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AMENDMENT 14
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Telecommunications and exchange between information technology systems — Requirements for local and metropolitan area networks —

Part 3: Standard for Ethernet

AMENDMENT 14: Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s optical access PHYs

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

Partie 3: Norme pour Ethernet

AMENDEMENT 14: Liaisons physiques (PHY) d'accès optique 10 Gb/s, 25 Gb/s et 50 Gb/s bidirectionnelles

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ISO/IEC/IEEE 8802-3:2021/Amd.14 was prepared by the LAN/MAN of the IEEE Computer Society (as IEEE 802.3cp-2021) 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*.

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IEEE Std 802.3cp™-2021
(Amendment to IEEE Std 802.3™-2018
as amended by IEEE Std 802.3cb™-2018,
IEEE Std 802.3bt™-2018,
IEEE Std 802.3cd™-2018,
IEEE Std 802.3cn™-2019,
IEEE Std 802.3cg™-2019,
IEEE Std 802.3cq™-2020,
IEEE Std 802.3cm™-2020,
IEEE Std 802.3ch™-2020,
IEEE Std 802.3ca™-2020,
IEEE Std 802.3cr™-2021,
IEEE Std 802.3cu™-2021,
IEEE Std 802.3cv™-2021,
and IEEE Std 802.3ct™-2021)

IEEE Standard for Ethernet

Amendment 14: Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs

Developed by the

LAN/MAN Standards Committee
of the
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Approved 16 June 2021

IEEE SA Standards Board

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Abstract: This amendment to IEEE Std 802.3-2018 adds Physical Layer specifications and management parameters for 10 Gb/s, 25 Gb/s, and 50 Gb/s Ethernet optical interfaces for bidirectional operation over a single strand of single-mode fiber with reaches of at least 10 km, 20 km, and 40 km.

Keywords: 10GBASE-BR10, 10GBASE-BR20, 10GBASE-BR40, 25GBASE-BR10, 25GBASE-BR20, 25GBASE-BR40, 50GBASE-BR10, 50GBASE-BR20, 50GBASE-BR40, bidirectional (BiDi), Ethernet, forward error correction (FEC), IEEE 802.3™, IEEE 802.3cp™, multi-gigabit Ethernet bidirectional Physical Layers, Physical Coding Sublayer (PCS), Physical Medium Attachment (PMA) sublayer, Physical Medium Dependent (PMD) sublayer

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Introduction

This introduction is not part of IEEE Std 802.3cp-2021, IEEE Standard for Ethernet—Amendment 14: Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs.

IEEE Std 802.3™ was first published in 1985. Since the initial publication, many projects have added functionality or provided maintenance updates to the specifications and text included in the standard. Each IEEE 802.3 project/amendment is identified with a suffix (e.g., IEEE Std 802.3ba™-2010).

The half duplex Media Access Control (MAC) protocol specified in IEEE Std 802.3-1985 is Carrier Sense Multiple Access with Collision Detection (CSMA/CD). This MAC protocol was key to the experimental Ethernet developed at Xerox Palo Alto Research Center, which had a 2.94 Mb/s data rate. Ethernet at 10 Mb/s was jointly released as a public specification by Digital Equipment Corporation (DEC), Intel and Xerox in 1980. Ethernet at 10 Mb/s was approved as an IEEE standard by the IEEE Standards Board in 1983 and subsequently published in 1985 as IEEE Std 802.3-1985. Since 1985, new media options, new speeds of operation, and new capabilities have been added to IEEE Std 802.3. A full duplex MAC protocol was added in 1997.

Some of the major additions to IEEE Std 802.3 are identified in the marketplace with their project number. This is most common for projects adding higher speeds of operation or new protocols. For example, IEEE Std 802.3u™ added 100 Mb/s operation (also called Fast Ethernet), IEEE Std 802.3z added 1000 Mb/s operation (also called Gigabit Ethernet), IEEE Std 802.3ae added 10 Gb/s operation (also called 10 Gigabit Ethernet), IEEE Std 802.3ah™ specified access network Ethernet (also called Ethernet in the First Mile) and IEEE Std 802.3ba added 40 Gb/s operation (also called 40 Gigabit Ethernet) and 100 Gb/s operation (also called 100 Gigabit Ethernet). These major additions are all now included in and are superseded by IEEE Std 802.3-2018 and are not maintained as separate documents.

At the date of IEEE Std 802.3cp-2021 publication, IEEE Std 802.3 was composed of the following documents:

IEEE Std 802.3-2018

Section One—Includes Clause 1 through Clause 20 and Annex A through Annex H and Annex 4A. Section One includes the specifications for 10 Mb/s operation and the MAC, frame formats and service interfaces used for all speeds of operation.

Section Two—Includes Clause 21 through Clause 33 and Annex 22A through Annex 33E. Section Two includes management attributes for multiple protocols and speed of operation as well as specifications for providing power over twisted pair cabling for multiple operational speeds. It also includes general information on 100 Mb/s operation as well as most of the 100 Mb/s Physical Layer specifications.

Section Three—Includes Clause 34 through Clause 43 and Annex 36A through Annex 43C. Section Three includes general information on 1000 Mb/s operation as well as most of the 1000 Mb/s Physical Layer specifications.

Section Four—Includes Clause 44 through Clause 55 and Annex 44A through Annex 55B. Section Four includes general information on 10 Gb/s operation as well as most of the 10 Gb/s Physical Layer specifications.

Section Five—Includes Clause 56 through Clause 77 and Annex 57A through Annex 76A. Clause 56 through Clause 67 and Clause 75 through Clause 77, as well as associated annexes, specify subscriber access and other Physical Layers and sublayers for operation from 512 kb/s to 10 Gb/s, and defines

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services and protocol elements that enable the exchange of IEEE Std 802.3 format frames between stations in a subscriber access network. Clause 68 specifies a 10 Gb/s Physical Layer specification. Clause 69 through Clause 74 and associated annexes specify Ethernet operation over electrical backplanes at speeds of 1000 Mb/s and 10 Gb/s.

Section Six—Includes Clause 78 through Clause 95 and Annex 83A through Annex 93C. Clause 78 specifies Energy-Efficient Ethernet. Clause 79 specifies IEEE 802.3 Organizationally Specific Link Layer Discovery Protocol (LLDP) type, length, and value (TLV) information elements. Clause 80 through Clause 95 and associated annexes include general information on 40 Gb/s and 100 Gb/s operation as well the 40 Gb/s and 100 Gb/s Physical Layer specifications. Clause 90 specifies Ethernet support for time synchronization protocols.

Section Seven—Includes Clause 96 through Clause 115 and Annex 97A through Annex 115A. Clause 96 through Clause 98, Clause 104, and associated annexes, specify Physical Layers and optional features for 100 Mb/s and 1000 Mb/s operation over a single twisted pair. Clause 100 through Clause 103, as well as associated annexes, specify Physical Layers for the operation of the EPON protocol over coaxial distribution networks. Clause 105 through Clause 114 and associated annexes include general information on 25 Gb/s operation as well as 25 Gb/s Physical Layer specifications. Clause 99 specifies a MAC merge sublayer for the interspersing of express traffic. Clause 115 and its associated annex specify a Physical Layer for 1000 Mb/s operation over plastic optical fiber.

Section Eight—Includes Clause 116 through Clause 126 and Annex 119A through Annex 120E. Clause 116 through Clause 124 and associated annexes include general information on 200 Gb/s and 400 Gb/s operation as well the 200 Gb/s and 400 Gb/s Physical Layer specifications. Clause 125 and Clause 126 include general information on 2.5 Gb/s and 5 Gb/s operation as well as 2.5 Gb/s and 5 Gb/s Physical Layer specifications.

IEEE Std 802.3cb™-2018

Amendment 1—This amendment includes changes to IEEE Std 802.3-2018 and its amendments, and adds Clause 127 through Clause 130, Annex 127A, Annex 128A, Annex 128B, and Annex 130A. This amendment adds new Physical Layers for operation at 2.5 Gb/s and 5 Gb/s over electrical backplanes.

IEEE Std 802.3bt™-2018

Amendment 2—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 145, Annex 145A, Annex 145B, and Annex 145C. This amendment adds power delivery using all four pairs in the structured wiring plant, resulting in greater power being available to end devices. This amendment also allows for lower standby power consumption in end devices and adds a mechanism to better manage the available power budget.

IEEE Std 802.3cd™-2018

Amendment 3—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 131 through Clause 140 and Annex 135A through Annex 136D. This amendment adds MAC parameters, Physical Layers, and management parameters for the transfer of IEEE 802.3 format frames at 50 Gb/s, 100 Gb/s, and 200 Gb/s.

IEEE Std 802.3cn™-2019

Amendment 4—This amendment includes changes to IEEE Std 802.3-2018 and adds 50 Gb/s, 200 Gb/s, and 400 Gb/s Physical Layer specifications and management parameters for operation over single-mode fiber with reaches of at least 40 km.

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IEEE Std 802.3cg™-2019

Amendment 5—This amendment includes changes to IEEE Std 802.3-2018 and its amendments and adds Clause 146 through Clause 148 and Annex 146A and Annex 146B. This amendment adds 10 Mb/s Physical Layer specifications and management parameters for operation on a single balanced pair of conductors.

IEEE Std 802.3cq™-2020

Amendment 6—This amendment includes editorial and technical corrections, refinements, and clarifications to Clause 33 and related portions of the standard.

IEEE Std 802.3cm™-2020

Amendment 7—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 150. This amendment adds Physical Layer (PHY) specifications and management parameters for 400 Gb/s operation on four pairs (400GBASE-SR4.2) and eight pairs (400GBASE-SR8) of multimode fiber, over reaches of at least 100 m.

IEEE Std 802.3ch™-2020

Amendment 8—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 149, Annex 149A, Annex 149B, and Annex 149C. This amendment adds physical layer specifications and management parameters for operation at 2.5 Gb/s, 5 Gb/s, and 10 Gb/s over a single balanced pair of conductors.

IEEE Std 802.3ca™-2020

Amendment 9—This amendment to IEEE Std 802.3-2018 extends the operation of Ethernet passive optical networks (EPONs) to multiple channels of 25 Gb/s providing both symmetric and asymmetric operation for the following data rates (downstream/upstream): 25/10 Gb/s, 25/25 Gb/s, 50/10 Gb/s, 50/25 Gb/s, and 50/50 Gb/s. This amendment specifies the 25 Gb/s EPON Multi-Channel Reconciliation Sublayer (MCRS), Nx25G-EPON Physical Coding Sublayers (PCSs), Physical Media Attachment (PMA) sublayers, and Physical Medium Dependent (PMD) sublayers that support both symmetric and asymmetric data rates while maintaining backward compatibility with already deployed 10 Gb/s EPON equipment. The EPON operation is defined for distances of at least 20 km, and for a split ratio of at least 1:32.

IEEE Std 802.3cr™-2021

Amendment 10—This amendment includes changes to IEEE Std 802.3-2018 and adds Annex J. This amendment replaces references to the IEC 60950 series of standards (including IEC 60950-1 “Information technology equipment—Safety—Part 1: General requirements”) with appropriate references to the IEC 62368 “Audio/video, information and communication technology equipment” series and makes appropriate changes to the standard corresponding to the new references.

IEEE Std 802.3cu™-2021

Amendment 11—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 151. This amendment adds Physical Layer (PHY) specifications and management parameters for 100 Gb/s and 400 Gb/s operation over single-mode fiber, based on 100 Gb/s per wavelength optical signaling.

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IEEE Std 802.3cv™-2021

Amendment 12—This amendment includes editorial and technical corrections, refinements, and clarifications to Clause 145, Power over Ethernet, and related portions of the standard.

IEEE Std 802.3ct™-2021

Amendment 13—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 152 through Clause 154 and Annex 154A. This amendment adds 100 Gb/s Physical Layer specifications and management parameters for operation over DWDM systems with reaches of at least 80 km.

IEEE Std 802.3cp™-2021

Amendment 14—This amendment includes changes to IEEE Std 802.3-2018 and adds Clause 157, Clause 158, Clause 159, and Clause 160. This amendment adds Physical Layer specifications and management parameters for 10 Gb/s, 25 Gb/s, and 50 Gb/s Ethernet optical interfaces for bidirectional operation over a single strand of single-mode fiber.

Two companion documents exist, IEEE Std 802.3.1 and IEEE Std 802.3.2. IEEE Std 802.3.1 describes Ethernet management information base (MIB) modules for use with the Simple Network Management Protocol (SNMP). IEEE Std 802.3.2 describes YANG data models for Ethernet. IEEE Std 802.3.1 and IEEE Std 802.3.2 are updated to add management capability for enhancements to IEEE Std 802.3 after approval of those enhancements.

IEEE Std 802.3 will continue to evolve. New Ethernet capabilities are anticipated to be added within the next few years as amendments to this standard.

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IEEE Standard for Ethernet

Amendment 14: Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs

(This amendment is based on IEEE Std 802.3™-2018 as amended by IEEE Std 802.3cb™-2018, IEEE Std 802.3bt™-2018, IEEE Std 802.3cd™-2018, IEEE Std 802.3cn™-2019, IEEE Std 802.3cg™-2019, IEEE Std 802.3cq™-2020, IEEE Std 802.3cm™-2020, IEEE Std 802.3ch™-2020, IEEE Std 802.3ca™-2020, IEEE Std 802.3cr™-2021, IEEE Std 802.3cu™-2021, IEEE Std 802.3cv™-2021, and IEEE Std 802.3ct™-2021.)

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.

Cross references that refer to clauses, tables, equations, or figures not covered by this amendment are highlighted in green.[1]

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

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1. Introduction

1.4 Definitions

Insert the following three new definitions after 1.4.52 "10BROAD36":

1.4.52a 10GBASE-BR10: IEEE 802.3 Physical Layer specification for a 10 Gb/s bidirectional link over one single-mode fiber with reach up to at least 10 km. There are different specifications for 10GBASE-BR10-D and 10GBASE-BR10-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 158.)

1.4.52b 10GBASE-BR20: IEEE 802.3 Physical Layer specification for a 10 Gb/s bidirectional link over one single-mode fiber with reach up to at least 20 km. There are different specifications for 10GBASE-BR20-D and 10GBASE-BR20-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 158.)

1.4.52c 10GBASE-BR40: IEEE 802.3 Physical Layer specification for a 10 Gb/s bidirectional link over one single-mode fiber with reach up to at least 40 km. There are different specifications for 10GBASE-BR40-D and 10GBASE-BR40-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 158.)

Insert the following three new definitions after 1.4.91 "25GBASE":

1.4.91a 25GBASE-BR10: IEEE 802.3 Physical Layer specification for a 25 Gb/s bidirectional link over one single-mode fiber with reach up to at least 10 km. There are different specifications for 25GBASE-BR10-D and 25GBASE-BR10-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 159.)

1.4.91b 25GBASE-BR20: IEEE 802.3 Physical Layer specification for a 25 Gb/s bidirectional link over one single-mode fiber with reach up to at least 20 km. There are different specifications for 25GBASE-BR20-D and 25GBASE-BR20-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 159.)

1.4.91c 25GBASE-BR40: IEEE 802.3 Physical Layer specification for a 25 Gb/s bidirectional link over one single-mode fiber with reach up to at least 40 km. There are different specifications for 25GBASE-BR40-D and 25GBASE-BR40-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 159.)

Insert the following three new definitions after 1.4.128aac "50/50G-EPON" as inserted by IEEE Std 802.3ca-2020:

1.4.128aad 50GBASE-BR10: IEEE 802.3 Physical Layer specification for a 50 Gb/s bidirectional link over one single-mode fiber with reach up to at least 10 km. There are different specifications for 50GBASE-BR10-D and 50GBASE-BR10-U; a transmission path connects one to the other. (See IEEE Std 802.3 Clause 160.)

1.4.128aae 50GBASE-BR20: IEEE 802.3 Physical Layer specification for a 50 Gb/s bidirectional link over one single-mode fiber with reach up to at least 20 km. There are different specifications for 50GBASE-BR20-D and 50GBASE-BR20-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 160.)

1.4.128aaf 50GBASE-BR40: IEEE 802.3 Physical Layer specification for a 50 Gb/s bidirectional link over one single-mode fiber with reach up to at least 40 km. There are different specifications for 50GBASE-BR40-D and 50GBASE-BR40-U; a transmission path connects one to the other. (See IEEE Std 802.3, Clause 160.)

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1.5 Abbreviations

Insert the following new abbreviation into the list in 1.5, in alphanumeric order:

BiDi	bidirectional

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30. Management

30.5 Layer management for medium attachment units (MAUs)

30.5.1 MAU managed object class

30.5.1.1 MAU attributes

30.5.1.1.2 aMAUType

Insert the following new types into the "APPROPRIATE SYNTAX" section of 30.5.1.1.2 after 10GBASE-T1 (as inserted by IEEE Std 802.3ch-2020) as follows:

APPROPRIATE SYNTAX:

…

10GBASE-BR10-D	One single-mode fiber OLT PHY supporting a distance of at least 10 km as specified in Clause 158
10GBASE-BR10-U	One single-mode fiber ONU PHY supporting a distance of at least 10 km as specified in Clause 158
10GBASE-BR20-D	One single-mode fiber OLT PHY supporting a distance of at least 20 km as specified in Clause 158
10GBASE-BR20-U	One single-mode fiber ONU PHY supporting a distance of at least 20 km as specified in Clause 158
10GBASE-BR40-D	One single-mode fiber OLT PHY supporting a distance of at least 40 km as specified in Clause 158
10GBASE-BR40-U	One single-mode fiber ONU PHY supporting a distance of at least 40 km as specified in Clause 158

…

Insert the following new types into the "APPROPRIATE SYNTAX" section of 30.5.1.1.2 after 25GBASE-T as follows:

APPROPRIATE SYNTAX:

…

25GBASE-BR10-D	One single-mode fiber OLT PHY supporting a distance of at least 10 km as specified in Clause 159
25GBASE-BR10-U	One single-mode fiber ONU PHY supporting a distance of at least 10 km as specified in Clause 159
25GBASE-BR20-D	One single-mode fiber OLT PHY supporting a distance of at least 20 km as specified in Clause 159
25GBASE-BR20-U	One single-mode fiber ONU PHY supporting a distance of at least 20 km as specified in Clause 159
25GBASE-BR40-D	One single-mode fiber OLT PHY supporting a distance of at least 40 km as specified in Clause 159
25GBASE-BR40-U	One single-mode fiber ONU PHY supporting a distance of at least 40 km as specified in Clause 159

…

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Insert the following new types into the "APPROPRIATE SYNTAX" section of 30.5.1.1.2 after 50GBASE-ER (as inserted by IEEE Std 802.3cn-2019) as follows:

APPROPRIATE SYNTAX:

…

50GBASE-BR10-D	One single-mode fiber OLT PHY supporting a distance of at least 10 km as specified in Clause 160
50GBASE-BR10-U	One single-mode fiber ONU PHY supporting a distance of at least 10 km as specified in Clause 160
50GBASE-BR20-D	One single-mode fiber OLT PHY supporting a distance of at least 20 km as specified in Clause 160
50GBASE-BR20-U	One single-mode fiber ONU PHY supporting a distance of at least 20 km as specified in Clause 160
50GBASE-BR40-D	One single-mode fiber OLT PHY supporting a distance of at least 40 km as specified in Clause 160
50GBASE-BR40-U	One single-mode fiber ONU PHY supporting a distance of at least 40 km as specified in Clause 160

…

Change the first paragraph of the "BEHAVIOUR DEFINED AS" section of 30.5.1.1.2 as follows:

BEHAVIOUR DEFINED AS:

Returns a value that identifies the internal MAU type. If an AUI is to be identified to access an external MAU, the type "AUI" is returned. A SET operation to one of the possible enumerations indicated by aMAUTypeList will force the MAU into the new operating mode. If a Clause 22 MII or Clause 35 GMII is present, then this will map to the mode force bits specified in 22.2.4.1. If a Clause 45 MDIO Interface is present, then this will map to the PCS type selection bit(s) in the 10G WIS Control 2 register specified in 45.2.2.6.6, the PCS Control 2 register specified in 45.2.3.6.1, the PMA/PMD type selection bits in the PMA/PMD Control 2 register specified in 45.2.1.6, the PMA/PMD control 1 register specified in 45.2.1.1, the ~~25G~~ RS-FEC Enable bit in the RS-FEC control register specified in 45.2.1.110.1, and the PCS control 1 register 45.2.3.1. If Clause 28, Clause 37, or Clause 73 Auto-Negotiation is operational, then this will change the advertised ability to the single enumeration specified in the SET operation, and cause an immediate link renegotiation. A change in the MAU type will also be reflected in aPHYType.

30.5.1.1.16 aFECmode

Change the last paragraph of the "BEHAVIOUR DEFINED AS" section of 30.5.1.1.16 as follows:

BEHAVIOUR DEFINED AS:

…

If a Clause 45 MDIO Interface is present, then this attribute maps to the FEC control register (see 45.2.10.3) for 1000BASE-PX, to the BASE-R FEC control register (see 45.2.1.102) and the ~~25G~~ RS-FEC Enable bit in the RS-FEC control register (see 45.2.1.110) for 10GBASE-R and 25GBASE-R, or FEC enable bit in the BASE-R FEC control register (see 45.2.1.102).;

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44. Introduction to 10 Gb/s baseband network

44.3 Delay constraints

Insert a new row at the end of Table 44–2, as modified by IEEE Std 802.3ch-2020, as follows (unchanged rows not shown):

Table 44–2—Round-trip delay constraints (informative)

Sublayer	Maximum (bit time)	Maximum (pause_quanta)	Notes
…			
10GBASE-BRx RS-FEC	24 576	48	See 108.4.

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45. Management Data Input/Output (MDIO) Interface

45.2 MDIO Interface Registers

45.2.1 PMA/PMD registers

Change the row for registers 1.34 and 1.35 in Table 45–3 as follows (unchanged rows not shown):

Table 45–3—PMA/PMD registers

Register address	Register name	Subclause
…		
1.34~~, 1.35~~	BiDi PMA/PMD extended ability 1~~Reserved~~	45.2.1.27a
1.35	BiDi PMA/PMD extended ability 2	45.2.1.27b
…		

45.2.1.6 PMA/PMD control 2 register (Register 1.7)

Change the indicated reserved rows of Table 45–7 (as inserted by IEEE Std 802.3cn-2019) as follows (unchanged table rows and bit description lines not shown):

Table 45–7—PMA/PMD control 2 register bit definitions

Bit(s)	Name	Description	R/W[a]
…			
1.7.6:0	PMA/PMD type selection	6 5 4 3 2 1 0 ~~1 1 1 x x x x = reserved~~ 1 1 1 1 1 x x = reserved 1 1 1 1 0 1 x = reserved 1 1 1 1 0 0 1 = reserved 1 1 1 1 0 0 0 = 50GBASE-BR40-U PMA/PMD 1 1 1 0 1 1 1 = 50GBASE-BR20-U PMA/PMD 1 1 1 0 1 1 0 = 50GBASE-BR10-U PMA/PMD 1 1 1 0 1 0 1 = 50GBASE-BR40-D PMA/PMD 1 1 1 0 1 0 0 = 50GBASE-BR20-D PMA/PMD 1 1 1 0 0 1 1 = 50GBASE-BR10-D PMA/PMD 1 1 1 0 0 1 0 = 25GBASE-BR40-U PMA/PMD 1 1 1 0 0 0 1 = 25GBASE-BR20-U PMA/PMD 1 1 1 0 0 0 0 = 25GBASE-BR10-U PMA/PMD ~~1 1 0 1 x x x = reserved~~ 1 1 0 1 1 1 1 = 25GBASE-BR40-D PMA/PMD 1 1 0 1 1 1 0 = 25GBASE-BR20-D PMA/PMD 1 1 0 1 1 0 1 = 25GBASE-BR10-D PMA/PMD 1 1 0 1 1 0 0 = 10GBASE-BR40-U PMA/PMD 1 1 0 1 0 1 1 = 10GBASE-BR20-U PMA/PMD 1 1 0 1 0 1 0 = 10GBASE-BR10-U PMA/PMD 1 1 0 1 0 0 1 = 10GBASE-BR40-D PMA/PMD 1 1 0 1 0 0 0 = 10GBASE-BR20-D PMA/PMD ~~1 1 0 0 1 x x = reserved~~ 1 1 0 0 1 1 1 = 10GBASE-BR10-D PMA/PMD 1 1 0 0 1 1 0 = reserved 1 1 0 0 1 0 x = reserved …	R/W

[a]R/W = Read/Write, RO = Read only

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45.2.1.7 PMA/PMD status 2 register (Register 1.8)

45.2.1.7.4 Transmit fault (1.8.11)

Insert a new row in Table 45–9 after the row for "5GBASE-KR" (as inserted by IEEE Std 802.3cb-2018) as follows (unchanged rows not shown):

Table 45–9—Transmit fault description location

PMA/PMD	Description location
…	
10GBASE-BR10, 10GBASE-BR20, 10GBASE-BR40	158.5.8
…	

Insert a new row in Table 45–9 after the row for "25GBASE-LR, 25GBASE-ER" as follows (unchanged rows not shown):

Table 45–9—Transmit fault description location

PMA/PMD	Description location
…	
25GBASE-BR10, 25GBASE-BR20, 25GBASE-BR40	159.5.8
…	

Insert a new row in Table 45–9 after the row for "50GBASE-FR, 50GBASE-LR, 50GBASE-ER" (as changed by IEEE Std 802.3cn-2019) as follows (unchanged rows not shown):

Table 45–9—Transmit fault description location

PMA/PMD	Description location
…	
50GBASE-BR10, 50GBASE-BR20, 50GBASE-BR40	160.5.8
…	

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45.2.1.7.5 Receive fault (1.8.10)

Insert a new row in Table 45–10 after the row for "5GBASE-KR" (as inserted by IEEE Std 802.3cb-2018) as follows (unchanged rows not shown):

Table 45–10—Receive fault description location

PMA/PMD	Description location
…	
10GBASE-BR10, 10GBASE-BR20, 10GBASE-BR40	158.5.9
…	

Insert a new row in Table 45–10 after the row for "25GBASE-LR, 25GBASE-ER" as follows (unchanged rows not shown):

Table 45–10—Receive fault description location

PMA/PMD	Description location
…	
25GBASE-BR10, 25GBASE-BR20, 25GBASE-BR40	159.5.9
…	

Insert a new row in Table 45–9 after the row for "50GBASE-FR, 50GBASE-LR, 50GBASE-ER" (as changed by IEEE Std 802.3cn-2019) as follows (unchanged rows not shown):

Table 45–10—Receive fault description location

PMA/PMD	Description location
…	
50GBASE-BR10, 50GBASE-BR20, 50GBASE-BR40	160.5.9
…	

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45.2.1.8 PMD transmit disable register (Register 1.9)

Insert a new row in Table 45–12 after the row for "5GBASE-KR" (as inserted by IEEE Std 802.3cb-2018) as follows (unchanged rows not shown):

Table 45–12—Transmit disable description location

PMA/PMD	Description location
…	
10GBASE-BR10, 10GBASE-BR20, and 10GBASE-BR40	158.5.6
…	

Insert a new row in Table 45–12 after the row for "25GBASE-LR and 25GBASE-ER" as follows (unchanged rows not shown):

Table 45–12—Transmit disable description location

PMA/PMD	Description location
…	
25GBASE-BR10, 25GBASE-BR20, and 25GBASE-BR40	159.5.6
…	

Insert a new row in Table 45–12 after the row for "50GBASE-FR, 50GBASE-LR, and 50GBASE-ER" (as changed by IEEE Std 802.3cn-2019) as follows (unchanged rows not shown):

Table 45–12—Transmit disable description location

PMA/PMD	Description location
…	
50GBASE-BR10, 50GBASE-BR20, and 50GBASE-BR40	160.5.6
…	

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Insert new subclauses 45.2.1.27a and 45.2.1.27b after 45.2.1.27 as follows:

45.2.1.27a BiDi PMA/PMD extended ability 1 (Register 1.34)

The assignment of bits in the BiDi PMA/PMD extended ability 1 register is shown in Table 45–31a.

Table 45–31a—BiDi PMA/PMD extended ability 1 register bit definitions

Bit(s)	Name	Description	R/W[a]
1.34.15:12	Reserved	Value always 0	RO
1.34.11	25GBASE-BR40-U ability	1 = PMA/PMD is able to perform 25GBASE-BR40-U 0 = PMA/PMD is not able to perform 25GBASE-BR40-U	RO
1.34.10	25GBASE-BR40-D ability	1 = PMA/PMD is able to perform 25GBASE-BR40-D 0 = PMA/PMD is not able to perform 25GBASE-BR40-D	RO
1.34.9	25GBASE-BR20-U ability	1 = PMA/PMD is able to perform 25GBASE-BR20-U 0 = PMA/PMD is not able to perform 25GBASE-BR20-U	RO
1.34.8	25GBASE-BR20-D ability	1 = PMA/PMD is able to perform 25GBASE-BR20-D 0 = PMA/PMD is not able to perform 25GBASE-BR20-D	RO
1.34.7	25GBASE-BR10-U ability	1 = PMA/PMD is able to perform 25GBASE-BR10-U 0 = PMA/PMD is not able to perform 25GBASE-BR10-U	RO
1.34.6	25GBASE-BR10-D ability	1 = PMA/PMD is able to perform 25GBASE-BR10-D 0 = PMA/PMD is not able to perform 25GBASE-BR10-D	RO
1.34.5	10GBASE-BR40-U ability	1 = PMA/PMD is able to perform 10GBASE-BR40-U 0 = PMA/PMD is not able to perform 10GBASE-BR40-U	RO
1.34.4	10GBASE-BR40-D ability	1 = PMA/PMD is able to perform 10GBASE-BR40-D 0 = PMA/PMD is not able to perform 10GBASE-BR40-D	RO
1.34.3	10GBASE-BR20-U ability	1 = PMA/PMD is able to perform 10GBASE-BR20-U 0 = PMA/PMD is not able to perform 10GBASE-BR20-U	RO
1.34.2	10GBASE-BR20-D ability	1 = PMA/PMD is able to perform 10GBASE-BR20-D 0 = PMA/PMD is not able to perform 10GBASE-BR20-D	RO
1.34.1	10GBASE-BR10-U ability	1 = PMA/PMD is able to perform 10GBASE-BR10-U 0 = PMA/PMD is not able to perform 10GBASE-BR10-U	RO
1.34.0	10GBASE-BR10-D ability	1 = PMA/PMD is able to perform 10GBASE-BR10-D 0 = PMA/PMD is not able to perform 10GBASE-BR10-D	RO

[a]RO = Read only

45.2.1.27a.1 25GBASE-BR40-U ability (1.34.11)

When read as a one, bit 1.34.11 indicates that the PMA/PMD is able to operate as a 25GBASE-BR40-U PMA/PMD type. When read as a zero, bit 1.34.11 indicates that the PMA/PMD is not able to operate as a 25GBASE-BR40-U PMA/PMD type.

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45.2.1.27a.2 25GBASE-BR40-D ability (1.34.10)

When read as a one, bit 1.34.10 indicates that the PMA/PMD is able to operate as a 25GBASE-BR40-D PMA/PMD type. When read as a zero, bit 1.34.10 indicates that the PMA/PMD is not able to operate as a 25GBASE-BR40-D PMA/PMD type.

45.2.1.27a.3 25GBASE-BR20-U ability (1.34.9)

When read as a one, bit 1.34.9 indicates that the PMA/PMD is able to operate as a 25GBASE-BR20-U PMA/PMD type. When read as a zero, bit 1.34.9 indicates that the PMA/PMD is not able to operate as a 25GBASE-BR20-U PMA/PMD type.

45.2.1.27a.4 25GBASE-BR20-D ability (1.34.8)

When read as a one, bit 1.34.8 indicates that the PMA/PMD is able to operate as a 25GBASE-BR20-D PMA/PMD type. When read as a zero, bit 1.34.8 indicates that the PMA/PMD is not able to operate as a 25GBASE-BR20-D PMA/PMD type.

45.2.1.27a.5 25GBASE-BR10-U ability (1.34.7)

When read as a one, bit 1.34.7 indicates that the PMA/PMD is able to operate as a 25GBASE-BR10-U PMA/PMD type. When read as a zero, bit 1.34.7 indicates that the PMA/PMD is not able to operate as a 25GBASE-BR10-U PMA/PMD type.

45.2.1.27a.6 25GBASE-BR10-D ability (1.34.6)

When read as a one, bit 1.34.6 indicates that the PMA/PMD is able to operate as a 25GBASE-BR10-D PMA/PMD type. When read as a zero, bit 1.34.6 indicates that the PMA/PMD is not able to operate as a 25GBASE-BR10-D PMA/PMD type.

45.2.1.27a.7 10GBASE-BR40-U ability (1.34.5)

When read as a one, bit 1.34.5 indicates that the PMA/PMD is able to operate as a 10GBASE-BR40-U PMA/PMD type. When read as a zero, bit 1.34.5 indicates that the PMA/PMD is not able to operate as a 10GBASE-BR40-U PMA/PMD type.

45.2.1.27a.8 10GBASE-BR40-D ability (1.34.4)

When read as a one, bit 1.34.4 indicates that the PMA/PMD is able to operate as a 10GBASE-BR40-D PMA/PMD type. When read as a zero, bit 1.34.4 indicates that the PMA/PMD is not able to operate as a 10GBASE-BR40-D PMA/PMD type.

45.2.1.27a.9 10GBASE-BR20-U ability (1.34.3)

When read as a one, bit 1.34.3 indicates that the PMA/PMD is able to operate as a 10GBASE-BR20-U PMA/PMD type. When read as a zero, bit 1.34.3 indicates that the PMA/PMD is not able to operate as a 10GBASE-BR20-U PMA/PMD type.

45.2.1.27a.10 10GBASE-BR20-D ability (1.34.2)

When read as a one, bit 1.34.2 indicates that the PMA/PMD is able to operate as a 10GBASE-BR20-D PMA/PMD type. When read as a zero, bit 1.34.2 indicates that the PMA/PMD is not able to operate as a 10GBASE-BR20-D PMA/PMD type.

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45.2.1.27a.11 10GBASE-BR10-U ability (1.34.1)

When read as a one, bit 1.34.1 indicates that the PMA/PMD is able to operate as a 10GBASE-BR10-U PMA/PMD type. When read as a zero, bit 1.34.1 indicates that the PMA/PMD is not able to operate as a 10GBASE-BR10-U PMA/PMD type.

45.2.1.27a.12 10GBASE-BR10-D ability (1.34.0)

When read as a one, bit 1.34.0 indicates that the PMA/PMD is able to operate as a 10GBASE-BR10-D PMA/PMD type. When read as a zero, bit 1.34.0 indicates that the PMA/PMD is not able to operate as a 10GBASE-BR10-D PMA/PMD type.

45.2.1.27b BiDi PMA/PMD extended ability 2 (Register 1.35)

The assignment of bits in the BiDi PMA/PMD extended ability 2 register is shown in Table 45–31b.

Table 45–31b—BiDi PMA/PMD extended ability 2 register bit definitions

Bit(s)	Name	Description	R/W[a]
1.35.15:6	Reserved	Value always 0	RO
1.35.5	50GBASE-BR40-U ability	1 = PMA/PMD is able to perform 50GBASE-BR40-U 0 = PMA/PMD is not able to perform 50GBASE-BR40-U	RO
1.35.4	50GBASE-BR40-D ability	1 = PMA/PMD is able to perform 50GBASE-BR40-D 0 = PMA/PMD is not able to perform 50GBASE-BR40-D	RO
1.35.3	50GBASE-BR20-U ability	1 = PMA/PMD is able to perform 50GBASE-BR20-U 0 = PMA/PMD is not able to perform 50GBASE-BR20-U	RO
1.35.2	50GBASE-BR20-D ability	1 = PMA/PMD is able to perform 50GBASE-BR20-D 0 = PMA/PMD is not able to perform 50GBASE-BR20-D	RO
1.35.1	50GBASE-BR10-U ability	1 = PMA/PMD is able to perform 50GBASE-BR10-U 0 = PMA/PMD is not able to perform 50GBASE-BR10-U	RO
1.35.0	50GBASE-BR10-D ability	1 = PMA/PMD is able to perform 50GBASE-BR10-D 0 = PMA/PMD is not able to perform 50GBASE-BR10-D	RO

[a]RO = Read only

45.2.1.27b.1 50GBASE-BR40-U ability (1.35.5)

When read as a one, bit 1.35.5 indicates that the PMA/PMD is able to operate as a 50GBASE-BR40-U PMA/PMD type. When read as a zero, bit 1.35.5 indicates that the PMA/PMD is not able to operate as a 50GBASE-BR40-U PMA/PMD type.

45.2.1.27b.2 50GBASE-BR40-D ability (1.35.4)

When read as a one, bit 1.35.4 indicates that the PMA/PMD is able to operate as a 50GBASE-BR40-D PMA/PMD type. When read as a zero, bit 1.35.4 indicates that the PMA/PMD is not able to operate as a 50GBASE-BR40-D PMA/PMD type.

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45.2.1.27b.3 50GBASE-BR20-U ability (1.35.3)

When read as a one, bit 1.35.3 indicates that the PMA/PMD is able to operate as a 50GBASE-BR20-U PMA/PMD type. When read as a zero, bit 1.35.3 indicates that the PMA/PMD is not able to operate as a 50GBASE-BR20-U PMA/PMD type.

45.2.1.27b.4 50GBASE-BR20-D ability (1.35.2)

When read as a one, bit 1.35.2 indicates that the PMA/PMD is able to operate as a 50GBASE-BR20-D PMA/PMD type. When read as a zero, bit 1.35.2 indicates that the PMA/PMD is not able to operate as a 50GBASE-BR20-D PMA/PMD type.

45.2.1.27b.5 50GBASE-BR10-U ability (1.35.1)

When read as a one, bit 1.35.1 indicates that the PMA/PMD is able to operate as a 50GBASE-BR10-U PMA/PMD type. When read as a zero, bit 1.35.1 indicates that the PMA/PMD is not able to operate as a 50GBASE-BR10-U PMA/PMD type.

45.2.1.27b.6 50GBASE-BR10-D ability (1.35.0)

When read as a one, bit 1.35.0 indicates that the PMA/PMD is able to operate as a 50GBASE-BR10-D PMA/PMD type. When read as a zero, bit 1.35.0 indicates that the PMA/PMD is not able to operate as a 50GBASE-BR10-D PMA/PMD type.

45.2.1.110 RS-FEC control register (Register 1.200)

Change the row for bit 1.200.2 in Table 45–88 as follows (unchanged rows not shown):

Table 45–88—RS-FEC control register bit definitions

Bit(s)	Name	Description	R/W[a]
1.200.2	~~25G~~ RS-FEC Enable	1 = ~~The 25GBASE-R~~Clause 108 Reed-Solomon FEC is enabled 0 = ~~The 25GBASE-R~~Clause 108 Reed-Solomon FEC is disabled	R/W

[a]R/W = Read/Write, RO = Read only

Change the title and content of 45.2.1.110.1 as follows:

45.2.1.110.1 ~~25G~~ RS-FEC enable (1.200.2)

Bit 1.200.2 enables the ~~25GBASE-R~~ Reed-Solomon FEC described in Clause 108. When set to a one, this bit enables the ~~25GBASE-R~~ Reed-Solomon FEC. When set to a zero, bit 1.200.2 disables the ~~25GBASE-R~~ Reed-Solomon FEC (see 108.6.3). Writes to bit 1.200.2 are ignored and reads return a one if the RS-FEC does not have the ability to disable the RS-FEC function.

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49. Physical Coding Sublayer (PCS) for 64B/66B, type 10GBASE-R

49.2 Physical Coding Sublayer (PCS)

49.2.2 Functions within the PCS

Change the second to fifth paragraphs of 49.2.2 as follows:

When communicating with the XGMII, the PCS uses a four octet-wide, synchronous data path, with packet delimiting being provided by transmit control signals (TXCn = 1) and receive control signals (RXCn = 1). When communicating with the PMA, ~~or~~ WIS, or FEC, the PCS uses a 16-bit wide, synchronous data path that conveys 16 encoded bits. Alignment to 64B/66B block is performed in the PCS. The WIS, ~~and~~ PMA, and FEC sublayers operate independent of block and packet boundaries. The PCS provides the functions necessary to map packets between the XGMII format and the PMA service interface format.

When the transmit channel is in normal mode, the PCS Transmit process continuously generates blocks based upon the TXD <31:0> and TXC <3:0> signals on the XGMII. The Gearbox function of the PCS Transmit process then packs the resulting bits into 16-bit transmit data-units. Transmit data-units are sent to the PMA, ~~or~~ WIS, or FEC service interface via the PMA_UNITDATA.request, ~~or~~ WIS_UNITDATA.request, or FEC_UNITDATA.request primitive, respectively. When the WIS is present, the PCS Transmit process also adapts between the XGMII and WIS data rates by deleting idle characters.

When the transmit channel is in test-pattern mode, a test pattern is packed into the transmit data-units that are sent to the PMA service interface via the PMA_UNITDATA.request primitive.

When the receive channel is in normal mode, the PCS Synchronization process continuously monitors PMA_SIGNAL.indication(SIGNAL_OK), ~~or~~ WIS_SIGNAL.indication(SIGNAL_OK), or FEC_SIGNAL.indication(SIGNAL_OK). When SIGNAL_OK indicates OK, then the PCS Synchronization process accepts data-units via the PMA_UNITDATA.indication primitive, ~~or~~ the WIS_UNITDATA.indication primitive~~,~~ or the FEC_UNITDATA.indication primitive. It attains block synchronization based on the 2-bit synchronization headers and conveys received blocks to the PCS Receive process. The PCS Synchronization process sets the sync_status flag to indicate whether the PCS has obtained synchronization.

49.2.13.2.2 Variables

Change the definition of the "signal_ok" variable in 49.2.13.2.2 as follows:

signal_ok
: Boolean variable that is set based on the most recently received value of PMA_SIGNAL.indication(SIGNAL_OK), ~~or~~ WIS_SIGNAL.indication(SIGNAL_OK), or FEC_SIGNAL.indication(SIGNAL_OK). It is true if the value was OK and false if the value was FAIL.

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56. Introduction to Ethernet for subscriber access networks

56.1 Overview

Change the second paragraph of 56.1 (as modified by IEEE Std 802.3ca-2020) splitting it into two paragraphs as follows:

In addition, a mechanism for network Operations, Administration, and Maintenance (OAM) is included to facilitate network operation and troubleshooting. ~~100BASE-LX10 extends the reach of 100BASE-X to achieve 10 km over conventional single-mode two-fiber cabling.~~

The relationships between these EFM elements and the ISO/IEC Open System Interconnection (OSI) reference model are shown in Figure 56–1 and Figure 56–1a for point-to-point topologies, Figure 56–2 for 1G-EPON topologies, Figure 56–3 for 10/10G-EPON topologies, Figure 56–4 for 10/1G-EPON topologies, Figure 56–5 for EPoC topologies, and Figure 56–6 for Nx25G-EPON topologies.

Insert new Figure 56–1a after Figure 56–1 as follows:

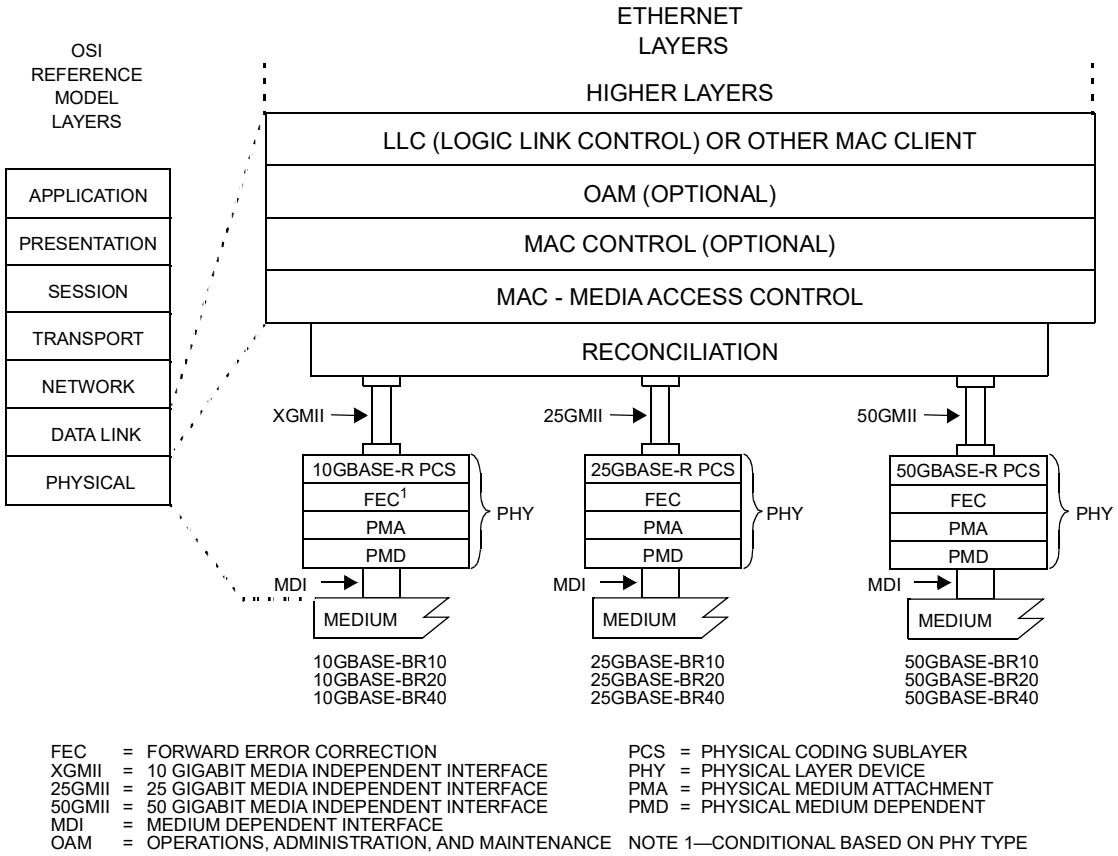

Figure 56–1a—Architectural positioning of EFM: higher rate P2P topologies

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Change 56.1.1 as follows. Note that footnotes 2 and 3 are deleted.

56.1.1 Summary of P2P sublayers

EFM P2P supports operation at several different bit rates, depending on the characteristics of the underlying medium. ~~In the case of point-to-point optical fiber media, bit rates of 100 Mb/s and 1000 Mb/s are supported, using the 100BASE-X and 1000BASE-X Physical Coding Sublayer (PCS) and Physical Medium Attachment (PMA) sublayers defined in 66.1 and 66.2, respectively. In the case of point-to-point copper, EFM supports a variety of bit rates, depending on the span and the signal-to-noise ratio (SNR) characteristics of the medium as described in Clause 61 through Clause 63. 2BASE-TL supports a nominal bit rate of 2 Mb/s at a nominal reach of 2700 meters.[2] 10PASS-TS supports a nominal bit rate of 10 Mb/s at a nominal reach of 750 meters.[3]~~

Insert new subclauses 56.1.1.1 and 56.1.1.2 at the end of 56.1.1 as follows:

56.1.1.1 P2P fiber media

The 100BASE-X Physical Coding Sublayer (PCS) and Physical Medium Attachment (PMA) sublayers are used to support a bit rate of 100 Mb/s as defined in 66.1. 100BASE-LX10 extends the reach of 100BASE-X to achieve 10 km over conventional single-mode two-fiber cabling.

The 1000BASE-X PCS and PMA sublayers are used to support a bit rate of 1000 Mb/s as defined in 66.2.

The 10GBASE-R PCS, RS-FEC, and PMA sublayers are used to support a bit rate of 10 Gb/s as defined in Clause 158.

The 25GBASE-R PCS, RS-FEC, and PMA sublayers are used to support a bit rate of 25 Gb/s as defined in Clause 159.

The 50GBASE-R PCS, RS-FEC, and PMA sublayers are used to support a bit rate of 50 Gb/s as defined in Clause 160.

56.1.1.2 P2P copper media

The P2P copper links support a variety of bit rates, depending on the span and the signal-to-noise ratio (SNR) characteristics of the medium as described in Clause 61 and Clause 63.

The 2BASE-TL P2P link supports a nominal bit rate of 2 Mb/s at a nominal reach of 2700 meters (see Annex 63B for a more detailed discussion of bit rates and reach).

The 10PASS-TS P2P link supports a nominal bit rate of 10 Mb/s at a nominal reach of 750 meters (see Annex 62B for a more detailed discussion of bit rates and reach).

56.1.2 Summary of P2MP sublayers

56.1.2.2 Reconciliation Sublayer (RS) and media independent interfaces

Change the first sentence of 56.1.2.2 as follows:

The Clause 22 RS and MII, Clause 35 RS and GMII, ~~and~~ Clause 46 RS and XGMII, Clause 106 RS and 25GMII, and Clause 132 RS and 50GMII are all employed for the same purpose in EFM, that being the interconnection between the MAC sublayer and the PHY sublayers.

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[2] ~~Refer to Annex 63B for a more detailed discussion of bit rates and reach.~~

[3] ~~Refer to Annex 62B for a more detailed discussion of bit rates and reach.~~

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56.1.3 Physical Layer signaling systems

Insert the following text below the second paragraph of 56.1.3:

EFM extends the family of 10GBASE-R Physical Layer signaling systems to include the following combinations of bidirectional PMDs defined in Clause 158:

- 10GBASE-BR10-D and 10GBASE-BR10-U
- 10GBASE-BR20-D and 10GBASE-BR20-U
- 10GBASE-BR40-D and 10GBASE-BR40-U

EFM extends the family of 25GBASE-R Physical Layer signaling systems to include the following combinations of bidirectional PMDs defined in Clause 159:

- 25GBASE-BR10-D and 25GBASE-BR10-U
- 25GBASE-BR20-D and 25GBASE-BR20-U
- 25GBASE-BR40-D and 25GBASE-BR40-U

EFM extends the family of 50GBASE-R Physical Layer signaling systems to include the following combinations of bidirectional PMDs defined in Clause 160:

- 50GBASE-BR10-D and 50GBASE-BR10-U
- 50GBASE-BR20-D and 50GBASE-BR20-U
- 50GBASE-BR40-D and 50GBASE-BR40-U

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Insert new rows into Table 56–1 and change table footnote a (as modified by IEEE Std 802.3ca-2020) after the row for "1000BASE-BX10-U" as follows (unchanged rows not shown):

Table 56–1—Summary of EFM Physical Layer signaling systems

Name	Location	Rate[a]	Nominal reach (km)	Medium	Clause
…					
10GBASE-BR10-D	OLT	10 Gb/s	10	One single-mode fiber	158
10GBASE-BR10-U	ONU				
10GBASE-BR20-D	OLT		20		
10GBASE-BR20-U	ONU				
10GBASE-BR40-D	OLT		40		
10GBASE-BR40-U	ONU				
25GBASE-BR10-D	OLT	25 Gb/s	10	One single-mode fiber	159
25GBASE-BR10-U	ONU				
25GBASE-BR20-D	OLT		20		
25GBASE-BR20-U	ONU				
25GBASE-BR40-D	OLT		40		
25GBASE-BR40-U	ONU				
50GBASE-BR10-D	OLT	50 Gb/s	10	One single-mode fiber	160
50GBASE-BR10-U	ONU				
50GBASE-BR20-D	OLT		20		
50GBASE-BR20-U	ONU				
50GBASE-BR40-D	OLT		40		
50GBASE-BR40-U	ONU				
…					

[a] For Physical Layer signaling systems the transmit rate is denoted with the abbreviation "(tx)" to the location; whereas, the receive rate is denoted with the abbreviation "(rx)".

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Change Table 56–2 as follows reformatting header rows to accommodate added columns:

Table 56–2—Nomenclature and clause correlation for P2P systems

Nomenclature	Clause																					
	57	78	58		59		61	62	63	66		49	51	158	107	108	109	159	133	134	135	160
	OAM	EEE	100BASE-LX10 PMD	100BASE-BX10 PMD	1000BASE-LX10 PMD	1000BASE-BX10 PMD	Cu PCS	10PASS-TS PMA & PMD	2BASE-TL PMA & PMD	100BASE-X PCS, PMA	1000BASE-X PCS, PMA	10GBASE-R PCS	10GBASE-R PMA	10GBASE-BRx PMD	25GBASE-R PCS	Reed-Solomon FEC	25GBASE-R PMA	25GBASE-BRx PMD	50GBASE-R PCS	50GBASE-R RS-FEC	50GBASE-R PMA	50GBASE-BRx PMD
2BASE-TL	O[a]						M		M													
10PASS-TS	O						M	M														
100BASE-LX10	O		M							M												
100BASE-BX10	O			M						M												
1000BASE-LX10	O				M						M											
1000BASE-BX10	O					M					M											
10GBASE-BR10	O											M	M	M								
10GBASE-BR20	O											M	M	M		M						
10GBASE-BR40	O											M	M	M								
25GBASE-BR10	O	O													M	M	M	M				
25GBASE-BR20	O	O													M	M	M	M				
25GBASE-BR40	O	O													M	M	M	M				
50GBASE-BR10	O	O																	M	M	M	M
50GBASE-BR20	O	O																	M	M	M	M
50GBASE-BR40	O	O																	M	M	M	M

[a]O = Optional, M = Mandatory

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