Case 1.2 in Categories A and B, and Case 2 in Category ~~A+ and A~~.

FLR requirement for PTP is not specified by this standard. Requirements on PTP are described in IEEE Std 1588 and requirements for the PTP telecom profile for phase/time synchronization with full timing

support from the network in ITU-T G.8275.1. These requirements do not include explicit requirements on PTP FLR; however, they provide indications on expected FLR levels that can impact PTP performance [see the requirements on message rates as specified in 6.2.8 of ITU-T G.8275.1 (06/2016)].

The requirements for the different Categories are explained in the following subclauses; they are also summarized in Table 2 in the Requirements for the eCPRI Transport Network V1.42 [B6].

[Category A \(6.4.1.1\) and Category B \(6.4.1.2\) requirements are relevant for carrier aggregation radio access technologies \(used between two cooperating eRE/REs\); see Table IL.2 in ITU-T G.8271 \(03/2020 \[B14a\].](#)

Delete 6.4.1.1 [“Category A+,” including Equation (6-1)], and renumber the successive subclauses of 6.4.1 accordingly.

6.4.1.1 ~~6.4.1.2~~ Category A

Change the new 6.4.1.1 as shown:

Category A is applicable to Case 1.2 and Case 2. The maximum relative TE can be determined as shown by ~~Equation (6-2)~~ [Equation \(6-1\)](#) and ~~Equation (6-3)~~ [Equation \(6-2\)](#) for the applicable cases:

$$\text{Case 1.2: } \max|TE|_{\text{relative}} = 130 \text{ ns} - 2 \times |TE_{eRE/RE}| - 2 \times |TE_{T-TSC}| \text{ ~~= 60 ns~~ } \quad \text{(6-2) (6-1)}$$

$$\text{Case 2: } \max|TE|_{\text{relative}} = 130 \text{ ns} - 2 \times |TE_{eRE/RE}| \text{ ~~= 70 ns~~ } \quad \text{(6-3) (6-2)}$$

where

$|TE_{eRE/RE}|$ is the budget for all respective internal eRE/RE TE
 $|TE_{T-TSC}|$ is the budget for T-TSC TE

~~Equation (6-2)~~ [Equation \(6-1\)](#) and ~~Equation (6-3)~~ [Equation \(6-2\)](#) are derived from [section 6.5.3.1](#) of 3GPP TS 36.104-~~2018~~ [v15.4.0](#) [B1]. The maximum Time Alignment Error is 130 ns.

[For example:](#)

- In Case 1.2, ~~a 60 ns budget remains for the maximum relative TE of the bridged network as at the input of the eRE/REs if $|TE_{eRE/RE}|$ is 20 ns (see Table 6-1) and $|TE_{T-TSC}|$ is 15 ns. ($|TE_{T-TSC}| = 15 \text{ ns}$ could be considered similar to the value for an ITU-T G.8273.2 Class C Telecom Time Slave Clock; see [section 4.2](#) in the Requirements for the eCPRI Transport Network V1.2 [B6].~~
- In Case 2, ~~a 70 ns budget remains for the maximum relative TE of the bridged network as at the input of the eRE/REs if $|TE_{eRE/RE}|$ is 30 ns (see Table 6-1).~~

~~Category A requirements are relevant, e.g., for intra-band contiguous carrier aggregation radio access technology (used between two cooperating eRE/REs).~~

6.4.1.2 ~~6.4.1.3~~ Category B

Change the new 6.4.1.2 as shown:

Category B is applicable to Case 1.1, Case 1.2, and Case 2. The maximum relative TE can be determined as shown by ~~Equation (6-4)~~ [Equation \(6-3\)](#), ~~Equation (6-5)~~ [Equation \(6-4\)](#), and ~~Equation (6-6)~~ [Equation \(6-5\)](#) for the different cases:

$$\text{Case 1.1: } \max|TE|_{\text{relative}} = 260 \text{ ns} - 2 \times |TE_{eRE/RE}| - 2 \times |TE_{T-TSC}| \text{ ~~=100 ns~~ } \quad \text{(6-4) (6-3)}$$

$$\text{Case 1.2: } \max|TE|_{\text{relative}} = 260 \text{ ns} - 2 \times |TE_{eRE/RE}| - 2 \times |TE_{T-TSC}| \text{ ~~=190 ns~~ } \quad \text{(6-5) (6-4)}$$

$$\text{Case 2: } \max|TE|_{\text{relative}} = 260 \text{ ns} - 2 \times |TE_{eRE/RE}| \text{ ~~=200 ns~~ } \quad \text{(6-6) (6-5)}$$

where

$|TE_{eRE/RE}|$ is the budget for all respective internal eRE/RE TE
 $|TE_{T-TSC}|$ is a budget for T-TSC TE

Equation (6-4) Equation (6-3), Equation (6-5) Equation (6-4), and Equation (6-6) Equation (6-5) are derived from [section 6.5.3.1](#) of 3GPP TS 36.104 [v15.4.0](#) [B1]. The maximum Time Alignment Error is 260 ns.

For example:

- In Case 1.1, [a 100 ns budget remains for the maximum relative TE of the bridged network as at the input of the eRE/REs if \$|TE_{eRE/RE}|\$ is 20 ns \(see Table 6-1\) and \$|TE_{T-TSC}|\$ is 60 ns. \(\$|TE_{T-TSC}| = 60 \text{ ns}\$ is on the order of the value for an ITU-T G.8273.2 Class B Telecom Time Slave Clock, where \$|TE_{T-TSC}| = |cTE_{T-TSC}| + |dTE_{T-TSC}| = 20 \text{ ns} + 40 \text{ ns} = 60 \text{ ns}\$, according to ITU-T G.8273.2 Class B Telecom Time Slave Clock, where \$cTE\$ is constant \$TE_2\$ and \$dTE\$ is dynamic \$TE_2\$ \).](#)
- In Case 1.2, [a 190 ns budget remains for the maximum relative TE of the bridged network as at the input of the eRE/REs if \$|TE_{eRE/RE}|\$ is 20 ns \(see Table 6-1\) and \$|TE_{T-TSC}|\$ is 15 ns. \(\$|TE_{T-TSC}| = 15 \text{ ns}\$ could be considered similar to the value for an ITU-T G.8273.2 Class C Telecom Time Slave Clock, see \[section 4.2 in the Requirements for the eCPRI Transport Network V1.2\]\(#\) \[B6\]\).](#)
- In Case 2, [a 200 ns budget remains for the maximum relative TE of the bridged network as at the input of the eRE/REs if \$|TE_{eRE/RE}|\$ is 30 ns \(see Table 6-1\).](#)

~~Category B requirements are relevant, e.g., for intra-band non-contiguous and inter-band carrier aggregation radio access technologies (used between two cooperating eRE/REs).~~

6.4.2 Frequency synchronization requirements

Change the first and second paragraphs of 6.4.2 as shown (text of footnote 20 remains unchanged):

The frequency synchronization requirements are based on 3GPP TS 36.104 [B1]. As applied to the bridged network, they are related to the need for the eRE/RE to recover a timing signal that meets the applicable synchronization requirements on the radio interface. In particular, ± 50 ppb ([on the short term of a 1 ms observation window](#)) is required on the radio air interface (3GPP TS 36.104 [B1]) at the output of the eRE/RE. In worst case, the network should deliver at least ± 16 ppb (on the long term) at the input of the eRE/RE.²⁰ [The use of PTP and \(optionally\) Synchronous Ethernet by eRE/RE is possible only if the eRE/RE can filter network noise so that the total of all frequency errors is less than the 3GPP limit of \$\pm 50\$ ppb \(on the short term\).](#)

When frequency synchronization is recovered via Synchronous Ethernet (ITU-T G.8262) [or enhanced Synchronous Ethernet \(ITU-T G.8262.1\)](#), the applicable requirements at the input of the eRE/RE are defined by the Synchronous Ethernet network limits in 9.2.1 of ITU-T G.8261 (08/2019).

7. Bridge and synchronization functions

7.3 Frame preemption

Change 7.3 as shown:

Frame preemption is the suspension of the transmission of a preemptable frame to allow one or more express frames to be transmitted before the transmission of the preemptable frame is resumed. IEEE Std 802.3²¹ specifies the MAC Merge sublayer, which supports interspersing express traffic with preemptable traffic. The MAC Merge sublayer supports two ways to hold the transmission of preemptable traffic in the presence of express traffic (until subsequent release): the MAC Merge sublayer can preempt (interrupt) preemptable traffic being currently transmitted, and the MAC Merge sublayer can prevent starting the transmission of preemptable traffic (see 99.1 of IEEE Std 802.3²¹). The IEEE 802.1Q bridge forwarding process optionally supports frame preemption. The benefits provided by frame preemption decrease as the data rate of a bridge port increases.

Frame preemption takes some time; the express frame cannot be transmitted immediately. If frame preemption is possible, then the express frame can be transmitted only after the transmission of the current fragment of the preemptable frame including the Cyclic Redundancy Check (CRC) of the frame and the Inter Packet Gap (IPG). Preemption occurs only if at least 60 octets of the preemptable frame have been transmitted and at least 64 octets (including the frame CRC) remain to be transmitted. The earliest starting position of preemption is controlled by the addFragSize variable, which is a 2-bit integer value indicating, in units of 64 octets, the minimum number of octets over 64 octets required in non-final fragments by the receiver (see 99.4.4 and 79.3.7 of IEEE Std 802.3²¹). Preemption happens within $(1240 + 512 \times \text{addFragSize})$ bit times. That is, the worst case is 1240 bit times when addFragSize = 0, which is used for the worst-case calculations in this document.

If PTP messages are carried by express frames or by frames that are smaller than 124 octets, then they are not preempted.

7.4 Network synchronization

Change item a)3) in the lettered list in the introductory text of 7.4 as shown (Figure 7-2 and NOTE 1 remain unchanged):

- 3) *Timing distribution to a cluster of eRE/REs from the nearest common master / boundary clock.* An example is shown in Figure 7-2, where the nearest common master / boundary clock is implemented in Node *n*, which is the starting point from where the relative phase deviation can be calculated. This allows for a relatively short synchronization chain, with target performance in terms of maximum absolute TE, relative to Node *n*, depending on the length of the chain and the characteristics of the PTP clocks. As an example, 100 ns can be met in a short chain (e.g., two hops) with properly performing clocks (e.g., Class B or Class C of ITU-T G.8273.2).

Change item a)4) in the lettered list in the introductory text of 7.4 as shown (Figure 7-3 and NOTE 2 remain unchanged):

- 4) *General deployment* as described by an appropriate PTP profile, e.g., as described by the time synchronization architecture as per ITU-T G.8275 [B16], the telecom profile as per ITU-T G.8275.1 with network characteristics as per ITU-T G.8271.1 and clocks as per ITU-T G.8273.2

²¹At the time of publication of this standard, the relevant content of IEEE Std 802.3 was separately published as IEEE Std 802.3br-2016.

[Telecom-Boundary Clock (T-BC)] and ITU-T G.8273.3 [Telecom-Transparent Clock (T-TC)]; see example in Figure 7-3. In this case, the target performance in terms of maximum absolute TE relative to an internationally recognized time reference (e.g., TAI) is 1.1 μ s at the input of the end station in order to meet 1.5 μ s at the output of the end station (including some budget for synchronization network rearrangements).

Change item b) in the lettered list in the introductory text of 7.4 as shown (NOTE 3 remains unchanged):

- b) *Physical layer frequency synchronization* (e.g., SyncE). This is specified by ITU-T (G.8261, G.8262, [G.8262.1](#), and G.8264) as a way to deliver frequency synchronization over the physical layer. Synchronous Ethernet support of PTP operations is assumed in ITU-T G.8275.1 based networks (and ITU-T G.8273.2 clocks); an end station can use it for the purpose of frequency synchronization and/or to support PTP operations.

Change item c) in the lettered list in the introductory text of 7.4 as shown (NOTE 4 remains unchanged):

- c) *Global Navigation Satellite System (GNSS) or Regional Navigation Satellite System at the eRE/REs*. Examples of satellite systems are Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), [Galileo](#), BeiDou Navigation Satellite System (BDS), [Indian Regional Navigation Satellite System \(IRNSS\)](#), and [Galileo Quasi-Zenith Satellite System \(QZSS\)](#). The expected accuracy in typical installations is of the order of 100 ns. As a reference, ITU-T G.8272 (PRTC specification) specifies 100 ns, and ITU-T G.8272.1 specifies 30 ns for enhanced PRTC in a central location.

8. Fronthaul profiles

Change the second paragraph of the introductory text of Clause 8 as shown:

Profile A (8.1) and Profile B (8.2) are applicable to both Class 1 (6.2) and Class 2 (6.3) because the two Classes have similar requirements. Three types of fronthaul flows can be distinguished based on their requirements. Based on Table 1 in the Requirements for the eCPRI Transport Network V1.42 [B6], this document refers to the three types of fronthaul flows and corresponding fronthaul traffic classes as follows:

Change item a) and item b) in the lettered list in the introductory text of Clause 8 as shown:

- a) High Priority Fronthaul (HPF) data, which includes Class 1 IQ data (6.2.3) and Class 2 User Plane (fast) data (see Table 1 and Table 1A in the Requirements for the eCPRI Transport Network V1.2 [B6] and 6.3.2) ~~with 100 μ s maximum end-to-end one-way latency;~~
- b) Medium Priority Fronthaul (MPF) data, which has 1 ms maximum end-to-end one-way latency, thus includes Class 2 User Plane (slow) data and Class 2 C&M Plane (fast) data (see Table 1 in the Requirements for the eCPRI Transport Network V1.42 [B6], and 6.3.2.1 and 6.3.3, respectively);

Change the third paragraph in the introductory text of Clause 8 as shown:

As Class 1 IQ data [item a) in 6.2.1] and Class 2 User Plane data [item a) in 6.3.1] belong to HPF [preceding item a)], they are treated the same way in Profile A (8.1) and Profile B (8.2). Thus, Class 2 User Plane data flows are considered as if they were CBR data flows, i.e., a User Plane data flow had the same amount of data in each time window (6.3.2). There are Class 2 User Plane data flows that do not use all the bandwidth allocated in the bridged network due to the time windows with no packet (6.3.1). This unused bandwidth can be used by any other traffic, whether fronthaul or not.

Change the fourth paragraph in the introductory text of Clause 8 as shown:

Class 2 User Plane (slow) data and Class 2 C&M Plane (fast) data belong to MPF [preceding item b)] because they have similar requirements (see Table 1 in the Requirements for the eCPRI Transport Network V1.42 [B6]).

8.1 Profile A

8.1.3 Meeting latency targets

Change the third paragraph of 8.1.3 as shown:

The propagation delay [$t_{\text{Propagation}}$, item d) in 7.1] can be a significant part of the end-to-end latency. For instance, if the distance between eRE/RE and eREC/REC is 10 km, then the propagation delay is roughly 50 μ s, which is half of the 100 μ s end-to-end one-way latency budget of ~~HPF data~~ the High 100 latency class (6.2.3.1, 6.3.2.1).

Change the last two paragraphs of 8.1.3 as shown (text of footnote 22 remains unchanged):

In order to avoid ingress traffic exceeding the amount considered during network design, flow metering (8.6.5 of IEEE Std 802.1Q-2018) with the MEF 10.34 bandwidth profile per traffic class is used at the ingress of the bridged network. Therefore, edge bridges of a fronthaul bridged network shall implement the

MEF 10.34 token bucket bandwidth profile, which is configured such that excess HPF traffic is discarded in order to meet the HPF requirements. That is, the ingress HPF traffic is limited to the amount that is considered during network design, e.g., for worst-case delay calculations.

The network is configured to avoid starvation of MPF and LPF traffic taking into account their bandwidth requirements.²² Furthermore, the bandwidth design is enforced with MEF 10.34 bandwidth profile per traffic class at the ingress of the bridged network. That is, bandwidth profile is configured to limit ingress HPF, MPF, and LPF traffic to the amount that is considered during network design. Excess HPF and MPF traffic is configured to be discarded in order to avoid starvation of LPF. Excess LPF traffic can be allowed. The bandwidth profile can be configured such that unused bandwidth assigned to HPF and MPF is available to lower priority traffic classes. That is, token sharing may be enabled from HPF and MPF to lower priority traffic classes (see ~~Annex C~~ [Appendix D](#) in MEF 10.34). For instance, non-fronthaul traffic can use the bandwidth not used by fronthaul traffic.

8.2 Profile B

8.2.3 Meeting latency targets

Change the last paragraph of 8.2.3 as shown:

The worst-case queuing delay for HPF is as explained in 8.1.3 because MPF and LPF are not preemptable. That is, the total worst-case end-to-end latency for an HPF data information flow can be calculated according to Equation (8-1) as explained in 8.1.3. MEF 10.34 bandwidth profile per traffic class is used at the ingress of the bridged network in order to meet the latency targets of fronthaul traffic. Bandwidth profiles are configured as described in 8.1.3.