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ISO/IEC/IEEE 8802-3

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

Part 3: Standard for Ethernet

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

Partie 3: Norme pour Ethernet

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This fourth edition cancels and replaces the third edition (ISO/IEC/IEEE 8802-3:2021), which has been technically revised. It also incorporates the Amendments ISO/IEC/IEEE 8802-3:2021/Amd 2:2021, ISO/IEC/IEEE 8802-3:2021/Amd 3:2021, ISO/IEC/IEEE 8802-3:2021/Amd 4:2021, ISO/IEC/IEEE 8802-3:2021/Amd 5:2021, ISO/IEC/IEEE 8802-3:2021/Amd 6:2021, ISO/IEC/IEEE 8802-3:2021/Amd 7:2021, ISO/IEC/IEEE 8802-3:2021/Amd 8:2021, ISO/IEC/IEEE 8802-3:2021/Amd 9:2021, ISO/IEC/IEEE 8802-3:2021/Amd 10:2021, ISO/IEC/IEEE 8802-3:2021/Amd 11:2021, ISO/IEC/IEEE 8802-3:2021/Amd 12:2021, ISO/IEC/IEEE 8802-3:2021/Amd 13:2021, ISO/IEC/IEEE 8802-3:2021/Amd 14:2021, ISO/IEC/IEEE 8802-3:2021/Amd 1:2021.

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IEEE Std 802.3™-2022
(Revision of
IEEE Std 802.3-2018)

IEEE Standard for Ethernet

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 13 May 2022

IEEE SA Standards Board

Abstract: Ethernet local area network operation is specified for selected speeds of operation from 1 Mb/s to 400 Gb/s using a common media access control (MAC) specification and management information base (MIB). The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) MAC protocol specifies shared medium (half duplex) operation, as well as full duplex operation. Speed specific Media Independent Interfaces (MIIs) allow use of selected Physical Layer devices (PHYs) for operation over coaxial, twisted pair or fiber optic cables, or electrical backplanes. System considerations for multisegment shared access networks describe the use of Repeaters that are defined for operational speeds up to 1000 Mb/s. Local Area Network (LAN) operation is supported at all speeds. Other specified capabilities include: various PHY types for access networks, PHYs suitable for metropolitan area network applications, and the provision of power over selected twisted pair PHY types.

Keywords: 2.5 Gigabit Ethernet, 5 Gigabit Ethernet, 10 Gigabit Ethernet, 25 Gigabit Ethernet, 40 Gigabit Ethernet, 50 Gigabit Ethernet, 100 Gigabit Ethernet, 200 Gigabit Ethernet, 400 Gigabit Ethernet, AN, attachment unit interface, AUI, Auto-Negotiation, Backplane Ethernet, balanced cable, data processing, DTE Power via the MDI, EEE, Energy-Efficient Ethernet, EPoC, EPON, EPON protocol over coax, Ethernet, Ethernet in the first mile, Ethernet Passive Optical Network, express traffic, Fast Ethernet, FEC, forward error correction, Gigabit Ethernet, IEEE 802.3™, information exchange, isolation, LAN, local area network, management, MCRS, MDI, media independent interface, medium dependent interface, MIB, MII, MMF, MPCP, Multi-Channel Reconciliation Sublayer, multimode fiber, multipoint control protocol, P2MP, PCS, PD, PHY, physical coding sublayer, Physical Layer, Physical Layer Collision Avoidance, Physical Layer device, physical medium attachment, physical medium dependent, PLCA, PMA, PMD, PoDL, PoE, point to multipoint, Power over Data Lines, Power over Ethernet, Power Sourcing Equipment, Powered Device, PSE, reconciliation sublayer, repeater, RS, single-mode fiber, SMF, type field

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Historical participants

The following individuals participated in the IEEE 802.3 working group during various stages of the standard's development. Since the initial publication, many IEEE standards have added functionality or provided updates to material included in this standard. Included is a historical list of participants who have dedicated their valuable time, energy, and knowledge to the creation of this material:

IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
IEEE Std 802.3-1985, Original 10 Mb/s standard, MAC, PLS, AUI, 10BASE5	23 June 1983 (IEEE) 31 December 1984 (ANSI)	**Donald C. Loughry,** *Working Group Chair*
IEEE Std 802.3a-1988 (Clause 10), 10 Mb/s MAU 10BASE2	15 November 1985 (IEEE) 28 December 1987 (ANSI)	**Donald C. Loughry,** *Working Group Chair* **Alan Flatman,** *Task Force Chair*
IEEE Std 802.3b-1985 (Clause 11), 10 Mb/s Broadband MAU, 10BROAD36	19 September 1985 (IEEE) 28 February 1986 (ANSI)	**Donald C. Loughry,** *Working Group Chair* **Menachem Abraham,** *Task Force Chair*
IEEE Std 802.3c-1985 (9.1–9.8), 10 Mb/s Baseband Repeater	12 December 1985 (IEEE) 4 June 1986 (ANSI)	**Donald C. Loughry,** *Working Group Chair* **Geoffrey O. Thompson,** *Task Force Chair*
IEEE Std 802.3d-1987 (9.9), 10 Mb/s Fiber MAU, FOIRL	10 December 1987 (IEEE) 9 February 1989 (ANSI)	**Donald C. Loughry,** *Working Group Chair* **Steven Moustakas,** *Task Force Chair*
IEEE Std 802.3e-1987 (Clause 12), 1 Mb/s MAU and Hub 1BASE5	11 June 1987 (IEEE) 15 December 1987 (ANSI)	**Donald C. Loughry,** *Working Group Chair* **Robert Galin,** *Task Force Chair*
IEEE Std 802.3h-1990 (Clause 5), 10 Mb/s Layer Management, DTEs	28 September 1990 (IEEE) 11 March 1991 (ANSI)	**Donald C. Loughry,** *Working Group Chair* **Andy J. Luque,** *Task Force Chair*
IEEE Std 802.3i-1990 (Clauses 13 and 14), 10 Mb/s UTP MAU, 10 BASE-T	28 September 1990 (IEEE) 11 March 1991 (ANSI)	**Donald C. Loughry**, *Working Group Chair* **Patricia Thaler,** *Task Force Chair (initial)* **Richard Anderson,** *Task Force Chair (final)*

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IEEE Std 802.3j-1993 (Clauses 15–18), 10 Mb/s Fiber MAUs 10BASE-FP, 10BASE-FB, and 10BASE-FL	15 September 1993 (IEEE) 15 March 1994 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Keith Amundsen,** *Task Force Chair (initial)* **Frederick Scholl,** *Task Force Chair (final)* **Michael E. Lee,** *Technical Editor*
IEEE Std 802.3k-1993 (Clause 19), 10 Mb/s Layer Management, Repeaters	17 September 1992 (IEEE) 8 March 1993 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Joseph S. Skorupa,** *Task Force Chair* **Geoffrey O. Thompson,** *Vice Chair and Editor*
IEEE Std 802.3*l*-1992 (14.10), 10 Mb/s PICS Proforma 10BASE-T MAU	17 September 1992 (IEEE) 23 February 1993 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Mike Armstrong,** *Task Force Chair and Editor* **Paul Nikolich,** *Vice Chair* **William Randle,** *Editorial Coordinator*
IEEE Std 802.3m-1995, Maintenance 2	21 September 1995 (IEEE) 16 July 1996 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Gary Robinson,** *Maintenance Chair*
IEEE Std 802.3n-1995, Maintenance 3	21 September 1995 (IEEE) 4 April 1996 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Gary Robinson,** *Maintenance Chair*
IEEE Std 802.3p-1993 (Clause 20), Management, 10 Mb/s Integrated MAUs	17 June 1993 (IEEE) 4 January 1994 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Joseph S. Skorupa,** *Task Force Chair* **Geoffrey O. Thompson,** *Vice Chair and Editor*
IEEE Std 802.3q-1993 (Clause 5), 10 Mb/s Layer Management, GDMO Format	17 June 1993 (IEEE) 4 January 1994 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Joseph S. Skorupa,** *Task Force Chair* **Geoffrey O. Thompson,** *Vice Chair and Editor*
IEEE Std 802.3r-1996 (8.8), Type 10BASE5 Medium Attachment Unit PICS proforma	29 July 1996 (IEEE) 6 January 1997 (ANSI)	**Patricia Thaler,** *Working Group Chair* **Imre Juhász**, *Task Force Chair* **William Randle,** *Task Force Editor*
IEEE Std 802.3s-1995, Maintenance 4	21 September 1995 (IEEE) 8 April 1996 (ANSI)	**Geoffrey O. Thompson,** *Working Group Chair* **Gary Robinson,** *Maintenance Chair*
IEEE Std 802.3t-1995, 120 Ω informative annex to 10BASE-T	14 June 1995 (IEEE) 12 January 1996 (ANSI)	**Geoffrey O. Thompson,** *Working Group Chair* **Jacques Christ,** *Task Force Chair*
IEEE Std 802.3u-1995 (Clauses 21–30), Type 100BASE-T MAC parameters, Physical Layer, MAUs, and Repeater for 100 Mb/s Operation	14 June 1995 (IEEE) 4 April 1996 (ANSI)	**Geoffrey O. Thompson,** *Working Group Chair* **Peter Tarrant,** *Task Force Chair (Phase 1)* **Howard Frazier,** *Task Force Chair (Phase 2)* **Paul Sherer,** *Task Force Editor-in-Chief (Phase 1)* **Howard Johnson,** *Task Force Editor-in-Chief (Phase 2)* **Colin Mick,** *Task Force Comment Editor*
IEEE Std 802.3v-1995, 150 Ω informative annex to 10BASE-T	12 December 1995 (IEEE) 16 July 1996 (ANSI)	**Geoffrey O. Thompson,** *Working Group Chair* **Larry Nicholson,** *Task Force Chair*
IEEE Std 802.3x-1997 and IEEE Std 802.3y-1997 (Revisions to IEEE Std 802.3, Clauses 31 and 32), Full-Duplex Operation and Type 100BASE-T2	20 March 1997 (IEEE) 5 September 1997 (ANSI)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Rich Seifert,** *Task Force Chair and Editor (802.3x)* **J. Scott Carter,** *Task Force Chair (802.3y)* **Colin Mick**, *Task Force Editor (802.3y)*
IEEE Std 802.3z-1998 (Clauses 34–39, 41–42), Type 1000BASE-X MAC Parameters, Physical Layer, Repeater, and Management Parameters for 1000 Mb/s Operation	25 June 1998 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Howard M. Frazier, Jr.,** *Task Force Chair* **Howard W. Johnson,** *Task Force Editor*
IEEE Std 802.3aa-1998, Maintenance 5	25 June 1998 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **Colin Mick**, *Task Force Editor*

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IEEE Std 802.3ab-1999 (Clause 40), Physical Layer Parameters and Specifications for 1000 Mb/s Operation Over 4 Pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T	26 June 1999 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary* **George Eisler**, *Task Force Chair* **Colin Mick**, *Task Force Editor*
IEEE Std 802.3ac-1998, Frame Extensions for Virtual Bridged Local Area Network (VLAN) Tagging on IEEE 802.3 Networks	16 September 1998 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Andy J. Luque,** *Working Group Secretary* **Ian Crayford,** *Task Force Chair* **Rich Seifert,** *Task Force Editor*
IEEE Std 802.3ad-2000 (Clause 43), Aggregation of Multiple Link Segments	30 March 2000 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary* **Steven Haddock,** *Task Force Chair* **Tony Jeffree,** *Task Force Co-Editor* **Rich Seifert,** *Task Force CoEditor*
IEEE Std 802.3-2002 (IEEE 802.3ag, Maintenance 6, Revision of the base), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and Physical Layer specifications	14 January 2002 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary*
IEEE Std 802.3ae-2002, (Clauses 44–53) Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation	13 June 2002 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary* **R. Jonathan Thatcher,** *Task Force Chair* **Stephen Haddock,** *Task Force Vice Chair* **Bradley J. Booth,** *Task Force Editor* **Lacreshia Laningham,** *Task Force Assistant Editor* **Benjamin Brown,** *Logic Track Chair* **Walter Thirion,** *Optical Track Chair*
IEEE Std 802.3af-2003, (Clause 33) Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)	12 June 2003 (IEEE)	**Geoffrey O. Thompson,** *Working Group Chair (Phase 1)* **Robert M. Grow,** *Working Group Chair (Phase 2)* **David J. Law,** *Working Group Vice Chair* **Robert M. Grow,** *Working Group Secretary (Phase 1)* **Steven B. Carlson,** *Working Group Secretary (Phase 2)* **Steven B. Carlson,** *Task Force Chair* **Michael S. McCormack,** *Task Force Editor (Phase 1)* **John J. Jetzt,** *Task Force Editor (Phase 2)* **Chad M. Jones,** *Task Force Comment Editor*
IEEE Std 802.3ah-2004, Media Access Control Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks	6 April 2005 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Steven B. Carlson,** *Working Group Secretary* **Howard Frazier,** *Task Force Chair* **Wael W. Diab,** *Task Force Editor-in-Chief* **Hugh Barrass,** *Task Force Vice-Chair* **Scott Simon,** *Task Force Recording Secretary* **Behrooz Rezvani,** *Task Force Executive Secretary*
IEEE Std 802.3aj-2003, Maintenance 7	11 September 2003 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Chair* **Steven B. Carlson,** *Working Group Secretary* **Catherine K. N. Berger,** *Task Force Editor*
IEEE Std 802.3ak-2004, Physical Layer and Management Parameters for 10Gb/s Operation, Type 10GBASE-CX4	9 February 2004 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Steven B. Carlson,** *Working Group Secretary* **Daniel J. Dove,** *Task Force Chair* **Howard A. Baumer,** *Task Force Editor*

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IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
IEEE Std 802.3-2005 (IEEE 802.3REVam, Revision of the base), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and Physical Layer specifications	9 June 2005 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael W. Diab,** *Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Piers Dawe,** *Review Editor*
IEEE Std 802.3an-2006, Physical Layer and Management Parameter for 10 Gb/s Operation, Type 10GBASE-T	8 June 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Task Force Chair* **Sanjay Kasturia,** *Task Force Editor-in Chief* **George Eisler,** *Task Force Recording Secretary*
IEEE Std 802.3ap-2007, Ethernet Operation over Electrical Backplanes	22 March 2007 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice-Chair* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer* **Adam Healey,** *Task Force Chair* **John D'Ambrosia,** *Task Force Secretary* **Schelto vanDoorn,** *Task Force Editor-in-Chief (Phase 1)* **Ilango S. Ganga,** *Task Force Editor-in-Chief (Phase 2)*
IEEE Std 802.3aq-2006, Physical Layer and Management Parameters for 10 Gb/s Operation, Type 10GBASE-LRM	15 September 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **David G. Cunningham,** *Task Force Chair* **Nick Weiner,** *Task Force Editor* **Piers Dawe,** *Task Force Contributing Editor*
IEEE Std 802.3as-2006, Frame format extensions	15 September 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Kevin Q. Daines,** *Task Force Chair* **Glenn W. Parsons,** *Task Force Editor*
IEEE Std 802.3-2005/Cor 1-2006 (IEEE 802.3au), DTE Power via MDI Isolation corrigendum	8 June 2006 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Editor* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary*
IEEE Std 802.3-2005/Cor 2-2007 (IEEE 802.3aw), 10GBASE-T corrigendum	7 June 2007 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Editor* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3-2008 (IEEE 802.3ay), Maintenance #9 (Revision of the base), Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and Physical Layer specifications	26 September 2008 (IEEE)	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Editor* **Wael William Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3at-2009 Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements	11 September 2009 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer* **Mike McCormack,** *Task Force Chair* **D. Matthew Landry,** *Task Force Chief Editor* **Chad Jones,** *Task Force Comment Editor*

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IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
IEEE Std 802.3av-2009 Physical Layer Specifications and Management Parameters for 10 Gb/s Passive Optical Networks	11 September 2009 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Bradley Booth,** *Working Group Treasurer* **Glen Kramer,** *Task Force Chair* **Duane Remein,** *Task Force Chief Editor* **Marek Hajduczenia,** *Task Force Assistant Editor*
IEEE Std 802.3az-2010 Media Access Control Parameters, Physical Layers, and Management Parameters for Energy-Efficient Ethernet	30 September 2010 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer* **Michael Bennett,** *Task Force Chair* **Sanjay Kasturia,** *Task Force Editor-in-Chief*
IEEE Std 802.3ba Media Access Control Parameters, Physical Layers, and Management Parameters for 40 Gb/s and 100 Gb/s Operation	17 June 2010 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair* **Ilango S. Ganga,** *Task Force Editor-in-Chief*
IEEE Std 802.3-2008/Cor 1-2009 (IEEE 802.3bb) Pause Reaction Delay Corrigendum.	9 December 2009 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3bc-2009 Ethernet Organizationally Specific Type, Length, Value (TLVs)	11 September 2009 (IEEE)	**David J. Law,** *Working Group Chair and Task Force Editor* **Wael W. Diab,** *Working Group Vice Chair, Task Force Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3bd-2011 MAC Control Frame for Priority-based Flow Control	16 June 2011 (IEEE)	**Tony Jeffree,** *IEEE 802.1 Working Group Chair* **Paul Congdon,** *IEEE 802.1 Working Group Vice Chair* **David J. Law,** *IEEE 802.3 Working Group Chair* **Wael W. Diab,** *IEEE 802.3 Working Group Vice Chair* **Pat Thaler,** *Data Center Bridging Task Group Chair*
IEEE Std 802.3bf-2011 Media Access Control (MAC) Service Interface and Management Parameters to Support Time Synchronization Protocols	16 May 2011 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Steven B. Carlson,** *Task Force Chair* **Marek Hajduczenia,** *Task Force Editor-in-Chief*
IEEE Std 802.3bg-2011 Physical Layer and Management Parameters for Serial 40 Gb/s Ethernet Operation Over Single-Mode Fiber	31 March 2011 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell,** *Task Force Chair* **Pete Anslow,** *Task Force Editor-in-Chief*
IEEE Std 802.3-2012 (IEEE 802.3ah), Maintenance #10 (Revision of the base), Standard for Ethernet	28 December 2012 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair, Task Force Chair and Editor-in-Chief* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasure*
IEEE Std 802.3bk-2013 Physical Layer Specifications and Management Parameters for Extended Ethernet Passive Optical Networks	23 August 2013 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Marek Hajduczenia,** *Task Force Chair* **Susumu Nishihara,** *Task Force Editor-in-Chief*

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IEEE Std 802.3bj-2014 Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables	12 June 2014 (IEEE)	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair (initial)* **Adam Healey,** *Working Group Secretary, (initial), Task Force Editor-in-Chief (initial), Working Group Vice-Chair (final), Task Force Chair (final)* **Pete Anslow,** *Working Group Secretary (final)* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair (initial)* **Matthew Brown,** *Task Force Editor-in-Chief (final)*
IEEE Std 802.3bm-2015 Physical Layer Specifications and Management Parameters for 40 Gb/s and 100 Gb/s Operation Over Fiber Optic Cables	16 February 2015 (IEEE)	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Dan Dove,** *Task Force Chair* **Kapil Shrikhande,** *Task Force Vice-Chair*
IEEE Std 802.3-2015 (IEEE 802.3bx), Maintenance #11 (Revision of the base), Standard for Ethernet	3 September 2015	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair, Task Force Chair, and Task Force Editor-in-Chief* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3bw-2015 Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)	26 October 2015	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary and Task Force Chair, Phase 2* **Valerie Maguire,** *Working Group Treasurer* **Thomas Hogenmüller**, *Task Force Chair, Phase 1* **Mehmet Tazebay**, *Task Force Vice-Chair* **Curtis Donahue**, *Task Force Editor-in-Chief*
IEEE Std 802.3by-2016 Media Access Control Parameters, Physical Layers, and Management Parameters for 25 Gb/s Operation	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell**, *Task Force Chair* **Matthew Brown**, *Task Force Editor-in-Chief*
IEEE Std 802.3bq-2016 Physical Layers and Management Parameters for 25 Gb/s and 40 Gb/s Operation, Types 25GBASE-T and 40GBASE-T	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **David Chalupsky**, *Task Force Chair* **George Zimmerman**, *Task Force Editor-in-Chief*
IEEE Std 802.3bp-2016 Physical Layer Specifications and Management Parameters for 1 Gb/s Operation over a Single Twisted-Pair Copper Cable	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary and Task Force Chair* **Valerie Maguire,** *Working Group Treasurer* **Marek Hajduczenia**, *Task Force Editor-in-Chief*
IEEE Std 802.3br-2016 Specification and Management Parameters for Interspersing Express Traffic	30 June 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Ludwig Winkel**, *Task Force Chair* **Patricia Thaler**, *Task Force Editor-in-Chief*

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IEEE Std 802.3bn-2016 Physical Layer Specifications and Management Parameters for Ethernet Passive Optical Networks Protocol over Coax	22 September 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Laubach**, *Task Force Chair* **Duane Remein**, *Task Force Editor-in-Chief*
IEEE Std 802.3bz-2016 Media Access Control Parameters, Physical Layers, and Management Parameters for 2.5 Gb/s and 5 Gb/s Operation, Types 2.5GBASE-T and 5GBASE-T	22 September 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **David Chalupsky**, *Task Force Chair* **George Zimmerman**, *Task Force Editor-in-Chief*
IEEE Std 802.3bu-2016 Physical Layer and Management Parameters for Power over Data Lines (PoDL) of Single Balanced Twisted-Pair Ethernet	7 December 2016	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Dave Dwelley,** *Task Force Chair, Phase 1* **Dan Dove,** *Task Force Chair, Phase 2* **Andy Gardner**, *Task Force Editor-in-Chief*
IEEE Std 802.3bv-2017 Physical Layer Specifications and Management Parameters for 1000 Mb/s Operation Over Plastic Optical Fiber	14 February 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Robert M. Grow,** *Task Force Chair* **Rubén Pérez-Aranda**, *Task Force Editor-in-Chief*
IEEE Std 802.3-2015/Cor 1-2017 (IEEE Std 802.3ce) Multilane Timestamping	23 March 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair, Task Force Chair, and Task Force Editor-in-Chief* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3bs-2017 Media Access Control Parameters, Physical Layers, and Management Parameters for 200 Gb/s and 400 Gb/s Operation	6 December 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair*
IEEE Std 802.3cc-2017 Physical Layer and Management Parameters for Serial 25 Gb/s Ethernet Operation Over Single-Mode Fiber	6 December 2017	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **David Lewis,** *Task Force Chair* **Kohichi R. Tamura,** *Task Force Editor-in-Chief*
IEEE Std 802.3cb-2018 Physical Layer Specifications and Management Parameters for 2.5 Gb/s and 5 Gb/s Operation over Backplane	27 September 2018	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Yong Kim,** *Task Force Chair, Phase 1* **Daniel F. Smith,** *Task Force Chair, Phase 2* **William Lo,** *Task Force Editor-in-Chief, Phase 1* **Daniel F. Smith,** *Task Force Editor-in-Chief, Phase 2*

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IEEE Std 802.3bt-2018 Physical Layer and Management Parameters for Power over Ethernet over 4 pairs	27 September 2018	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Chad Jones,** *Task Force Chair* **Koussalya Balasubramanian,** *Task Force Editor-in-Chief, Phase 1* **Lennart Yseboodt,** *Task Force Editor-in-Chief, Phase 2*
IEEE Std 802.3cd-2018 Media Access Control Parameters for 50 Gb/s and Physical Layers and Management Parameters for 50 Gb/s, 100 Gb/s, and 200 Gb/s Operation	5 December 2018	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell,** *Task Force Chair* **Matt Brown,** *Task Force Editor-in-Chief*
IEEE Std 802.3cn-2019 Physical Layers and Management Parameters for 50 Gb/s, 200 Gb/s, and 400 Gb/s Operation over Single-Mode Fiber	7 November 2019	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair*
IEEE Std 802.3cg-2019 Physical Layers Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors	7 November 2019	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **George Zimmerman,** *Task Force Chair* **Valerie Maguire,** *Task Force Editor-in-Chief*
IEEE Std 802.3cq-2020 Maintenance #13: Power over Ethernet over 2 pairs	30 January 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Chad Jones,** *Task Force Chair* **Lennart Yseboodt,** *Task Force Editor-in-Chief*
IEEE Std 802.3cm-2020 Physical Layer and Management Parameters for 400 Gb/s over Multimode Fiber	30 January 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Robert Lingle, Jr.,** *Task Force Chair* **Jonathan P. King,** *Task Force Editor-in-Chief, Phase 1* **Jonathan D. Ingham,** *Task Force Editor-in-Chief, Phase 2*
IEEE Std 802.3ch-2020 Physical Layer Specifications and Management Parameters for 2.5 Gb/s, 5 Gb/s, and 10 Gb/s Automotive Electrical Ethernet	4 June 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary, Phase 1* **Jon Lewis,** *Working Group Secretary, Phase 2* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Steven B. Carlson,** *Task Force Chair* **Natalie Wienckowski,** *Task Force Editor-in-Chief*
IEEE Std 802.3ca-2020 Physical Layer Specifications and Management Parameters for 25 Gb/s and 50 Gb/s Passive Optical Networks	4 June 2020	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Pete Anslow,** *Working Group Secretary, Phase 1* **Jon Lewis,** *Working Group Secretary, Phase 2* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Curtis Knittle,** *Task Force Chair* **Glen Kramer,** *Task Force Vice-Chair* **Marek Hajduczenia,** *Task Force Editor-in-Chief*

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IEEE Std 802.3cr-2021 Maintenance #14: Isolation	9 February 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary, Task Force Chair, and Task Force Editor* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3cu-2021 Physical Layers and Management Parameters for 100 Gb/s and 400 Gb/s Operation over Single-Mode Fiber at 100 Gb/s per Wavelength	9 February 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Mark Nowell,** *Task Force Chair* **Gary Nicholl,** *Editor-in-Chief*
IEEE Std 802.3cv-2021 Maintenance #15: Power over Ethernet	9 May 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary and Task Force Editor-in-Chief* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Chad Jones,** *Task Force Chair*
IEEE Std 802.3ct-2021 Physical Layers and Management Parameters for 100 Gb/s Operation over DWDM Systems	16 June 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **John D'Ambrosia,** *Task Force Chair* **Tom Issenhuth,** *Task Force Editor-in-Chief*
IEEE Std 802.3cp-2021 Bidirectional 10 Gb/s, 25 Gb/s, and 50 Gb/s Optical Access PHYs	16 June 2021	**David J. Law,** *Working Group Chair* **Adam Healey,** *Working Group Vice-Chair* **Jon Lewis,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer* **Frank Effenberger,** *Task Force Chair* **Duane Remein,** *Task Force Editor-in-Chief, Phase 1* **Yuanqiu Luo,** *Task Force Editor-in-Chief, Phase 2*

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Caldwell, Donald
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Chabot, Craig
Chacon Simon, Geoffrey
Chadha, Mandeep
Chalupsky, David
Champion, Bruce
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Introduction

This introduction is not part of IEEE Std 802.3-2022, IEEE Standard for Ethernet.

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. “Local Area Networks: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications” 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 and the ability to use an EtherType to specify the MAC client protocol were added in 1997. The title was changed to Standard for Ethernet with the 2012 Revision.

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 802.3-2022 and are not maintained as separate documents.

At the date of IEEE Std 802.3-2022 publication, IEEE Std 802.3 was composed of the following documents:

IEEE Std 802.3-2022

Section One—Includes Clause 1 through Clause 20 and Annex A through Annex K 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 33A. 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.

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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 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 as 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 140 and Annex 119A through Annex 136D. Clause 116 through Clause 124 and associated annexes include general information on 200 Gb/s and 400 Gb/s operation as well as 200 Gb/s and 400 Gb/s Physical Layer specifications. Clause 125 includes general information on 2.5 Gb/s and 5 Gb/s operation. Clause 126 through Clause 130 and associated annexes include 2.5 Gb/s and 5 Gb/s Physical Layer specifications. Clause 131 provides general information on 50 Gb/s operation. Clause 132 through Clause 140 and associated annexes include 50 Gb/s Physical Layer specifications and additional 100 Gb/s, 200 Gb/s, and 400 Gb/s Physical Layer specifications.

Section Nine—Includes Clause 141 through Clause 160 and Annex 142A through Annex 154A. Clause 141 through Clause 144 and associated annexes specify symmetric and asymmetric operation of Ethernet passive optical networks over multiple 25 Gb/s channels. Clause 145 and associated annexes specify increased power delivery using all four pairs in the structured wiring plant. Clause 146 through Clause 149 and associated annexes specify Physical Layers for 10 Mb/s, 2.5 Gb/s, 5 Gb/s, and 10 Gb/s operation over a single balanced pair of conductors. Clause 150 and Clause 151 include additional 400 Gb/s Physical Layer specifications. Clause 153 and Clause 154 specify 100 Gb/s operation over DWDM channels. Clause 157 through Clause 160 include 10 Gb/s, 25 Gb/s, and 50 Gb/s bidirectional Physical Layer specifications.

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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Acknowledgments

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IEEE Standard for Ethernet

1. Introduction

1.1 Overview

This is an international standard for Local and Metropolitan Area Networks (LANs and MANs), employing CSMA/CD as the shared media access method and the IEEE 802.3 (Ethernet) protocol and frame format for data communication. This international standard is intended to encompass several media types and techniques for a variety of MAC data rates as shown in Figure 1–1 and in 4.4.2.

1.1.1 Scope

This standard defines Ethernet local area, access and metropolitan area networks. Ethernet is specified at selected speeds of operation; and uses a common media access control (MAC) specification and management information base (MIB). The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) MAC protocol specifies shared medium (half duplex) operation, as well as full duplex operation. Speed specific Media Independent Interfaces (MIIs) provide an architectural and optional implementation interface to selected Physical Layer devices (PHYs). The Physical Layer encodes frames for transmission and decodes received frames with the modulation specified for the speed of operation, transmission medium and supported link length. Other specified capabilities include: control and management protocols, and the provision of power over selected twisted pair PHY types.

1.1.2 Basic concepts

This standard provides for two distinct modes of operation: half duplex and full duplex. A given IEEE 802.3 instantiation operates in either half or full duplex mode at any one time. The term “CSMA/CD MAC” is used throughout this standard synonymously with “802.3 MAC,” and may represent an instance of either a half duplex or full duplex mode data terminal equipment (DTE), even though full duplex mode DTEs do not implement the CSMA/CD algorithms traditionally used to arbitrate access to shared-media LANs.

1.1.2.1 Half duplex operation

In half duplex mode, the CSMA/CD media access method is the means by which two or more stations share a common transmission medium. To transmit, a station waits (defers) for a quiet period on the medium (that is, no other station is transmitting) and then sends the intended message in bit-serial form. If, after initiating a transmission, the message collides with that of another station, then each transmitting station intentionally transmits for an additional predefined period to ensure propagation of the collision throughout the system. The station remains silent for a random amount of time (backoff) before attempting to transmit again. Each aspect of this access method process is specified in detail in subsequent clauses of this standard.

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Half duplex operation can be used with certain media types and configurations as defined by this standard. For allowable configurations, see 4.4.2.

1.1.2.2 Full duplex operation

Full duplex operation allows simultaneous communication between a pair of stations using point-to-point media (dedicated channel). Full duplex operation does not require that transmitters defer, nor do they monitor or react to receive activity, as there is no contention for a shared medium in this mode. Full duplex mode can only be used when all of the following are true:

a) The physical medium is capable of supporting simultaneous transmission and reception without interference.
b) There are exactly two stations connected with a full duplex point-to-point link. Since there is no contention for use of a shared medium, the multiple access (i.e., CSMA/CD) algorithms are unnecessary.
c) Both stations on the LAN are capable of, and have been configured to use, full duplex operation.

The most common configuration envisioned for full duplex operation consists of a central bridge (also known as a switch) with a dedicated LAN connecting each bridge port to a single device. Repeaters as defined in this standard are outside the scope of full duplex operation.

Full duplex operation constitutes a proper subset of the MAC functionality required for half duplex operation.

1.1.3 Architectural perspectives

There are two important ways to view network design corresponding to the following:

a) *Architecture.* Emphasizing the logical divisions of the system and how they fit together.
b) *Implementation.* Emphasizing actual components, their packaging, and interconnection.

This standard is organized along architectural lines, emphasizing the large-scale separation of the system into two parts: the Media Access Control (MAC) sublayer of the Data Link Layer and the Physical Layer. These layers are intended to correspond closely to the lowest layers of the ISO/IEC Model for Open Systems Interconnection (see Figure 1–1). (See ISO/IEC 7498-1:1994.[6]) The Logical Link Control (LLC) sublayer, or other MAC client, and MAC sublayer together encompass the functions intended for the Data Link Layer as defined in the OSI model.

1.1.3.1 Architectural rationale

An architectural organization of the standard has two main advantages:

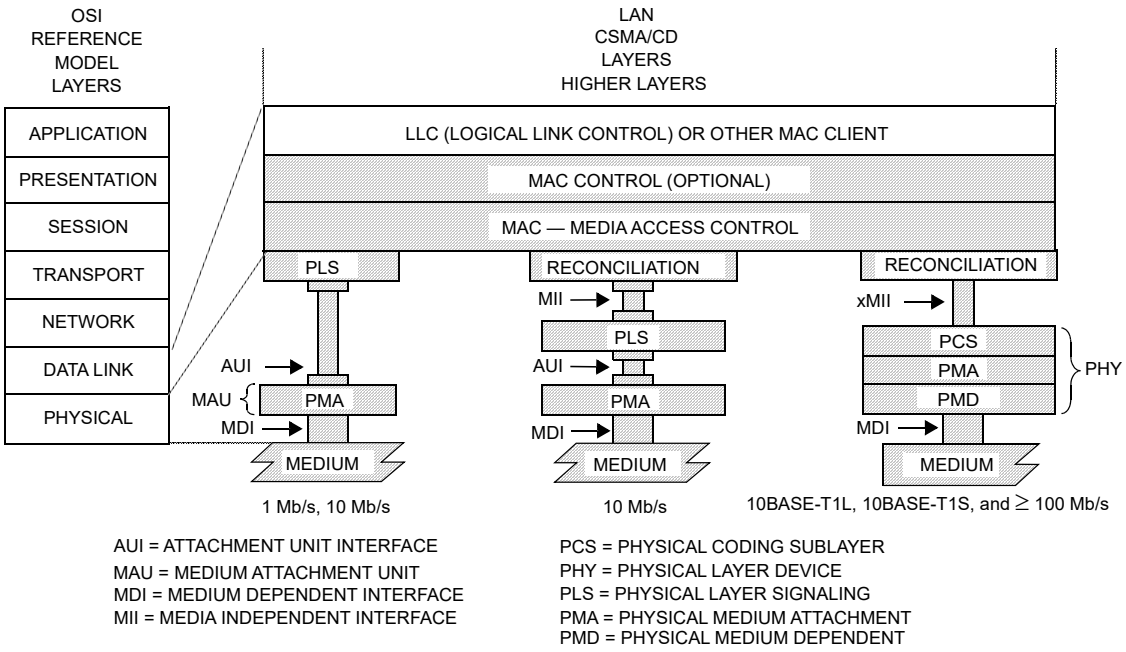
a) *Clarity.* A clean overall division of the design along architectural lines makes the standard clearer.
b) *Flexibility.* Segregation of medium-dependent aspects in the Physical Layer allows the LLC and MAC or equivalent sublayers to apply to a family of transmission media.

Partitioning the Data Link Layer allows various media access methods within the family of LAN standards.

The architectural model is based on a set of interfaces that may be different from those emphasized in implementations. One critical aspect of the design, however, shall be addressed largely in terms of the implementation interfaces: compatibility.

[6]For information about references, see 1.3.

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NOTE—In this figure, the xMII is used as a generic term for the Media Independent Interfaces for implementations of 10BASE-T1L, 10BASE-T1S, and 100 Mb/s and above. For example: for 100 Mb/s implementations this interface is called MII; for 1 Gb/s implementations it is called GMII; for 10 Gb/s implementations it is called XGMII; etc.

Figure 1–1—IEEE 802.3 standard relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model

1.1.3.2 Compatibility interfaces

The following important compatibility interfaces are defined within what is architecturally the Physical Layer.

a) *Medium Dependent Interfaces (MDI).* To communicate in a compatible manner, all stations shall adhere rigidly to the exact specification of physical media signals defined in the appropriate clauses in this standard, and to the procedures that define correct behavior of a station. The medium-independent aspects of the LLC sublayer and the MAC sublayer or equivalent should not be taken as detracting from this point; communication in an Ethernet Local Area Network requires complete compatibility at the Physical Medium interface (that is, the physical cable interface).

b) *Attachment Unit Interface (AUI).* Some DTEs are located some distance from their connection to the physical cable. A small amount of circuitry will exist in the Medium Attachment Unit (MAU) directly adjacent to the physical cable, while the majority of the hardware and all of the software will be placed within the DTE. The AUI is defined as a second compatibility interface. While conformance with this interface is not strictly necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing MAUs and DTEs. The AUI may be optional or not specified for some implementations of this standard that are expected to be connected directly to the medium and so do not use a separate MAU or its interconnecting AUI cable. The PLS and PMA are then part of a single unit, and no explicit AUI implementation is required.

c) *Media Independent Interface (MII).* It is anticipated that some DTEs will be connected to a remote PHY, and/or to different medium dependent PHYs. The MII is defined as a third compatibility interface. While conformance with implementation of this interface is not strictly necessary to ensure

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communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs. The MII is optional.

d) *Gigabit Media Independent Interface (GMII).* The GMII is designed to connect a 1 Gb/s capable MAC or repeater unit to a 1 Gb/s PHY. While conformance with implementation of this interface is not strictly necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 1 Gb/s speeds. The GMII is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the GMII. The GMII is optional.

e) *Ten-bit Interface (TBI).* The TBI is provided by the 1000BASE-X PMA sublayer as a physical instantiation of the PMA service interface. The TBI is recommended for 1000BASE-X systems, since it provides a convenient partition between the high-frequency circuitry associated with the PMA sublayer and the logic functions associated with the PCS and MAC sublayers. The TBI is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the TBI. The TBI is optional.

f) *10 Gigabit Media Independent Interface (XGMII).* The XGMII is designed to connect a 2.5 Gb/s, 5 Gb/s, or 10 Gb/s capable MAC to a PHY of the same rate. While conformance with implementation of this interface is not necessary to ensure communication, it allows maximum flexibility in intermixing PHYs and DTEs at 2.5 Gb/s, 5 Gb/s, and 10 Gb/s speeds. The XGMII is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the XGMII. The XGMII is optional.

g) *10 Gigabit Attachment Unit Interface (XAUI).* The XAUI is designed to extend the connection between a 10 Gb/s capable MAC and a 10 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 10 Gb/s speeds. The XAUI is intended for use as a chip-to-chip interface. No mechanical connector is specified for use with the XAUI. The XAUI is optional.

h) *10 Gigabit Sixteen-Bit Interface (XSBI).* The XSBI is provided as a physical instantiation of the PMA service interface for 10GBASE-R and 10GBASE-W PHYs. While conformance with implementation of this interface is not necessary to ensure communication, it provides a convenient partition between the high-frequency circuitry associated with the PMA sublayer and the logic functions associated with the PCS and MAC sublayers. No mechanical connector is specified for use with the XSBI. The XSBI is optional.

i) *25 Gigabit Media Independent Interface (25GMII).* The 25GMII is designed to connect a 25 Gb/s capable MAC to a 25 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 25 Gb/s speeds. The 25GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 25GMII. The 25GMII is optional.

j) *25 Gigabit Attachment Unit Interface (25GAUI).* The 25GAUI is a physical instantiation of the PMA service interface to extend the connection between 25 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 25 Gb/s speeds. The 25GAUI is intended for use as a chip-to-chip or a chip-to-module interface. No mechanical connector is specified for use with the 25GAUI. The 25GAUI is optional.

k) *40 Gb/s Media Independent Interface (XLGMII).* The XLGMII is designed to connect a 40 Gb/s capable MAC to a 40 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 40 Gb/s speeds. The XLGMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the XLGMII. The XLGMII is optional.

l) *40 Gb/s Attachment Unit Interface (XLAUI).* The XLAUI is a physical instantiation of the PMA service interface to extend the connection between 40 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 40 Gb/s speeds. The XLAUI is

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intended for use as a chip-to-chip or a chip-to-module interface. No mechanical connector is specified for use with the XLAUI. The XLAUI is optional.

m) *40 Gb/s Parallel Physical Interface (XLPPI)*. The XLPPI is provided as a physical instantiation of the PMD service interface for 40GBASE-SR4 and 40GBASE-LR4 PMDs. The XLPPI has four lanes. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in connecting the 40GBASE-SR4 or 40GBASE-LR4 PMDs. The XLPPI is intended for use as a chip-to-module interface. No mechanical connector is specified for use with the XLPPI. The XLPPI is optional.

n) *50 Gb/s Media Independent Interface (50GMII).* The 50GMII is designed to connect a 50 Gb/s capable MAC to a 50 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 50 Gb/s speeds. The 50GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 50GMII. The 50GMII is optional.

o) *50 Gb/s Attachment Unit Interface (LAUI-2/50GAUI-n).* The LAUI-2/50GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 50 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 50 Gb/s speeds. The LAUI-2/50GAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Two widths of 50GAUI-n are defined: a two-lane version (50GAUI-2) in Annex 135D and Annex 135E, and a one-lane version (50GAUI-1) in Annex 135F and Annex 135G. No mechanical connector is specified for use with the LAUI-2/50GAUI-n. The LAUI-2/50GAUI-n is optional.

p) *100 Gb/s Media Independent Interface (CGMII).* The CGMII is designed to connect a 100 Gb/s capable MAC to a 100 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 100 Gb/s speeds. The CGMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the CGMII. The CGMII is optional.

q) *100 Gb/s Attachment Unit Interface (CAUI-n/100GAUI-n).* The CAUI-n/100GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 100 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 100 Gb/s speeds. The CAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Three widths of CAUI-n are defined: a ten-lane version (CAUI-10) in Annex 83A and Annex 83B, a four-lane version (CAUI-4/100GAUI-4) in Annex 83D, Annex 83E, Annex 135D, and Annex 135E, and a two-lane version (100GAUI-2) in Annex 135F and Annex 135G. No mechanical connector is specified for use with the CAUI-n/100GAUI-n. The CAUI-n/100GAUI-n is optional.

r) *100 Gb/s Parallel Physical Interface (CPPI)*. The CPPI is provided as a physical instantiation of the PMD service interface for 100GBASE-SR10 PMDs. The CPPI has ten lanes. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in connecting the 100GBASE-SR10 PMDs. The CPPI is intended for use as a chip-to-module interface. No mechanical connector is specified for use with the CPPI. The CPPI is optional.

s) *200 Gb/s Media Independent Interface (200GMII).* The 200GMII is designed to connect a 200 Gb/s capable MAC to a 200 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 200 Gb/s speeds. The 200GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 200GMII. The 200GMII is optional.

t) *200 Gb/s Attachment Unit Interface (200GAUI-n).* The 200GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 200 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 200 Gb/s speeds. The 200GAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Two widths of 200GAUI-n are defined: an eight-lane version (200GAUI-8) in Annex 120B and

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Annex 120C, and a four-lane version (200GAUI-4) in Annex 120D and Annex 120E. No mechanical connector is specified for use with the 200GAUI-n. The 200GAUI-n is optional.

u) *400 Gb/s Media Independent Interface (400GMII).* The 400GMII is designed to connect a 400 Gb/s capable MAC to a 400 Gb/s PHY. While conformance with implementation of this interface is not necessary to ensure communication, it allows flexibility in intermixing PHYs and DTEs at 400 Gb/s speeds. The 400GMII is a logical interconnection intended for use as an intra-chip interface. No mechanical connector is specified for use with the 400GMII. The 400GMII is optional.

v) *400 Gb/s Attachment Unit Interface (400GAUI-n).* The 400GAUI-n is a physical instantiation of the PMA service interface to extend the connection between 400 Gb/s capable PMAs. While conformance with implementation of this interface is not necessary to ensure communication, it is recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at 400 Gb/s speeds. The 400GAUI-n is intended for use as a chip-to-chip or a chip-to-module interface. Two widths of 400GAUI-n are defined: a sixteen-lane version (400GAUI-16) in Annex 120B and Annex 120C, and an eight-lane version (400GAUI-8) in Annex 120D and Annex 120E. No mechanical connector is specified for use with the 400GAUI-n. The 400GAUI-n is optional.

1.1.4 Layer interfaces

In the architectural model used here, the layers interact by way of well-defined interfaces, providing services as specified in Clause 2 and Clause 6. In general, the interface requirements are as follows:

a) The interface between the MAC sublayer and its client includes facilities for transmitting and receiving frames, and provides per-operation status information for use by higher-layer error recovery procedures.
b) The interface between the MAC sublayer and the Physical Layer includes signals for framing (carrier sense, receive data valid, transmit initiation) and contention resolution (collision detect), facilities for passing a pair of serial bit streams (transmit, receive) between the two layers, and a wait function for timing.

These interfaces are described more precisely in 4.3. Additional interfaces are necessary to provide for MAC Control services, and to allow higher level network management facilities to interact with these layers to perform operation, maintenance, and planning functions. Network management functions are described in Clause 30.

1.1.5 Application areas

Use of this standard is not restricted to any specific environments or applications.

In the context of this standard, the term “LAN” is used to indicate all networks that utilize the IEEE 802.3 (Ethernet) protocol for communication. These may include (but are not limited to) LANs and MANs.

1.1.6 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[7] [8]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

[7]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

[8]The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

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The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

1.2 Notation

1.2.1 State diagram conventions

The operation of a protocol can be described by subdividing the protocol into a number of interrelated functions. The operation of the functions can be described by state diagrams. Each diagram represents the domain of a function and consists of a group of connected, mutually exclusive states. Only one state of a function is active at any given time (see Figure 1–1).

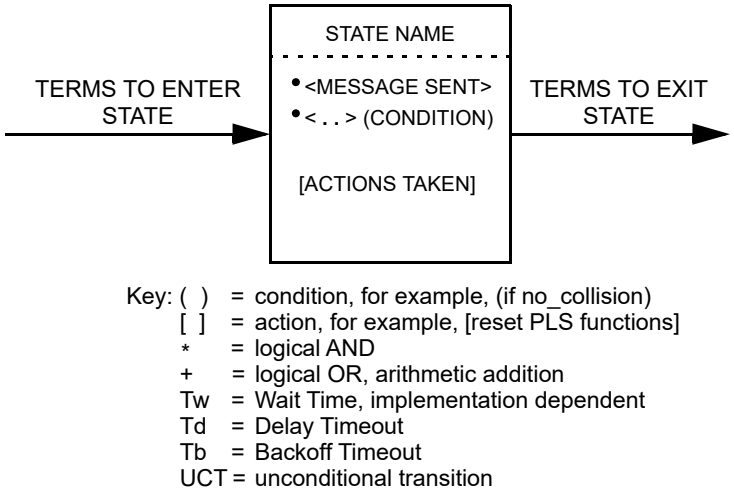


Figure 1–1—State diagram notation example

Each state that the function can assume is represented by a rectangle. These are divided into two parts by a horizontal line. In the upper part the state is identified by a name in capital letters. The lower part contains the name of any ON signal that is generated by the function. Actions are described by short phrases and enclosed in brackets.

All permissible transitions between the states of a function are represented graphically by arrows between them. A transition that is global in nature (for example, an exit condition from all states to the IDLE or RESET state) is indicated by an open arrow. Labels on transitions are qualifiers that have to be fulfilled before the transition will be taken. The label UCT designates an unconditional transition. Qualifiers described by short phrases are enclosed in parentheses.

State transitions and sending and receiving of messages occur instantaneously. When a state is entered and the condition to leave that state is not immediately fulfilled, the state executes continuously, sending the messages and executing the actions contained in the state in a continuous manner.

Some devices described in this standard (e.g., repeaters) are allowed to have two or more ports. State diagrams that are capable of describing the operation of devices with an unspecified number of ports require a qualifier notation that allows testing for conditions at multiple ports. The notation used is a term that

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includes a description in parentheses of which ports have to meet the term for the qualifier to be satisfied (e.g., ANY and ALL). It is also necessary to provide for term-assignment statements that assign a name to a port that satisfies a qualifier. The following conventions are used to describe a term-assignment statement that is associated with a transition:

a) The character ":" (colon) is a delimiter used to denote that a term assignment statement follows.
b) The character "⇐" (left arrow) denotes assignment of the value following the arrow to the term preceding the arrow.

The state diagrams contain the authoritative statement of the functions they depict; when apparent conflicts between descriptive text and state diagrams arise, the state diagrams are to take precedence. This does not override, however, any explicit description in the text that has no parallel in the state diagrams.

The models presented by state diagrams are intended as the primary specifications of the functions to be provided. It is important to distinguish, however, between a model and a real implementation. The models are optimized for simplicity and clarity of presentation, while any realistic implementation may place heavier emphasis on efficiency and suitability to a particular implementation technology. It is the functional behavior of any unit that has to match the standard, not its internal structure. The internal details of the model are useful only to the extent that they specify the external behavior clearly and precisely.

1.2.2 Service specification method and notation

The service of a layer or sublayer is the set of capabilities that it offers to a user in the next higher (sub)layer. Abstract services are specified here by describing the service primitives and parameters that characterize each service. This definition of service is independent of any particular implementation (see Figure 1–2).

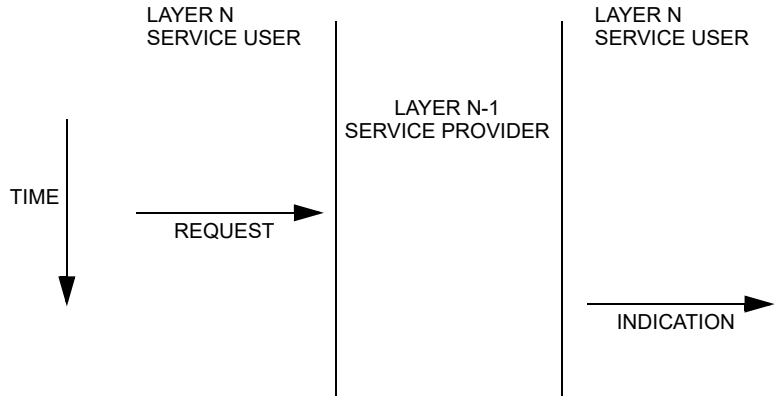


Figure 1–2—Service primitive notation

Specific implementations may also include provisions for interface interactions that have no direct end-to-end effects. Examples of such local interactions include interface flow control, status requests and indications, error notifications, and layer management. Specific implementation details are omitted from this service specification both because they will differ from implementation to implementation and because they do not impact the peer-to-peer protocols.

1.2.2.1 Classification of service primitives

Primitives are of two generic types:

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a) REQUEST. The request primitive is passed from layer N to layer N-1 to request that a service be initiated.
b) INDICATION. The indication primitive is passed from layer N-1 to layer N to indicate an internal layer N-1 event that is significant to layer N. This event may be logically related to a remote service request, or may be caused by an event internal to layer N-1.

The service primitives are an abstraction of the functional specification and the user-layer interaction. The abstract definition does not contain local detail of the user/provider interaction. For instance, it does not indicate the local mechanism that allows a user to indicate that it is awaiting an incoming call. Each primitive has a set of zero or more parameters, representing data elements that shall be passed to qualify the functions invoked by the primitive. Parameters indicate information available in a user/provider interaction; in any particular interface, some parameters may be explicitly stated (even though not explicitly defined in the primitive) or implicitly associated with the service access point. Similarly, in any particular protocol specification, functions corresponding to a service primitive may be explicitly defined or implicitly available.

1.2.3 Physical Layer and media notation

Users of this standard need to reference which particular implementation is being used or identified. Therefore, a means of identifying each implementation is given by a simple, three-field, type notation that is explicitly stated at the beginning of each relevant clause. In general, the Physical Layer type is specified by these fields:

<data rate> <modulation type> <additional distinction>

The data rate, if only a number, is in Mb/s, and if suffixed by a “G”, is in Gb/s. The modulation type (e.g., BASE) indicates how encoded data is transmitted on the medium. The additional distinction may identify characteristics of transmission or medium and, in some cases, the type of PCS encoding used (examples of additional distinctions are “T” for twisted pair, “B” for bidirectional optics, and “X” for a block PCS coding used for that speed of operation). Expansions for defined Physical Layer types are included in 1.4.

1.2.4 Physical Layer message notation

Messages generated within the Physical Layer, either within or between PLS and the MAU (that is, PMA circuitry), are designated by an italic type to designate either form of physical or logical message used to execute the Physical Layer signaling process (for example, *input_idle* or *mau_available*).

1.2.5 Hexadecimal notation

Numerical values designated by the 0x prefix indicate a hexadecimal interpretation of the corresponding number. For example: 0x0F represents an 8-bit hexadecimal value of the decimal number 15 and 0x00000000 represents a 32-bit hexadecimal value of the decimal number 0.

Numerical values designated with a 16 subscript indicate a hexadecimal interpretation of the corresponding number. For example: $0F_{16}$ represents an 8-bit hexadecimal value of the decimal number 15.

Hexadecimal values may also be indicated in text as hexadecimal or hex.

Hexadecimal numbers and values use upper case for hexadecimal digits A through F.

Separators may be used to improve readability of numbers—typically after every two or four hex digits counting from right to left. When hexadecimal is used for a fixed length value, protocol field, etc., where the value is not a multiple of 4 bits, the leftmost hexadecimal digit is truncated to fit the value's length (e.g., an 11 bit value of 0x25F is 010 0101 1111 in binary).

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1.2.6 Accuracy and resolution of numerical quantities

Unless otherwise stated, numerical limits in this standard are to be taken as exact, with the number of significant digits and trailing zeros having no significance.

1.2.7 Qm.n number format

The Qm.n number format is a fixed-point number format where the number of fractional bits is specified by n and optionally the number of integer bits is specified by m. For example, a Q14 number has 14 fractional bits; a Q2.14 number has 2 integer bits and 14 fractional bits. Preceding the "Q" with a "U" indicates an unsigned number.

1.2.8 Em dash (—) in a table cell

A table cell containing an em-dash (—) indicates a lack of data for that cell, or:

— For a units cell, that there is no unit for that parameter
— For a maximum cell, that there is no requirement on the maximum value of that parameter
— For a minimum cell, that there is no requirement on the minimum value of that parameter

1.3 Normative references

The following standards contain provisions that, through reference in this text, constitute provisions of this standard. Standards may be subject to revision, and parties subject to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid international standards. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

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[9]ANSI publications are available from the American National Standards Institute (https://www.ansi.org/).
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[13]CISPR documents are available from the International Electrotechnical Commission (https://www.iec.ch/). CISPR documents are also available in the United States from the American National Standards Institute (https://www.ansi.org/).
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[17]IEEE publications are available from The Institute of Electrical and Electronics Engineers (https://standards.ieee.org/).

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

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ISO/IEC 9314-1:1989, Information processing systems—Fibre Distributed Data Interface (FDDI)—Part 1: Token Ring Physical Layer Protocol (PHY).

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ISO/IEC 9646-2:1994, Information technology—Open Systems Interconnection—Conformance testing methodology and framework—Part 2: Abstract test suite specification.

[23]ISO/IEC publications are available from the International Organization for Standardization (https://www.iso.org/) and the International Electrotechnical Commission (https://www.iec.ch/). ISO/IEC publications are also available in the United States from the American National Standards Institute (https://www.ansi.org/).

[24]Previous editions of ISO/IEC standards are available from Deutsches Institut für Normung (https://www.din.de/).

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ITU-T Recommendation G.652, 2016—Characteristics of a single-mode optical fibre and cable.

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ITU-T Recommendation G.671, 2009—Transmission characteristics of optical components and subsystems.

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ITU-T Recommendation G.694.1—Spectral grids for WDM applications: DWDM frequency grid.

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[25]ITU-T publications are available from the International Telecommunications Union (https://www.itu.int/).

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ITU-T Recommendation I.430, 1995—Basic user-network interface—Layer 1 specification.

ITU-T Recommendation K.44, 2019—Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents—Basic Recommendation.

ITU-T Recommendation O.150, 1996—General requirements for instrumentation for performance measurements on digital transmission equipment.

ITU-T Recommendation O.153, 1992—Basic parameters for the measurement of error performance at bit rates below the primary rate.

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MATLAB Matrix Laboratory Software.[26]

NAMUR NE 021:2017, Electromagnetic Compatibility of Equipment for Industrial Processes and Laboratory.[27]

SAE J1292, Automobile and Motor Coach Wiring.

SCTE 02 2006, Specification for “F” Port, Female, Indoor.

SFF-8402, Rev 1.1, September 13, 2014, Specification for SFP+ 1X 28 Gb/s Pluggable Transceiver Solution (SFP28).[28]

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SFF-8436, Rev 4.8, October 31, 2013, Specification for QSFP+ 10 Gb/s 4X Pluggable Transceiver.

SFF-8470, Rev 3.3, April 3, 2006, Specification for Shielded High Speed Serial Multilane Copper Connector.

SFF-8482, Specification for Serial Attachment 2X Unshielded Connector.

SFF-8642, Rev 3.2, January 26, 2017, Specification for Mini Multilane 12X 10 Gb/s Shielded Connector (CXP10).

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TIA TSB-155-A-2010, Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T.[29]

TIA TSB-5021, Guidelines for the Assessment and Mitigation of Installed Cabling to Support 2.5GBASE-T and 5GBASE-T.

NOTE—Local and national standards such as those supported by ANSI, EIA, MIL, NFPA, and UL are not a formal part of this standard except where no international standard equivalent exists. A number of local and national standards are

[26]For information on MATLAB, contact The MathWorks (https://www.mathworks.com/).

[27]NAMUR publications are available from the User Association of Automation Technology in Process Industries (https://www.namur.net/).

[28]SFF specifications are available from the Storage Networking Industry Association (https://www.snia.org/sff/specifications/).

[29]TIA publications are available from the IHS Standards Store (https://global.ihs.com/) or from the Telecommunications Industry Association (https://www.tiaonline.org/).

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referenced as resource material; these bibliographical references are located in the bibliography in Annex A.[30]

1.4 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be referenced for terms not defined in this clause.[31]

1.4.1 1000BASE-BX10: IEEE 802.3 Physical Layer specification for a 1000 Mb/s point-to-point link over one single-mode optical fiber. (See IEEE Std 802.3, Clause 59 and Clause 66.)

1.4.2 1000BASE-CX: 1000BASE-X over specialty shielded balanced copper jumper cable assemblies. (See IEEE Std 802.3, Clause 39.)

1.4.3 1000BASE-H: IEEE 802.3 PCS and PMA sublayers for 1000 Mb/s Ethernet that support PMDs using duplex plastic optical fiber. (See IEEE Std 802.3, Clause 115.)

1.4.4 1000BASE-KX: IEEE 802.3 Physical Layer specification for 1 Gb/s using 1000BASE-X encoding over an electrical backplane. (See IEEE Std 802.3 Clause 70.)

1.4.5 1000BASE-LX: 1000BASE-X using long wavelength laser devices over multimode and single-mode fiber. (See IEEE Std 802.3, Clause 38.)

1.4.6 1000BASE-LX10: IEEE 802.3 Physical Layer specification for a 1000 Mb/s point-to-point link over two single-mode or multimode optical fibers. (See IEEE Std 802.3, Clause 59 and Clause 66.)

1.4.7 1000BASE-PX: A collection of IEEE 802.3 Physical Layer specifications for a 1000 Mb/s point-to-multipoint link over one single-mode optical fiber. (See IEEE Std 802.3, Table 56–1, Clause 60, Clause 65, and Clause 64.)

1.4.8 1000BASE-RHA: IEEE 802.3 Physical Layer specification for 1000 Mb/s Ethernet using 1000BASE-H encoding and red light (approximately 650 nm) PMD tailored for home-network and other consumer application requirements. (See IEEE Std 802.3, Clause 115.)

1.4.9 1000BASE-RHB: IEEE 802.3 Physical Layer specification for 1000 Mb/s Ethernet using 1000BASE-H encoding and red light (approximately 650 nm) PMD tailored for industrial application requirements. (See IEEE Std 802.3, Clause 115.)

1.4.10 1000BASE-RHC: IEEE 802.3 Physical Layer specification for 1000 Mb/s Ethernet using 1000BASE-H encoding and red light (approximately 650 nm) PMD tailored for automotive application requirements. (See IEEE Std 802.3, Clause 115.)

1.4.11 1000BASE-RHx: IEEE 802.3 specification for 1000 Mb/s Ethernet using duplex plastic optical fiber and red light (approximately 650 nm) with unspecified optical power budget (optical power budget is defined by the specific PMD type). (See IEEE Std 802.3, Clause 115.)

1.4.12 1000BASE-SX: 1000BASE-X using short wavelength laser devices over multimode fiber. (See IEEE Std 802.3, Clause 38.)

1.4.13 1000BASE-T: IEEE 802.3 Physical Layer specification for a 1000 Mb/s CSMA/CD LAN using four pairs of Category 5 balanced copper cabling. (See IEEE Std 802.3, Clause 40.)

[30]Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement this standard.
[31]The *IEEE Standards Dictionary Online* is available at https://dictionary.ieee.org/.

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1.4.14 1000BASE-T1: IEEE 802.3 Physical Layer specification for 1000 Mb/s Ethernet using a single twisted-pair copper cable. (See IEEE Std 802.3, Clause 97.)

1.4.15 1000BASE-X: IEEE 802.3 Physical Layer specification for a 1000 Mb/s CSMA/CD LAN that uses a Physical Layer derived from ANSI INCITS 230-1994 (FC-PH). (See IEEE Std 802.3, Clause 36.)

1.4.16 100BASE-BX10: IEEE 802.3 Physical Layer specification for a 100 Mb/s point-to-point link over one single-mode fiber. The link includes two different specifications for 100BASE-BX10-D and 100BASE-BX10-U. (See IEEE Std 802.3, Clause 58 and Clause 66.)

1.4.17 100BASE-FX: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network over two multimode optical fibers. (See IEEE Std 802.3, Clause 24 and Clause 26.)

1.4.18 100BASE-LX10: IEEE 802.3 Physical Layer specification for a 100 Mb/s point-to-point link over two single-mode optical fibers. (See IEEE Std 802.3, Clause 58 and Clause 66.)

1.4.19 100BASE-T: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network. (See IEEE Std 802.3, Clause 22 and Clause 28.)

1.4.20 100BASE-T1: IEEE 802.3 Physical Layer specification for a 100 Mb/s Ethernet full duplex local area network over a single balanced twisted-pair. (See IEEE Std 802.3, Clause 96.)

1.4.21 100BASE-T2: IEEE 802.3 specification for a 100 Mb/s CSMA/CD local area network over two pairs of Category 3 or better balanced cabling. (See IEEE Std 802.3, Clause 32.)

1.4.22 100BASE-T4: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network over four pairs of Category 3, 4, and 5 twisted-pair cabling. (See IEEE Std 802.3 Clause 23.)

1.4.23 100BASE-TX: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network over two pairs of Category 5 twisted-pair cabling. (See IEEE Std 802.3, Clause 24 and Clause 25.)

1.4.24 100BASE-X: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network that uses the Physical Medium Dependent (PMD) sublayer and Medium Dependent Interface (MDI) of the ISO/IEC 9314 group of standards developed by ASC X3T12 (FDDI). (See IEEE Std 802.3, Clause 24.)

1.4.25 100GBASE-CR10: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over ten lanes of shielded balanced copper cabling, with reach up to at least 7 m. (See IEEE Std 802.3, Clause 85.)

1.4.26 100GBASE-CR2: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over two lanes of shielded balanced copper cabling. (See IEEE Std 802.3, Clause 136.)

1.4.27 100GBASE-CR4: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding and Clause 91 RS-FEC over four lanes of shielded balanced copper cabling, with reach up to at least 5 m. (See IEEE Std 802.3, Clause 92.)

1.4.28 100GBASE-DR: IEEE 802.3 Physical Layer specification for 100 Gb/s serial transmission using 100GBASE-R encoding and 4-level pulse amplitude modulation over one wavelength on single-mode fiber, with reach up to at least 500 m. (See IEEE Std 802.3, Clause 140.)

1.4.29 100GBASE-ER4: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over four WDM lanes on single-mode fiber, with reach up to at least 40 km. (See IEEE Std 802.3, Clause 88.)

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1.4.30 100GBASE-FR1: IEEE 802.3 Physical Layer specification for 100 Gb/s serial transmission using 100GBASE-R encoding and 4-level pulse amplitude modulation over one wavelength on single-mode fiber, with reach up to at least 2 km. (See IEEE Std 802.3, Clause 140.)

1.4.31 100GBASE-KP4: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding, Clause 91 RS-FEC, and 4-level pulse amplitude modulation over four lanes of an electrical backplane, with a total insertion loss up to 33 dB at 7 GHz. (See IEEE Std 802.3, Clause 94.)

1.4.32 100GBASE-KR2: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over two lanes of an electrical backplane. (See IEEE Std 802.3, Clause 137.)

1.4.33 100GBASE-KR4: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding, Clause 91 RS-FEC, and 2-level pulse amplitude modulation over four lanes of an electrical backplane, with a total insertion loss up to 35 dB at 12.9 GHz. (See IEEE Std 802.3, Clause 93.)

1.4.34 100GBASE-LR1: IEEE 802.3 Physical Layer specification for 100 Gb/s serial transmission using 100GBASE-R encoding and 4-level pulse amplitude modulation over one wavelength on single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 140.)

1.4.35 100GBASE-LR4: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over four WDM lanes on single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 88.)

1.4.36 100GBASE-P: An IEEE 802.3 family of Physical Layer devices using 100GBASE-R encoding and a PMD that employs pulse amplitude modulation with more than 2 levels. (See IEEE Std 802.3, Clause 80.)

1.4.37 100GBASE-R: An IEEE 802.3 family of Physical Layer devices using 100GBASE-R encoding and a PMD that employs 2-level pulse amplitude modulation. (See IEEE Std 802.3, Clause 80.)

1.4.38 100GBASE-R encoding: The physical coding sublayer encoding defined in Clause 82 for 100 Gb/s operation. (See IEEE Std 802.3, Clause 82.)

1.4.39 100GBASE-SR10: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over ten lanes of multimode fiber, with reach up to at least 100 m. (See IEEE Std 802.3, Clause 86.)

1.4.40 100GBASE-SR2: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over two lanes of multimode fiber with reach up to at least 100 m. (See IEEE Std 802.3, Clause 138.)

1.4.41 100GBASE-SR4: IEEE 802.3 Physical Layer specification for 100 Gb/s using 100GBASE-R encoding over four lanes of multimode fiber, with reach up to at least 100 m. (See IEEE Std 802.3, Clause 95.)

1.4.42 100GBASE-Z: An IEEE 802.3 family of Physical Layer devices using 100GBASE-R encoding, a combination of phase and amplitude modulation, and coherent detection. (See IEEE Std 802.3, Clause 154.)

1.4.43 100GBASE-ZR: IEEE 802.3 Physical Layer specification for a 100 Gb/s dense wavelength division multiplexing (DWDM) PHY using 100GBASE-R encoding, dual polarization differential quadrature phase shift keying (DP-DQPSK) modulation, and coherent detection with reach up to at least 80 km. (See IEEE Std 802.3, Clause 154.)

1.4.44 100 Gb/s Attachment Unit Interface (CAUI-n, 100GAUI-n): A physical instantiation of the PMA service interface to extend the connection between 100 Gb/s capable PMAs over n lanes, used for chip-to-chip or chip-to-module interconnections. Three widths are defined: a ten-lane version (CAUI-10), two

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four-lane versions (CAUI-4, 100GAUI-4), and a two-lane version (100GAUI-2). (See IEEE Std 802.3, Annex 83A and Annex 83B for CAUI-10, Annex 83D and Annex 83E for CAUI-4, Clause 135, Annex 135D, and Annex 135E for 100GAUI-4, or Clause 135, Annex 135F, and Annex 135G for 100GAUI-2.)

1.4.45 100 Gb/s Media Independent Interface (CGMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 100 Gb/s operation. (See IEEE Std 802.3, Clause 81.)

1.4.46 100 Gb/s Parallel Physical Interface (CPPI): The interface between the Physical Medium Attachment (PMA) sublayer and the Physical Medium Dependent (PMD) sublayer for 100GBASE-SR10 PHYs. (See IEEE Std 802.3, Annex 86A.)

1.4.47 10/10G-EPON: An EPON architecture operating at 10 Gb/s in both downstream and upstream directions (symmetric rate). (See IEEE Std 802.3, Clause 56.)

1.4.48 10/1GBASE-PRX: A collection of IEEE 802.3 Physical Layer specifications for a 10 Gb/s downstream, 1 Gb/s upstream (10/1G-EPON) point-to-multipoint link over one single-mode optical fiber. (See IEEE Std 802.3, Table 56–1, Clause 75, Clause 76, and Clause 77.)

1.4.49 10/1G-EPON: An EPON architecture operating at 10 Gb/s in downstream direction and at 1 Gb/s data rate in upstream direction (asymmetric rate). (See IEEE Std 802.3, Clause 56.)

1.4.50 10BASE2: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over RG 58 coaxial cable. (See IEEE Std 802.3, Clause 10.)

1.4.51 10BASE5: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over coaxial cable (i.e., thicknet). (See IEEE Std 802.3, Clause 8.)

1.4.52 10BASE-F: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over multimode fiber optic cable. (See IEEE Std 802.3, Clause 15.)

1.4.53 10BASE-FB port: A port on a repeater that contains an internal 10BASE-FB Medium Attachment Unit (MAU) that can connect to a similar port on another repeater. (See IEEE Std 802.3, Clause 9, Figure 15–1b, and Clause 17.)

1.4.54 10BASE-FB segment: A fiber optic link segment providing a point-to-point connection between two 10BASE-FB ports on repeaters. (See link segment IEEE Std 802.3, Figure 15–1b and Figure 15–2.)

1.4.55 10BASE-FL segment: A fiber optic link segment providing point-to-point connection between two 10BASE-FL Medium Attachment Units (MAUs). (See link segment IEEE Std 802.3, Figure 15–1c and Figure 15–2.)

1.4.56 10BASE-FP segment: A fiber optic mixing segment, including one 10BASE-FP Star and all of the attached fiber pairs. (See IEEE Std 802.3, Figure 15–1a, Figure 1–2, and mixing segment.)

1.4.57 10BASE-FP Star: A passive device that is used to couple fiber pairs together to form a 10BASE-FP segment. Optical signals received at any input port of the 10BASE-FP Star are distributed to all of its output ports (including the output port of the optical interface from which it was received). A 10BASE-FP Star is typically composed of a passive-star coupler, fiber optic connectors, and a suitable mechanical housing. (See IEEE Std 802.3, 16.5.)

1.4.58 10BASE-T: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over two pairs of twisted-pair telephone wire. (See IEEE Std 802.3, Clause 14.)

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1.4.59 10BASE-T1L: IEEE 802.3 Physical Layer specification for a 10 Mb/s Ethernet local area network over a single balanced pair of conductors up to at least 1000 m reach. (See IEEE Std 802.3, Clause 146.)

1.4.60 10BASE-T1S: IEEE 802.3 Physical Layer specification for a 10 Mb/s Ethernet local area network over a single balanced pair of conductors up to at least 15 m reach. (See IEEE Std 802.3, Clause 147.)

1.4.61 10BASE-Te: IEEE 802.3 Physical Layer specification for an energy-efficient version of 10BASE-T for a 10 Mb/s CSMA/CD local area network over two pairs of Category 5 or better-balanced cabling. (See IEEE Std 802.3, Clause 14.)

1.4.62 10BROAD36: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over single broadband cable. (See IEEE Std 802.3, Clause 11.)

1.4.63 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.)

1.4.64 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.)

1.4.65 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.)

1.4.66 10GBASE-CX4: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-X encoding over four lanes over shielded balanced copper cabling. (See IEEE Std 802.3, Clause 54.)

1.4.67 10GBASE-E: IEEE 802.3 PMD specifications for 10 Gb/s serial transmission using extra long wavelength. (See IEEE Std 802.3, Clause 52.)

1.4.68 10GBASE-ER: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-R encoding and 10GBASE-E optics. (See IEEE Std 802.3, Clause 49 and Clause 52.)

1.4.69 10GBASE-EW: IEEE 802.3 Physical Layer specification for 10Gb/s using 10GBASE-W encoding and 10GBASE-E optics. (See IEEE Std 802.3, Clause 50 and Clause 52.)

1.4.70 10GBASE-KR: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-R encoding over an electrical backplane. (See IEEE Std 802.3 Clause 72.)

1.4.71 10GBASE-KX4: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-X encoding over an electrical backplane. (See IEEE Std 802.3 Clause 71.)

1.4.72 10GBASE-L: IEEE 802.3 PMD specifications for 10 Gb/s serial transmission using long wavelength. (See IEEE Std 802.3, Clause 52)

1.4.73 10GBASE-LR: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-R encoding and 10GBASE-L optics. (See IEEE Std 802.3, Clause 49 and Clause 52.)

1.4.74 10GBASE-LRM: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-R encoding and long wavelength optics for multimode fiber (See IEEE Std 802.3 Clause 68).

1.4.75 10GBASE-LW: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-W encoding and 10GBASE-L optics. (See IEEE Std 802.3, Clause 50 and Clause 52.)

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1.4.76 10GBASE-LX4: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-X encoding over four WWDM lanes over multimode fiber. (See IEEE Std 802.3, Clause 54.)

1.4.77 10GBASE-PR: A collection of IEEE 802.3 Physical Layer specifications for a 10 Gb/s (10/10G-EPON) point-to-multipoint link over one single-mode optical fiber. (See IEEE Std 802.3, Table 56–1, Clause 75, Clause 76, and Clause 77.)

1.4.78 10GBASE-R: An IEEE 802.3 physical coding sublayer for serial 10 Gb/s operation. (See IEEE Std 802.3, Clause 49.)

1.4.79 10GBASE-S: IEEE 802.3 PMD specifications for 10 Gb/s serial transmission using short wavelength. (See IEEE Std 802.3, Clause 52.)

1.4.80 10GBASE-SR: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-R encoding and 10GBASE-S optics. (See IEEE Std 802.3, Clause 49 and Clause 52.)

1.4.81 10GBASE-SW: IEEE 802.3 Physical Layer specification for 10 Gb/s using 10GBASE-W encoding and 10GBASE-S optics. (See IEEE Std 802.3, Clause 50 and Clause 52.)

1.4.82 10GBASE-T: IEEE 802.3 Physical Layer specification for a 10 Gb/s LAN using four pairs of Class E or Class F balanced copper cabling. (See IEEE Std 802.3, Clause 55.)

1.4.83 10GBASE-T1: IEEE 802.3 Physical Layer specification for a 10 Gb/s Ethernet full duplex local area network over a single balanced pair of conductors. (See IEEE Std 802.3, Clause 149.)

1.4.84 10GBASE-W: An IEEE 802.3 physical coding sublayer for serial 10 Gb/s operation that is data-rate and format compatible with SONET STS-192c. (See IEEE Std 802.3, Clause 49.)

1.4.85 10GBASE-X: An IEEE 802.3 physical coding sublayer for 10 Gb/s operation over XAUI and four lane PMDs. (See IEEE Std 802.3, Clause 48.)

1.4.86 10G-EPON: An EPON architecture operating at 10 Gb/s in either downstream or both downstream and upstream directions. This term collectively refers to 10/10G-EPON and 10/1G-EPON architectures. (See IEEE Std 802.3, Clause 56.)

1.4.87 10 Gigabit Attachment Unit Interface (XAUI): The interface between two 10 Gigabit Extender Sublayers (XGXS) to extend the reach of the XGMII for 10 Gb/s operation. (See IEEE Std 802.3, Clause 47.)

1.4.88 10 Gigabit Media Independent Interface (XGMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 2.5 Gb/s, 5 Gb/s, and 10 Gb/s operation. (See IEEE Std 802.3, Clause 46.)

1.4.89 10 Gigabit Sixteen-Bit Interface (XSBI): The interface between the Physical Coding Sublayer (PCS) in 10GBASE-R or the WAN Interface Sublayer (WIS) in 10GBASE-W and the Physical Medium Attachment (PMA) sublayer for 10 Gb/s operation. (See IEEE Std 802.3, Clause 51.)

1.4.90 10GPASS-XR: A collection of IEEE 802.3 EPON Protocol over Coax (EPoC) Physical Layer specifications for up to 10 Gb/s downstream and up to 1.6 Gb/s upstream point-to-multipoint link over a coax cable distribution network. (See IEEE Std 802.3, Table 56–1, Clause 100, Clause 101, Clause 102, and Clause 103.)

1.4.91 10PASS-TS: IEEE 802.3 Physical Layer specification up to 100 Mb/s point-to-point link over single copper wire pair. (See IEEE Std 802.3, Clause 61 and Clause 62.)

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1.4.92 1BASE5: IEEE 802.3 Physical Layer specification for a 1 Mb/s CSMA/CD local area network over two pairs of twisted-pair telephone wire. (See IEEE Std 802.3, Clause 12.)

1.4.93 1-Event classification: The application of a single class event during PI probing (see IEEE Std 802.3, Clause 33, 33.2.6).

1.4.94 1-Event class signature: The response of the PD to 1-Event classification (see IEEE Std 802.3, Clause 33).

1.4.95 1G-EPON: An EPON architecture operating at 1 Gb/s in both downstream and upstream directions.

1.4.96 2.5GBASE-KX: IEEE 802.3 Physical Layer specification for 2.5 Gb/s using 2.5GBASE-X encoding over an electrical backplane. (See IEEE Std 802.3, Clause 128.)

1.4.97 2.5GBASE-T: IEEE 802.3 Physical Layer specification for a 2.5 Gb/s LAN using four pairs of Category 5e/Class D balanced copper cabling. (See IEEE Std 802.3, Clause 126.)

1.4.98 2.5GBASE-T1: IEEE 802.3 Physical Layer specification for a 2.5 Gb/s Ethernet full duplex local area network over a single balanced pair of conductors. (See IEEE Std 802.3, Clause 149.)

1.4.99 2.5GBASE-X: IEEE 802.3 physical coding and physical medium attachment for serial 2.5 Gb/s operation. (See IEEE Std 802.3, Clause 127.)

1.4.100 2.5GPII: The 2.5 Gb/s PCS Internal Interface is a logical interface that is internal to the 2.5GBASE-X PCS and exists solely for the purposes of defining the 2.5GBASE-X PCS functionality. (See IEEE Std 802.3, 127.2.5.1.)

1.4.101 2.5GSEI: The 2.5 Gb/s Interface from storage sub-system or bridge subsystem onto backplane (See IEEE Std 802.3, Annex 128A.)

1.4.102 200GBASE-CR4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding over four lanes of shielded balanced copper cabling. (See IEEE Std 802.3, Clause 136)

1.4.103 200GBASE-DR4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding and 4-level pulse amplitude modulation over four lanes of single-mode fiber, with reach up to at least 500 m. (See IEEE Std 802.3, Clause 121.)

1.4.104 200GBASE-ER4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on single-mode fiber, with reach up to at least 40 km. (See IEEE Std 802.3, Clause 122.)

1.4.105 200GBASE-FR4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on single-mode fiber, with reach up to at least 2 km. (See IEEE Std 802.3, Clause 122.)

1.4.106 200GBASE-KR4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding over four lanes of an electrical backplane. (See IEEE Std 802.3, Clause 137.)

1.4.107 200GBASE-LR4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 122.)

1.4.108 200GBASE-R: An IEEE 802.3 family of Physical Layer devices using the physical coding sublayer defined in Clause 119 for 200 Gb/s operation. (See IEEE Std 802.3, Clause 119.)

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1.4.109 200GBASE-SR4: IEEE 802.3 Physical Layer specification for 200 Gb/s using 200GBASE-R encoding over four lanes of multimode fiber with reach up to at least 100 m. (See IEEE Std 802.3, Clause 138.)

1.4.110 200 Gb/s Attachment Unit Interface (200GAUI-n): A physical instantiation of the PMA service interface to extend the connection between 200 Gb/s capable PMAs over n lanes, used for chip-to-chip or chip-to-module interconnections. Two widths of 200GAUI-n are defined: an eight-lane version (200GAUI-8), and a four-lane version (200GAUI-4). (See IEEE Std 802.3, Annex 120B and Annex 120C for 200GAUI-8, or Annex 120D and Annex 120E for 200GAUI-4.)

1.4.111 200 Gb/s Media Independent Interface (200GMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 200 Gb/s operation. (See IEEE Std 802.3, Clause 117.)

1.4.112 200GMII Extender: The 200 Gb/s Media Independent Interface Extender extends the reach of the 200GMII and consists of two 200GXS sublayers with a 200GAUI-n between them. (See IEEE Std 802.3, Clause 118.)

1.4.113 200GXS: The 200 Gb/s Extender Sublayer (200GXS) is part of the 200GMII Extender. In functionality, it is almost identical to the 200GBASE-R PCS Sublayer defined in Clause 119. Two types of 200GXS are defined: the DTE 200GXS adjacent to the RS sublayer and the PHY 200GXS adjacent to the PHY. (See IEEE Std 802.3, Clause 118.)

1.4.114 25/10G-EPON: An EPON architecture supporting a maximum sustained throughput of 25 Gb/s in the downstream direction and 10 Gb/s in the upstream direction (asymmetric rate).

1.4.115 25/25G-EPON: An EPON architecture supporting a maximum sustained throughput of 25 Gb/s in both downstream and upstream directions (symmetric rate).

1.4.116 25GBASE: A family of Physical Layer devices (PHYs) for 25 Gb/s operation. (See IEEE Std 802.3, Clause 105.)

1.4.117 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.)

1.4.118 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.)

1.4.119 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.)

1.4.120 25GBASE-CR: IEEE 802.3 Physical Layer specification for 25 Gb/s using 25GBASE-R encoding over one lane of twinaxial copper cable. (See IEEE Std 802.3, Clause 110.)

1.4.121 25GBASE-CR-S: IEEE 802.3 Physical Layer specification equivalent to 25GBASE-CR without support for the RS-FEC sublayer specified in Clause 108. (See IEEE Std 802.3, Clause 110.)

1.4.122 25GBASE-ER: IEEE 802.3 Physical Layer specification for 25 Gb/s using 25GBASE-R encoding over single-mode fiber, with reach up to at least 40 km. (See IEEE Std 802.3, Clause 114.)

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1.4.123 25GBASE-KR: IEEE 802.3 Physical Layer specification for 25 Gb/s using 25GBASE-R encoding over one lane of an electrical backplane. (See IEEE Std 802.3, Clause 111.)

1.4.124 25GBASE-KR-S: IEEE 802.3 Physical Layer specification equivalent to 25GBASE-KR without support for the RS-FEC sublayer specified in Clause 108. (See IEEE Std 802.3, Clause 111.)

1.4.125 25GBASE-LR: IEEE 802.3 Physical Layer specification for 25 Gb/s using 25GBASE-R encoding over single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 114.)

1.4.126 25GBASE-R: An IEEE 802.3 physical coding sublayer for one-lane 25 Gb/s operation. (See IEEE Std 802.3, Clause 107.)

1.4.127 25GBASE-SR: IEEE 802.3 Physical Layer specification for 25 Gb/s using 25GBASE-R encoding over multimode fiber. (See IEEE Std 802.3, Clause 112.)

1.4.128 25GBASE-T: IEEE 802.3 Physical Layer specification for a 25 Gb/s LAN using four pairs of ANSI/TIA Category 8, ISO/IEC Class I, or ISO/IEC Class II balanced copper cabling. (See IEEE Std 802.3, Clause 113.)

1.4.129 25G-EPON: An EPON architecture supporting a maximum sustained throughput of 25 Gb/s in either downstream or both downstream and upstream directions. This term collectively refers to 25/10G-EPON and 25/25G-EPON architectures. (See IEEE Std 802.3, Clause 56.)

1.4.130 25 Gigabit Attachment Unit Interface (25GAUI): A physical instantiation of the Physical Medium Attachment (PMA) service interface to extend the connection between 25 Gb/s capable PMAs over one lane, used for chip-to-chip or chip-to-module interconnections. (See IEEE Std 802.3, Annex 109A and Annex 109B.)

1.4.131 25 Gigabit Media Independent Interface (25GMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 25 Gb/s operation. (See IEEE Std 802.3, Clause 106.)

1.4.132 2BASE-TL: IEEE 802.3 Physical Layer specification up to 5.696 Mb/s point-to-point link over single copper wire pair. (See IEEE Std 802.3, Clause 61 and Clause 63.)

1.4.133 2-Event classification: The application of two class events during PI probing (see IEEE Std 802.3, Clause 33, 33.2.6).

1.4.134 2-Event class signature: The response of the PD to 2-Event classification (see IEEE Std 802.3, Clause 33).

1.4.135 400GBASE-DR4: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over four lanes of single-mode fiber, with reach up to at least 500 m. (See IEEE Std 802.3, Clause 124.)

1.4.136 400GBASE-ER8: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over eight WDM lanes on single-mode fiber, with reach up to at least 40 km. (See IEEE Std 802.3, Clause 122.)

1.4.137 400GBASE-FR4: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on single-mode fiber, with reach up to at least 2 km. (See IEEE Std 802.3, Clause 151.)

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1.4.138 400GBASE-FR8: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over eight WDM lanes on single-mode fiber, with reach up to at least 2 km. (See IEEE Std 802.3, Clause 122.)

1.4.139 400GBASE-LR4-6: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over four WDM lanes on single-mode fiber, with reach up to at least 6 km. (See IEEE Std 802.3, Clause 151.)

1.4.140 400GBASE-LR8: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding and 4-level pulse amplitude modulation over eight WDM lanes on single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 122.)

1.4.141 400GBASE-R: An IEEE 802.3 family of Physical Layer devices using the physical coding sublayer defined in Clause 119 for 400 Gb/s operation. (See IEEE Std 802.3, Clause 119.)

1.4.142 400GBASE-SR16: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding over sixteen lanes of multimode fiber, with reach up to at least 100 m. (See IEEE Std 802.3, Clause 123.)

1.4.143 400GBASE-SR4.2: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding over eight lanes on multimode fiber in a bidirectional WDM format, with reach up to at least 150 m. (See IEEE Std 802.3, Clause 150.)

1.4.144 400GBASE-SR8: IEEE 802.3 Physical Layer specification for 400 Gb/s using 400GBASE-R encoding over eight lanes of multimode fiber, with reach up to at least 100 m. (See IEEE Std 802.3, Clause 138.)

1.4.145 400 Gb/s Attachment Unit Interface (400GAUI-n): A physical instantiation of the PMA service interface to extend the connection between 400 Gb/s capable PMAs over n lanes, used for chip-to-chip or chip-to-module interconnections. Two widths of 400GAUI-n are defined: a sixteen-lane version (400GAUI-16), and an eight-lane version (400GAUI-8). (See IEEE Std 802.3, Annex 120B and Annex 120C for 400GAUI-16, or Annex 120D and Annex 120E for 400GAUI-8.)

1.4.146 400 Gb/s Media Independent Interface (400GMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 400 Gb/s operation. (See IEEE Std 802.3, Clause 117.)

1.4.147 400GMII Extender: The 400 Gb/s Media Independent Interface Extender extends the reach of the 400GMII and consists of two 400GXS sublayers with a 400GAUI-n between them. (See IEEE Std 802.3, Clause 118.)

1.4.148 400GXS: The 400 Gb/s Extender Sublayer (400GXS) is part of the 400GMII Extender. In functionality, it is almost identical to the 400GBASE-R PCS Sublayer defined in Clause 119. Two types of 400GXS are defined: the DTE 400GXS adjacent to the RS sublayer and the PHY 400GXS adjacent to the PHY. (See IEEE Std 802.3, Clause 118.)

1.4.149 40GBASE-CR4: IEEE 802.3 Physical Layer specification for 40 Gb/s using 40GBASE-R encoding over four lanes of shielded balanced copper cabling, with reach up to at least 7 m. (See IEEE Std 802.3, Clause 85.)

1.4.150 40GBASE-ER4: IEEE 802.3 Physical Layer specification for 40 Gb/s using 40GBASE-R encoding over four WDM lanes on single-mode fiber, with reach up to at least 40 km. (See IEEE Std 802.3, Clause 87.)

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1.4.151 40GBASE-FR: IEEE 802.3 Physical Layer specification for 40 Gb/s serial transmission using 40GBASE-R encoding over one wavelength on single-mode fiber, with reach up to at least 2 km (See IEEE Std 802.3, Clause 89.)

1.4.152 40GBASE-KR4: IEEE 802.3 Physical Layer specification for 40 Gb/s using 40GBASE-R encoding over four lanes of an electrical backplane, with reach up to at least 1 m. (See IEEE Std 802.3, Clause 84.)

1.4.153 40GBASE-LR4: IEEE 802.3 Physical Layer specification for 40 Gb/s using 40GBASE-R encoding over four WDM lanes on single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 87.)

1.4.154 40GBASE-R: An IEEE 802.3 family of Physical Layer devices using 40GBASE-R encoding. (See IEEE Std 802.3, Clause 80.)

1.4.155 40GBASE-R encoding: The physical coding sublayer encoding defined in Clause 82 for 40 Gb/s operation. (See IEEE Std 802.3, Clause 82.)

1.4.156 40GBASE-SR4: IEEE 802.3 Physical Layer specification for 40 Gb/s using 40GBASE-R encoding over four lanes of multimode fiber, with reach up to at least 100 m. (See IEEE Std 802.3, Clause 86.)

1.4.157 40GBASE-T: IEEE 802.3 Physical Layer specification for a 40 Gb/s LAN using four pairs of ANSI/TIA Category 8, ISO/IEC Class I, or ISO/IEC Class II balanced copper cabling. (See IEEE Std 802.3, Clause 113.)

1.4.158 40 Gb/s Attachment Unit Interface (XLAUI): A physical instantiation of the PMA service interface to extend the connection between 40 Gb/s capable PMAs, used for chip-to-chip or chip-to-module interconnections. (See IEEE Std 802.3, Annex 83A and Annex 83B.)

1.4.159 40 Gb/s Media Independent Interface (XLGMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 40 Gb/s operation. (See IEEE Std 802.3, Clause 81.)

1.4.160 40 Gb/s Parallel Physical Interface (XLPPI): The interface between the Physical Medium Attachment (PMA) sublayer and the Physical Medium Dependent (PMD) sublayer for 40GBASE-SR4 and 40GBASE-LR4 PHYs. (See IEEE Std 802.3, Annex 86A.)

1.4.161 4B/3B: For IEEE 802.3, the data encoding technique used by 100BASE-T1 when converting 4-bit (4B) MII data with 25 MHz clock to 3-bit (3B) data with $33.33\overline{3}$ MHz clock. (See IEEE Std 802.3, 96.3.3.1.2.)

1.4.162 4D-PAM5: The symbol encoding method used in 1000BASE-T. The four-dimensional quinary symbols (4D) received from the 8B1Q4 data encoding are transmitted using five voltage levels (PAM5). Four symbols are transmitted in parallel each symbol period. (See IEEE Std 802.3, Clause 40.)

1.4.163 50/10G-EPON: An EPON architecture supporting a maximum sustained throughput of 50 Gb/s in the downstream direction and 10 Gb/s in the upstream direction (asymmetric rate). (See IEEE Std 802.3, Clause 56.)

1.4.164 50/25G-EPON: An EPON architecture supporting a maximum sustained throughput of 50 Gb/s in the downstream direction and 25 Gb/s in the upstream direction (asymmetric rate). (See IEEE Std 802.3, Clause 56.)

1.4.165 50/50G-EPON: An EPON architecture supporting a maximum sustained throughput of 50 Gb/s in both downstream and upstream directions (symmetric rate). (See IEEE Std 802.3, Clause 56.)

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1.4.166 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.)

1.4.167 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.)

1.4.168 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.)

1.4.169 50GBASE-CR: IEEE 802.3 Physical Layer specification for 50 Gb/s using 50GBASE-R encoding over one lane of shielded balanced copper cabling. (See IEEE Std 802.3, Clause 136.)

1.4.170 50GBASE-ER: IEEE 802.3 Physical Layer specification for 50 Gb/s serial transmission using 50GBASE-R encoding and 4-level pulse amplitude modulation over one wavelength on single-mode fiber, with reach up to at least 40 km. (See IEEE Std 802.3, Clause 139.)

1.4.171 50GBASE-FR: IEEE 802.3 Physical Layer specification for 50 Gb/s serial transmission using 50GBASE-R encoding and 4-level pulse amplitude modulation over one wavelength on single-mode fiber, with reach up to at least 2 km. (See IEEE Std 802.3, Clause 139.)

1.4.172 50GBASE-KR: IEEE 802.3 Physical Layer specification for 50 Gb/s using 50GBASE-R encoding over one lane of an electrical backplane. (See IEEE Std 802.3, Clause 137.)

1.4.173 50GBASE-LR: IEEE 802.3 Physical Layer specification for 50 Gb/s serial transmission using 50GBASE-R encoding and 4-level pulse amplitude modulation over one wavelength on single-mode fiber, with reach up to at least 10 km. (See IEEE Std 802.3, Clause 139.)

1.4.174 50GBASE-R: An IEEE 802.3 physical coding sublayer for one-lane 50 Gb/s operation. (See IEEE Std 802.3, Clause 131.)

1.4.175 50GBASE-SR: IEEE 802.3 Physical Layer specification for 50 Gb/s using 50GBASE-R encoding over multimode fiber with reach up to at least 100 m. (See IEEE Std 802.3, Clause 138.)

1.4.176 50 Gb/s Attachment Unit Interface (50GAUI-n, LAUI-2): A physical instantiation of the PMA service interface to extend the connection between 50 Gb/s capable PMAs over one lane (50GAUI-1) or two lanes (50GAUI-2, LAUI-2), used for chip-to-chip or chip-to-module interconnections. (See IEEE Std 802.3, Clause 135 and Annex 135B through Annex 135G.)

1.4.177 50 Gb/s Media Independent Interface (50GMII): The interface between the Reconciliation Sublayer (RS) and the Physical Coding Sublayer (PCS) for 50 Gb/s operation. (See IEEE Std 802.3, Clause 132.)

1.4.178 50G-EPON: An EPON architecture supporting a maximum sustained throughput of 50 Gb/s in either downstream or both downstream and upstream directions. This term collectively refers to 50/10G-EPON, 50/25G-EPON, and 50/50G-EPON architectures. (See IEEE Std 802.3, Clause 56.)

1.4.179 5GBASE-KR: IEEE 802.3 Physical Layer specification for 5 Gb/s using 5GBASE-R encoding over an electrical backplane. (See IEEE Std 802.3, Clause 130.)

1.4.180 5GBASE-R: An IEEE 802.3 physical coding sublayer and physical medium attachment sublayer for serial 5 Gb/s operation. (See IEEE Std 802.3, Clause 129.)

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1.4.181 5GBASE-T: IEEE 802.3 Physical Layer specification for a 5 Gb/s LAN using four pairs of Category 5e/Class D balanced copper cabling. (See IEEE Std 802.3, Clause 126.)

1.4.182 5GBASE-T1: IEEE 802.3 Physical Layer specification for a 5 Gb/s Ethernet full duplex local area network over a single balanced pair of conductors. (See IEEE Std 802.3, Clause 149.)

1.4.183 5GSEI: The 5 Gb/s Interface from storage sub-system or bridge subsystem onto backplane (See IEEE Std 802.3, Annex 130A.)

1.4.184 64B/65B transmission code: A block oriented encoding where 64-bit blocks are prepended with a single bit to indicate whether the block contains only data or a mix of data and control information. The details of each 64B/65B encoding are specific to the PCS. (See IEEE Std 802.3, Clause 55, and Clause 115.)

1.4.185 8B/10B transmission code: A DC-balanced octet-oriented data encoding specified in IEEE Std 802.3, Table 36–1a–e and Table 36–2.

1.4.186 8B1Q4: For IEEE 802.3, the data encoding technique used by 1000BASE-T when converting GMII data (8B-8 bits) to four quinary symbols (Q4) that are transmitted during one clock (1Q4). (See IEEE Std 802.3, Clause 40.)

1.4.187 ability: A mode that a device can advertise using Auto-Negotiation. For modes that represent a type of data service, a device shall be able to operate that data service before it may advertise this ability. A device may support multiple abilities. (See IEEE Std 802.3, 28.2.1.2.2.)

1.4.188 Acknowledge Bit: A bit used by IEEE 802.3 Auto-Negotiation to indicate that a station has successfully received multiple identical copies of the link codeword. This bit is only set after an identical link codeword has been received three times in succession. (See IEEE Std 802.3, 28.2.1.2.5.)

1.4.189 advertised ability: An operational mode that is advertised using Auto-Negotiation. (See IEEE Std 802.3, 28.2.1.2.2.)

1.4.190 agent: A term used to refer to the managed nodes in a network. Managed nodes are those nodes that contain a network management entity (NME), which can be used to configure the node and/or collect data describing operation of that node. The agent is controlled by a network control host or manager that contains both an NME and network management application (NMA) software to control the operations of agents. Agents include systems that support user applications as well as nodes that provide communications services such as front-end processors, bridges, and routers. (See IEEE Std 802.3, Clause 30.)

1.4.191 agent code: A term used to refer to network management entity software residing in a node that can be used to remotely configure the host system based on commands received from the network control host, collect information documenting the operation of the host, and communicate with the network control host. (See IEEE Std 802.3, Clause 30.)

1.4.192 Aggregation group: A collection of PMEs that may be aggregated according to a particular implementation of the PME aggregation function. (See IEEE Std 802.3, 61.2.2.)

1.4.193 agile device: A device that supports automatic switching between multiple Physical Layer technologies. (See IEEE Std 802.3, Clause 28.)

1.4.194 ampacity: The maximum current, in ampere, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

1.4.195 AN half-duplex function: The ability to exchange Auto-Negotiation DME pages over a single differential-pair medium. (See IEEE Std 802.3, Clause 98.)

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1.4.196 anomaly: A discrepancy between the actual and desired characteristics of an item. This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.197 arbitration: In 1000BASE-X, Auto-Negotiation process that ensures proper sequencing of configuration information between link partners using the Physical Coding Sublayer (PCS) Transmit and Receive functions. (See IEEE Std 802.3, Clause 36 and Clause 37.)

1.4.198 Attachment Unit Interface (AUI): In 10 Mb/s CSMA/CD, the interface between the Medium Attachment Unit (MAU) and the data terminal equipment (DTE) within a data station. Note that the AUI carries encoded signals and provides for duplex data transmission. (See IEEE Std 802.3, Clause 7 and Clause 8.)

1.4.199 Auto-Negotiation: The algorithm that allows two devices at either end of a link segment to negotiate common data service functions. (See IEEE Std 802.3, Clause 28, Clause 37, Clause 73, and Clause 98.)

1.4.200 balanced cable: A cable consisting of one or more metallic symmetrical cable elements (twisted pairs or quads). (From ISO/IEC 11801.)

1.4.201 Bandplan: The set of parameters that control the lowest and highest frequencies and power at which 10PASS-TS and 2BASE-TL may operate.

1.4.202 baseband coaxial system: A system whereby information is directly encoded and impressed upon the transmission medium. At any point on the medium only one information signal at a time can be present without disruption.

1.4.203 Base link codeword: The first 16-bit message exchanged during IEEE 802.3 Auto-Negotiation. (See IEEE Std 802.3, 28.2.1.2.)

1.4.204 Base Page: *See:* **Base link codeword**.

1.4.205 BASE-R: An IEEE 802.3 family of Physical Layer devices using the 64B/66B encoding defined in Clause 49, Clause 82, Clause 107, Clause 119, or Clause 129 of IEEE Std 802.3.

1.4.206 BASE-T1: PHYs that belong to the set of specific Ethernet PCS/PMA/PMDs that operate on a single twisted-pair copper cable, including 10BASE-T1L, 10BASE-T1S, 100BASE-T1, and 1000BASE-T1. (See IEEE Std 802.3, Clause 96, Clause 97, Clause 146, and Clause 147.)

1.4.207 basic frame: A MAC frame that carries a Length/Type field with the Length or Type interpretation and has a maximum length of 1518 octets. The basic frame is not intended to allow inclusion of additional tags (i.e., untagged) or encapsulations required by higher layer protocols. (See IEEE Std 802.3, 3.2.7.)

1.4.208 baud (Bd): A unit of signaling speed, expressed as the number of times per second the signal can change the electrical state of the transmission line or other medium.

NOTE—Depending on the encoding strategies, a signal event may represent a single bit, more, or less than one bit. *Contrast with:* **bit rate**; **bits per second**. (From IEEE Std 610.7-1995 [B38].)

1.4.209 Binary Phase Shift Keying (Binary PSK or BPSK): A form of modulation in which binary data are transmitted by changing the carrier phase by 180 degrees. (See IEEE Std 802.3, Clause 11.)

1.4.210 bit cell: The time interval used for the transmission of a single data (CD0 or CD1) or control (CVH or CVL) symbol.

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1.4.211 bit error ratio (BER): The ratio of the number of bits received in error to the total number of bits received.

1.4.212 bit interleaved parity N (BIP-N): A method of error monitoring using even (or odd) parity, such that an N-bit codeword is generated over a specified portion of an input data stream in such a manner that the i-th bit of the codeword provides even (or odd) parity over the i-th bit of all N-bit sequences in the covered portion of the data stream. This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.213 bit rate (BR): The total number of bits per second transferred to or from the Media Access Control (MAC). For example, 100BASE-T has a bit rate of one hundred million bits per second (10^8 b/s).

1.4.214 bit rate (BR)/2: One-half of the BR in hertz.

1.4.215 bit time (BT): The duration of one bit as transferred to and from the Media Access Control (MAC). The bit time is the reciprocal of the bit rate. For example, for 100BASE-T the bit time is 10^{-8} s or 10 ns.

1.4.216 black link approach: The specification of the input, output, and transfer characteristics of the unidirectional transmission path from TP2 to TP3 for a given dense wavelength division multiplexing (DWDM) channel within a DWDM black link, without specifying how the transmission path is implemented. (See, for example, IEEE Std 802.3, Clause 154, Figure 154–3.)

1.4.217 BR/2: *See:* **bit rate (BR)/2.**

1.4.218 branch cable: In 10BROAD36, the Attachment Unit Interface (AUI) cable interconnecting the data terminal equipment and Medium Attachment Unit (MAU) system components.

1.4.219 bridge: A layer 2 interconnection device that does not form part of a CSMA/CD collision domain but conforms to IEEE Std 802.1Q. A bridge does not form part of a CSMA/CD collision domain but, rather appears as a Media Access Control (MAC) to the collision domain. (See also IEEE 100.)

1.4.220 broadband local area network (LAN): A local area network in which information is transmitted on modulated carriers, allowing coexistence of multiple simultaneous services on a single physical medium by frequency division multiplexing. (See IEEE Std 802.3, Clause 11.)

1.4.221 bundle: A group of signals that have a common set of characteristics and differ only in their information content.

1.4.222 carrier extension: The addition of non-data symbols to the end of frames that are less than slotTime bits in length so that the resulting transmission is at least one slotTime in duration.

1.4.223 carrier sense: In a local area network, an ongoing activity of a data station to detect whether another station is transmitting.

NOTE—The carrier sense signal indicates that one or more DTEs are currently transmitting.

1.4.224 Category 3 balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 16 MHz (i.e., performance meets the requirements of a Class C link as per ISO/IEC 11801:1995). Commonly used by IEEE 802.3 10BASE-T installations. In addition to the requirements outlined in ISO/IEC 11801:1995, IEEE Std 802.3 Clause 14, Clause 23, and Clause 32 specify additional requirements for cabling when used with 10BASE-T, 100BASE-T4, and 100BASE-T2.

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1.4.225 Category 4 balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 20 MHz as per ISO/IEC 11801:1995. In addition to the requirements outlined in ISO/IEC 11801:1995, IEEE Std 802.3 Clause 14, Clause 23, and Clause 32 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, and 100BASE-T2.

1.4.226 Category 5 balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 100 MHz (i.e., cabling components meet the performance specified in ISO/IEC 11801:1995 and ANSI/EIA/TIA-568-A-1995). In addition to the requirements outlined in ISO/IEC 11801:1995 and ANSI/EIA/TIA-568-A-1995, IEEE Std 802.3 Clause 14, Clause 23, Clause 25, and Clause 40 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, 100BASE-TX, and 1000BASE-T.

1.4.227 Category 5e balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 100 MHz per ISO/IEC 11801:2002 and ANSI/TIA-568-B.2-2001. (See IEEE Std 802.3, Clause 14, Clause 25, Clause 40, Clause 33, and Clause 126.)

1.4.228 Category 6A balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 500 MHz (i.e., cabling components meet the performance specified in ISO/IEC 11801:2002 Amendment 2 and ANSI/TIA-568-C.2). In addition to the requirements outlined in ISO/IEC 11801:2002 Amendment 2 and ANSI/TIA-568-C.2, IEEE Std 802.3 Clause 14, Clause 23, Clause 25, Clause 40, Clause 55, and Clause 126 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 5GBASE-T, and 10GBASE-T.

1.4.229 Category 6 balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 250 MHz per ISO/IEC 11801:2002 and ANSI/TIA-568-C.2-2009. (See IEEE Std 802.3, Clause 14, Clause 25, Clause 40, Clause 55, Clause 33, and Clause 126.)

1.4.230 Category 7A balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 1000 MHz (i.e., cabling components meet the performance specified in ISO/IEC 11801:2002 Amendment 2). In addition to the requirements outlined in ISO/IEC 11801:2002 Amendment 2, IEEE Std 802.3 Clause 14, Clause 23, Clause 25, Clause 40, Clause 55, and Clause 126 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 5GBASE-T, and 10GBASE-T.

1.4.231 Category 7 balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 600 MHz (i.e., cabling components meet the performance specified in ISO/IEC 11801:2002). In addition to the requirements outlined in ISO/IEC 11801:2002, IEEE Std 802.3 Clause 14, Clause 23, Clause 25, Clause 40, Clause 55, and Clause 126 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 5GBASE-T, and 10GBASE-T.

1.4.232 Category 8 balanced cabling: Balanced 100 Ω cables and associated connecting hardware whose transmission characteristics are specified up to 2000 MHz (i.e., cabling components that meet the Category 8.1 or Category 8.2 requirements specified in ISO/IEC DIS 11801-1:2016 or Category 8 specified in ANSI/TIA-568-C.2-1-2016). In addition to the requirements outlined in ISO/IEC DIS 11801-1 and ANSI/TIA-568-C.2-1, IEEE Std 802.3 Clause 14, Clause 23, Clause 25, Clause 40, Clause 55, Clause 113, and Clause 126 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, 100BASE-TX, 1000BASE-T, 2.5GBASE-T, 5GBASE-T, 10GBASE-T, 25GBASE-T, and 40GBASE-T.

1.4.233 CATV-type broadband medium: *See:* **Community Antenna Television (CATV)-type broadband medium.**

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1.4.234 center wavelength: The average of two optical wavelengths at which the spectral radiant intensity is 50% of the maximum value. (See IEEE Std 802.3, Clause 11.)

1.4.235 channel: In 10BROAD36 and 10GPASS-XR, a band of frequencies dedicated to a certain service transmitted on the broadband medium. Otherwise, a defined path along which data in the form of an electrical or optical signal passes. (For 10BROAD36, see IEEE Std 802.3, Clause 11, for 10GPASS-XR see Clause 100, Clause 101, and Clause 102.)

1.4.236 channel insertion loss: As used in IEEE 802.3 for fiber optic links, the static loss of light through a link between a transmitter and receiver. It includes the loss of the fiber, connectors, and splices and, for EPON links, optional power splitter/combiner.

1.4.237 Channel Operating Margin (COM): A figure of merit for a channel derived from a measurement of its scattering parameters. (See IEEE Std 802.3, Clause 93A.1.)

1.4.238 channel spacing: The center-to-center difference in frequency or wavelength between adjacent channels in a WDM application. Dense wavelength division multiplexing (DWDM) channel spacings are based on the grid found in ITU-T G.694.1.

1.4.239 chassis ground: The electrical node that contains the chassis (see IEEE 100).

1.4.240 circuit: The physical medium on which signals are carried across the Attachment Unit Interface (AUI) for 10BASE-T or Media Independent Interface (MII) for 100BASE-T. For 10BASE-T, the data and control circuits consist of an A circuit and a B circuit forming a balanced transmission system so that the signal carrier on the B circuit is the inverse of the signal carried on the A circuit.

1.4.241 Class II repeater: A type of IEEE 802.3 100BASE-T repeater set with internal delay such that only two or fewer such repeater sets may exist between any two DTEs within a single collision domain when two maximum length copper cable segments are used. (See IEEE Std 802.3, Clause 27.)

1.4.242 Class I repeater: A type of 100BASE-T repeater set with internal delay such that only one repeater set may exist between any two DTEs within a single collision domain when two maximum length copper cable segments are used. (See IEEE Std 802.3, Clause 27.)

1.4.243 Clocked Data One (CD1): A Manchester-encoded data 1. A CD1 is encoded as a LO for the first half of the bit-cell and a HI for the second half of the bit-cell. (See IEEE Std 802.3, Clause 12.)

1.4.244 Clocked Data Zero (CD0): A Manchester-encoded data 0. A CD0 is encoded as a HI for the first half of the bit-cell and a LO for the second half of the bit-cell. (See IEEE Std 802.3, Clause 12.)

1.4.245 Clocked Violation HI (CVH): A symbol that deliberately violates Manchester-encoding rules, used as a part of the Collision Presence signal. A CVH is encoded as a transition from LO to HI at the beginning of the bit cell, HI for the entire bit cell, and a transition from HI to LO at the end of the bit cell. (See IEEE Std 802.3, Clause 12.)

1.4.246 Clocked Violation LO (CVL): A symbol that deliberately violates Manchester-encoding rules, used as a part of the Collision Presence signal. A CVL is encoded as a transition from HI to LO at the beginning of the bit cell, LO for the entire bit cell, and a transition from LO to HI at the end of the bit cell. (See IEEE Std 802.3, Clause 12.)

1.4.247 coax cable distribution network (CCDN): A radio frequency (RF) distribution plant composed of either amplified or passive coaxial media.

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1.4.248 coaxial cable: A two-conductor (center conductor, shield system), concentric, constant impedance transmission line used as the trunk medium in the baseband system.

1.4.249 coaxial cable interface: The electrical and mechanical interface to the shared coaxial cable medium either contained within or connected to the Medium Attachment Unit (MAU). Also known as the Medium Dependent Interface (MDI).

1.4.250 coaxial cable section: A single length of coaxial cable, terminated at each end with a male BNC connector. Cable sections are joined to other cable sections via BNC plug/receptacle barrel or Type T adapters.

1.4.251 coaxial cable segment: A length of coaxial cable made up from one or more coaxial cable sections and coaxial connectors, and terminated at each end in its characteristic impedance.

1.4.252 coax line terminal (CLT): The network-end DTE for a coaxial access network. The CLT is the master entity in a P2MP EPoC network with regard to the MPCP protocol.

1.4.253 coax network unit (CNU): The subscriber-end DTE to a coaxial access network. A CNU is a slave entity in a P2MP EPoC network with regard to the MPCP protocol.

1.4.254 code-bit: Within IEEE 802.3, in 100BASE-T, the unit of data passed across the Physical Medium Attachment (PMA) service interface, and the smallest signaling element used for transmission on the medium. A group of five code-bits constitutes a code-group in the 100BASE-X Physical Coding Sublayer (PCS). (See IEEE Std 802.3, Clause 24.)

1.4.255 code-group: For IEEE 802.3, a set of encoded symbols representing encoded data or control information. For 100BASE-T4, a set of six ternary symbols that, when representing data, conveys an octet. For 100BASE-TX and 100BASE-FX, a set of five code-bits that, when representing data, conveys a nibble. For 100BASE-T2, a pair of PAM5×5 symbols that, when representing data, conveys a nibble. For 1000BASE-X, a set of ten bits that, when representing data, conveys an octet. For 1000BASE-T, a vector of four 8B1Q4 coded quinary symbols that, when representing data, conveys an octet. For 100BASE-T1, a set of ternary symbols that, when representing data, conveys three bits, as defined in 96.3. For 10BASE-T1L, a set of three ternary symbols that, when representing data, conveys a nibble, as defined in 146.3. (See IEEE Std 802.3, Clause 23, Clause 24, Clause 32, Clause 36, Clause 40, Clause 96, and Clause 146.)

1.4.256 code-group alignment: In 1000BASE-X, the receiver action that resets the existing code-group boundary to that of the comma or K28.5 character currently being received. (See IEEE Std 802.3, Clause 36.)

1.4.257 code-group slipping: In 1000BASE-X, the receiver action to align the correct receive clock and code-group containing a comma. (See IEEE Std 802.3, Clause 36.)

1.4.258 Code Rule Violation (CRV): An analog waveform that is not the result of the valid Manchester-encoded output of a single optical transmitter. The collision of two or more 10BASE-FB optical transmissions will cause multiple CRVs. The preamble encoding of a single 10BASE-FP optical transmission contains a single CRV. (See IEEE Std 802.3, 16.3.1.1.)

1.4.259 collision: A condition that results from concurrent transmissions from multiple data terminal equipment (DTE) sources within a single collision domain.

1.4.260 collision domain: A single, half duplex mode CSMA/CD network. If two or more Media Access Control (MAC) sublayers are within the same collision domain and both transmit at the same time, a collision will occur. MAC sublayers separated by a repeater are in the same collision domain. MAC sublayers separated by a bridge are within different collision domains. (See IEEE Std 802.3.)

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1.4.261 collision presence: A signal generated within the Physical Layer by an end station or hub to indicate that multiple stations are contending for access to the transmission medium. (See IEEE Std 802.3, Clause 8 and Clause 12.)

1.4.262 comma: In 1000BASE-X, the seven-bit sequence that is part of an 8B/10B code-group that is used for the purpose of code-group alignment. (See IEEE Std 802.3, Clause 36.)

1.4.263 comma-: In 1000BASE-X, the seven-bit sequence (1100000) of an encoded data stream. (See IEEE Std 802.3, Clause 36.)

1.4.264 comma+: In 1000BASE-X, the seven-bit sequence (0011111) of an encoded data stream. (See IEEE Std 802.3, Clause 36.)

1.4.265 common-mode voltage: The instantaneous algebraic average of two signals applied to a balanced circuit, with both signals referenced to a common reference. Also called *longitudinal voltage* in the telephone industry.

1.4.266 Community Antenna Television (CATV)-type broadband medium: A broadband system comprising coaxial cables, taps, splitters, amplifiers, and connectors the same as those used in CATV or cable television installations. (See IEEE Std 802.3, Clause 11.)

1.4.267 Company ID (CID): A 24-bit unique number that identifies a manufacturer or other organization. A CID is used as a globally unique identifier on its own, and may be included as part of a context dependent identifier, as part of a protocol identifier, in other management data, etc. Any MAC addresses created from a CID are by definition, locally administered and not guaranteed to be unique in any MAC address context. OUI (see 1.4.440) and CID are non-overlapping and therefore mutually unique.

NOTE—See https://standards.ieee.org/develop/regauth/

1.4.268 compatibility interfaces: Several hardware points of attachment have been defined by this standard to allow connection of independently designed and manufactured components to the transmission medium. (See IEEE Std 802.3, 1.1.3.2.)

1.4.269 container: An SDH term that is equivalent to the payload capacity of a synchronous payload envelope. This definition is derived from ATIS-0900105.2008 and ATIS-0600416.1999(R2010), which take precedence.

1.4.270 continuous wave (CW): A carrier that is not modulated or switched.

1.4.271 Control mode: In 1000BASE-T, the period of operation in which the PHY is transmitting code-groups that represent control information. The end of a frame is accompanied by a transition to the Control mode, which immediately follows the Data mode and precedes the Idle mode. This occurs when the GMII signal TX_EN is set FALSE. During this time, several control fields are transmitted as code-groups to complete a stream. These include two convolutional encoder reset code-groups, two End-of-Stream delimiter (ESD) code-groups and, possibly, carrier extend code-groups. In 100BASE-T1, the period of operation in which the PHY is transmitting code-groups that represent control information. The end of a frame is accompanied by a transition to the Control mode, which immediately follows the Data mode and precedes the Idle mode. This occurs when the MII signal TX_EN is set FALSE. During this time, several control fields are transmitted as code-groups to complete a stream. (See IEEE Std 802.3, Clause 40 and Clause 96.)

1.4.272 Control Signal One (CS1): An encoded control signal used on the Control In and Control Out circuits. A CS1 is encoded as a signal at half the bit rate (BR)/2). (See IEEE Std 802.3, Clause 7.)

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1.4.273 Control Signal Zero (CS0): An encoded control signal used on the Control In and Control Out circuits. A CS0 is encoded as a signal at the bit rate (BR). (See IEEE Std 802.3, Clause 7.)

1.4.274 Coupled Power Ratio (CPR): The ratio (in dB) of the total power coupled into a multimode fiber to the optical power that can be coupled into a single-mode fiber.

1.4.275 cross connect: A group of connection points, often wall- or rack-mounted in a wiring closet, used to mechanically terminate and interconnect twisted-pair building wiring.

1.4.276 cyclic prefix (CP): A redundant set of samples prepended to an OFDM symbol.

1.4.277 data frame: Use of this term is restricted to Clause 9, 27 and 41 (*See:* **MAC Frame**).

1.4.278 Data mode: In 1000BASE-T, the period of operation in which the PHY is transmitting code-groups that represent data. This mode is preceded by a start of a frame during which the GMII signal TX_EN is set TRUE for data transmission. This mode begins with transmission of two Start-of-Stream delimiter code-groups followed by code-groups encoded from the data octets arriving on TXD<7:0> via the GMII. In 100BASE-T1, the period of operation in which the PHY is transmitting code-groups that represent data. This mode is preceded by a start of a frame during which the MII signal TX_EN is set TRUE for data transmission. This mode begins with transmission of three Start-of-Stream delimiter code-groups followed by code-groups encoded from the data nibbles arriving on TXD<3:0> via the MII. (See IEEE Std 802.3 Clause 40 and Clause 96.)

1.4.279 data terminal equipment (DTE): Any source or destination of data connected to the local area network.

1.4.280 dBm: Decibels referenced to 1.0 mW.

1.4.281 dBmV: Decibels referenced to 1.0 mV measured at the same impedance. Used to define signal levels in Community Antenna Television (CATV)-type broadband systems. (See IEEE Std 802.3 Clause 11.)

1.4.282 dedicated service: A CSMA/CD network in which the collision domain consists of two and only two DTEs so that the total network bandwidth is dedicated to supporting the flow of information between them.

1.4.283 deep sleep: One of the two modes of operation for Energy-Efficient Ethernet. Deep sleep refers to the mode for which the transmitter ceases transmission during Low Power Idle to maximize the energy saving potential. (See IEEE Std 802.3, Figure 78–3).

1.4.284 defect: A limited interruption in the ability of an item to perform a required function. This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.285 dense wavelength division multiplexing: An optical WDM technology where the frequency spacing is less than or equal to 1000 GHz.

1.4.286 differential group delay (DGD): The time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal.

1.4.287 differential Manchester encoding: Data encoding system used in Backplane Ethernet for Auto-Negotiation signaling and 10GBASE-KR training frame control channel encoding. (See IEEE Std 802.3 72.6.10.2.2 and 73.5.)

1.4.288 differential-mode voltage: The instantaneous algebraic difference between the potential of two signals applied to the two sides of a balanced circuit. Also called *metallic voltage* in the telephone industry.

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1.4.289 differential skew: The difference in time between the midpoint voltage crossings of the true and complement components of a differential signal.

1.4.290 dispersion slope: The rate of change of the chromatic dispersion of a fiber with wavelength.

1.4.291 Downstream: In an access network, where there is a clear indication in each deployment as to which end of a link is closer to a subscriber, transmission toward the subscriber end of the link.

1.4.292 drop cable: In 10BROAD36, the small diameter flexible coaxial cable of the broadband medium that connects to a Medium Attachment Unit (MAU). (*See:* **trunk cable**.)

1.4.293 DSQ128: The 128 point double square (DSQ) constellation mapping used in 10GBASE-T. This constellation is obtained by taking a 2D constellation with 16-level pulse amplitude modulation (PAM16) on each dimension and eliminating half the points to create a checkerboard pattern. This constellation is based on a lattice called RZ^2 in the literature. (See IEEE Std 802.3, Clause 55.)

NOTE—See also Forney [B28A][32]

1.4.294 dual duplex: Within IEEE 802.3, a signaling system that supports simultaneous duplex communication over two cabling pairs.

1.4.295 dual-signature PD: A PD that has independent detection signatures, class signatures, and maintain power signatures on each pairset. (See IEEE Std 802.3, Clause 145.)

1.4.296 duplex channel: Within IEEE 802.3, a communications channel capable of simultaneous duplex communication.

1.4.297 DWDM black link: An aggregate of pairs of dense wavelength division multiplexing (DWDM) channels, with each pair supporting one full duplex connection where the implementation of the transmission paths is not specified.

1.4.298 DWDM channel: The transmission path from TP2 associated with a transmitting DWDM PHY, to TP3 at a receiving DWDM PHY.

1.4.299 DWDM PHY: An Ethernet PHY that transmits and receives on selected dense wavelength division multiplexing (DWDM) center frequencies for transmission over one selected DWDM channel in each direction.

1.4.300 eight-pin modular: An eight-wire connector. (From IEC 60603-7.)

1.4.301 encapsulation: In 1000BASE-X, the process by which a MAC packet is enclosed within a PCS code-group stream. (See IEEE Std 802.3, Clause 36.)

1.4.302 encircled flux: The optical power within a specified radius of a fiber center, as a percentage of that within 36 μm (for 62.5 μm fiber) or 29 μm (for 50 μm fiber).

1.4.303 End_of_Packet Delimiter (EPD): In 1000BASE-X, a defined sequence of three single code-group 8B/10B ordered sets used to delineate the ending boundary of a data transmission sequence for a single packet. (See IEEE Std 802.3, Clause 36.)

1.4.304 End-of-Stream Delimiter (ESD): Within IEEE 802.3, a code-group pattern used to terminate a normal data transmission. For 100BASE-T4, the ESD is indicated by the transmission of five predefined ternary

[32]The numbers in brackets preceded by the letter B correspond to those of the bibliography in Annex A.

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code-groups named eop1-5. For 100BASE-X, the ESD is indicated by the transmission of the code-group/T/R. For 100BASE-T2, the ESD is indicated by two consecutive pairs of predefined PAM5×5 symbols (see Table 32–15), which are generated using unique Start-of-Stream Delimiter (SSD)/ESD coding rules. For 1000BASE-T, the ESD is indicated by two consecutive vectors of four quinary symbols as specified in Table 40–1. For 100BASE-T1, the ESD consists of three code-groups as defined in 96.3.3.3.5. (See IEEE Std 802.3, Clause 22, Clause 23, Clause 32, Clause 40, and Clause 96.)

1.4.305 Endpoint PSE: Power Sourcing Equipment (PSE) that is located at an endpoint.

1.4.306 Energy-Efficient Ethernet (EEE): Provides a protocol for PHYs to coordinate transitions to or from a lower level of power consumption, without changing the link status and without dropping or corrupting frames. (See IEEE Std 802.3, Clause 78).

1.4.307 envelope: In the Multi-Channel Reconciliation Sublayer (MCRS, see IEEE Std 802.3, Clause 143), an envelope encapsulates data belonging to a specific LLID being transmitted on a specific MCRS channel, i.e., the data or idles sourced from a specific MAC instance and sent over a specific MCRS channel.

1.4.308 envelope allocation: In Nx25G-EPON, an envelope allocation represents a transmission window allocated to a single LLID (including GLID). A single GATE MPCPDU can carry up to seven envelope allocations.

1.4.309 envelope descriptor: A set of parameters consisting of LLID, StartTime, and EnvLength. An envelope descriptor defines a specific envelope pending transmission. Envelope descriptors are generated by the local MPCP sublayer and are passed to MCRS at the appropriate time to start the envelope transmission.

1.4.310 envelope frame: A MAC frame that carries a Length/Type field with the Type interpretation that may indicate additional encapsulation information within the MAC client data and has a maximum length of 2000 octets. The envelope frame is intended to allow inclusion of additional prefixes and suffixes required by higher layer encapsulation protocols. The encapsulation protocols may use up to 482 octets. (See IEEE 802.3, 3.2.7.)

1.4.311 envelope header: An MCRS-specific marker that is inserted at the beginning of every envelope (envelope start header) and in place of every frame preamble (envelope continuation header). The envelope header includes fields that identify the LLID that sourced the encapsulated data and the length of the data (in units of EQ). Envelope headers also include a CRC8 field used to detect bit errors.

1.4.312 envelope quantum: A unit of information volume. Each envelope quantum represents 64 bits of data plus the layer-specific encoding. Thus, at the MAC Control sublayer and above, an envelope quantum is equal to 64 bits. Within the MCRS, an envelope quantum contains 72 bits (i.e., 64 bits of data and 8 bits of control). Within the PCS, after the 64B/66B encoding, an envelope quantum contains 66 bits, and after 256B/257B encoding, four envelope quanta are packed into a single 257-bit block.

1.4.313 EQT: The unit of measurement of time for time-related parameters specified in IEEE Std 802.3, Clause 144 Multipoint MAC Control for Nx25G-EPON. Each EQT is equal to the time required to transmit one EQ between the MCRS and the PCS across 25GMII, and equal to 2.56 ns.

1.4.314 EtherType: A 2 octet value that indicates the nature of the MAC client protocol. Type values are assigned by the IEEE Registration Authority. (See: IEEE Std 802.3, 3.2.6.)

1.4.315 Exception Window: A time interval during which the impedance of a mated connector and associated transmission line is allowed to exceed the impedance tolerance specification for signals passed through that connector.

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1.4.316 express Media Access Control (eMAC): The instance of a Media Access Control sublayer (IEEE Std 802.3, Annex 4A) that is the client of a MAC Merge sublayer service interface that handles express traffic. (See IEEE Std 802.3, Clause 99.)

1.4.317 express traffic: Frames transmitted through an express Media Access Control (eMAC) sublayer. (See IEEE Std 802.3, Clause 99.)

1.4.318 extension bit: A bit decoded from the received carrier stream that does not map into the data space but nonetheless denotes the presence of carrier for the purposes of CSMA/CD.

1.4.319 extinction ratio: The ratio of the low optical power level to the high optical power level on an optical segment. (See IEEE Std 802.3, Clause 15.)

1.4.320 eye-opening penalty: The difference, in dB, between (a) the optical power measured at the center of the data eye, and (b) the optical power measured at a point defined by the total worst-case peak-to-peak jitter at the receiver.

1.4.321 Fast Link Pulse (FLP) Burst: A group of no more than 33 and not less than 17 10BASE-T compatible link integrity test pulses. Each FLP Burst encodes 16 bits of data using an alternating clock and data pulse sequence. (See Figure 14–15, IEEE Std 802.3, Clause 14 and Figure 28–4, IEEE Std 802.3, Clause 28.)

1.4.322 Fast Link Pulse (FLP) Burst Sequence: The sequence of FLP Bursts transmitted by the local station. This term is intended to differentiate the spacing between FLP Bursts from the individual pulse spacings within an FLP Burst. (See IEEE Std 802.3, Clause 28.)

1.4.323 fast wake: One of the two modes of operation for Energy-Efficient Ethernet (EEE). Fast wake refers to the mode for which the transmitter continues to transmit signals during Low Power Idle so that the receiver can resume operation with a shorter wake time. (See IEEE Std 802.3, Figure 78–4.)

1.4.324 FEC lane (FECL): In 50GBASE-R and 100GBASE-R, the FEC distributes encoded data to multiple logical lanes; these logical lanes are called FEC lanes. One or more FEC lanes can be multiplexed and carried on a physical lane together at the PMA service interface. (See IEEE Std 802.3, Clause 135.)

1.4.325 fiber optic cable: A cable containing one or more optical fibers as specified in IEEE Std 802.3, 15.3.1.

1.4.326 Fiber Optic Inter-Repeater Link (FOIRL): A Fiber Optic Inter-Repeater Link segment and its two attached Medium Attachment Units (MAUs). (See IEEE Std 802.3, Clause 15.)

1.4.327 Fiber Optic Inter-Repeater Link (FOIRL) bit error ratio (BER): For 10BASE-F, the mean bit error ratio of the FOIRL. (See IEEE Std 802.3, Clause 9.)

1.4.328 Fiber Optic Inter-Repeater Link (FOIRL) collision: For 10BASE-F, the simultaneous transmission and reception of data in a Fiber Optic Medium Attachment Unit (FOMAU). (See IEEE Std 802.3, Clause 9.)

1.4.329 Fiber Optic Inter-Repeater Link (FOIRL) Compatibility Interface: For 10BASE-F, the FOMDI and Attachment Unit Interface (AUI) (optional); the two points at which hardware compatibility is defined to allow connection of independently designed and manufactured components to the baseband optical fiber cable link segment. (See IEEE Std 802.3, Clause 9.)

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1.4.330 Fiber Optic Inter-Repeater Link (FOIRL) Segment: A fiber optic link segment providing a point-to-point connection between two FOIRL Medium Attachment Units (MAUs) or between one FOIRL MAU and one 10BASE-FL MAU. *See:* **link segment**.

1.4.331 Fiber Optic Medium Attachment Unit (FOMAU): A MAU for fiber applications. (See IEEE Std 802.3, Clause 9.)

1.4.332 Fiber Optic Medium Attachment Unit's (FOMAU's) Receive Optical Fiber: For 10BASE-F, the optical fiber from which the local FOMAU receives signals. (See IEEE Std 802.3, Clause 9.)

1.4.333 Fiber Optic Medium Attachment Unit's (FOMAU's) Transmit Optical Fiber: For 10BASE-F, the optical fiber into which the local FOMAU transmits signals. (See IEEE Std 802.3, Clause 9.)

1.4.334 Fiber Optic Medium Dependent Interface (FOMDI): For 10BASE-F, the mechanical and optical interface between the optical fiber cable link segment and the Fiber Optic Medium Attachment Unit (FOMAU). (See IEEE Std 802.3, Clause 9.)

1.4.335 Fiber Optic Physical Medium Attachment (FOPMA): For 10BASE-F, the portion of the Fiber Optic Medium Attachment Unit (FOMAU) that contains the functional circuitry. (See IEEE Std 802.3 Clause 9.)

1.4.336 fiber pair: Optical fibers interconnected to provide two continuous light paths terminated at each end in an optical connector. Any intermediate optical connections have to have insertion and return loss characteristics that meet or exceed IEEE Std 802.3, 15.3.2.1 and 15.3.2.2, respectively. (See IEEE Std 802.3, 15.3.1.)

1.4.337 Fibre Channel (FC-PH): Name used to refer to ANSI INCITS 230-1994. (See IEEE Std 802.3, Clause 36.)

1.4.338 Fibre Distributed Data Interface (FDDI): A 100 Mb/s, fiber optic-based, token-ring local area network standard (ISO/IEC 9314 series of standards).

1.4.339 fixed stuff: Null or padding octets inserted to compensate for the bandwidth differences between the byte interleaving and the concatenation rules of SONET/SDH. This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.340 FLP Burst: *See:* **Fast Link Pulse (FLP) Burst.**

1.4.341 FOIRL: *See:* **Fiber Optic Inter-Repeater Link (FOIRL).**

1.4.342 FOMAU: *See:* **Fiber Optic Medium Attachment Unit (FOMAU).**

1.4.343 frame ground: *See:* **chassis ground**.

1.4.344 frame loss ratio: The number of transmitted frames not received as valid by the MAC divided by the total number of transmitted frames.

1.4.345 full duplex: A mode of operation of a network, DTE, or Medium Attachment Unit (MAU) that supports duplex transmission as defined in IEEE 100. Within the scope of this standard, this mode of operation allows for simultaneous communication between a pair of stations, provided that the Physical Layer is capable of supporting simultaneous transmission and reception without interference. (See IEEE Std 802.3.)

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1.4.346 Gigabit Media Independent Interface (GMII): The interface between the Reconciliation sublayer and the physical coding sublayer (PCS) for 1000 Mb/s operation. (See IEEE Std 802.3, Clause 35.)

1.4.347 GPON: A Gigabit-capable Passive Optical Network, as specified in ITU-T G.984.2.

NOTE—ITU-T G.984.2 [B48].

1.4.348 grant: Within P2MP protocols, a permission to transmit at a specific time, for a specific duration. Grants are issued by the OLT (master) to ONUs (slaves) by means of GATE messages. In IEEE Std 802.3, Clause 64 and Clause 77, a GATE MPCPDU contains one or multiple grants issued to a single LLID, with each grant resulting in one or multiple upstream bursts transmitted by the ONU. In Clause 144, a grant includes envelope allocations for multiple LLIDs and there is a one-to-one correspondence between the grants issued to an ONU and upstream bursts transmitted by that ONU.

1.4.349 group: A repeater port or a collection of repeater ports that can be related to the logical arrangement of ports within a repeater.

1.4.350 group delay: In 10BROAD36, the rate of change of total phase shift, with respect to frequency, through a component or system. Group delay variation is the maximum difference in delay as a function of frequency over a band of frequencies. (See IEEE Std 802.3, Clause 11.)

1.4.351 half duplex: A mode of operation of a CSMA/CD local area network (LAN) in which DTEs contend for access to a shared medium. Multiple, simultaneous transmissions in a half duplex mode CSMA/CD LAN result in interference, requiring resolution by the CSMA/CD access control protocol. (See IEEE Std 802.3.)

1.4.352 headend: In 10BROAD36, the location in a broadband system that serves as the root for the branching tree comprising the physical medium; the point to which all inbound signals converge and the point from which all outbound signals emanate. (See IEEE Std 802.3, Clause 11.)

1.4.353 header hub (HH): The highest-level hub in a hierarchy of hubs. The HH broadcasts signals transmitted to it by lower-level hubs or DTEs such that they can be received by all DTEs that may be connected to it either directly or through intermediate hubs. (See IEEE Std 802.3, 12.2.1.)

1.4.354 hub: A device used to provide connectivity between DTEs. Hubs perform the basic functions of restoring signal amplitude and timing, collision detection, and notification and signal broadcast to lower-level hubs and DTEs. (See IEEE Std 802.3, Clause 12.)

1.4.355 hybrid: A circuit (implementable with active or passive components) that enables full duplex transmission by allowing symbols to be transmitted and received on the same wire pair at the same time. It is often used together with an echo canceller to get adequate separation of transmit and receive signals.

1.4.356 idle (IDL): A signal condition where no transition occurs on the transmission line, that is used to define the end of a frame and ceases to exist after the next LO or HI transition on the Attachment Unit Interface (AUI) or Media Independent Interface (MII) circuits. An IDL always begins with a HI signal level. A driver is required to send the IDL signal for at least 2 bit times and a receiver is required to detect IDL within 1.6 bit times. (See IEEE Std 802.3, 7.3 and 12.3.2.4.4 for additional details.)

1.4.357 Idle mode: In 1000BASE-T, the period of operation in which the PHY is transmitting special code-groups that use only the values {2, 0, –2}. Idle mode occurs during startup when the PHYs at each end of a link are attempting to establish adaptive filter parameters and then synchronize both phase and timing so that normal operation can begin. Idle mode also occurs during normal operation between frames. Idle mode occurs after a control mode ends and before another Data mode begins. The Idle mode is not used between frames in a packet burst. (See IEEE Std 802.3, Clause 40.)

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1.4.358 IEEE 802.3 Power over Ethernet (IEEE 802.3 PoE): A system consisting of one PSE and one PD that provides power across balanced twisted-pair cabling. (See IEEE Std 802.3, Clause 33 and Clause 145.)

1.4.359 in-band signaling: The transmission of a signal using a frequency that is within the bandwidth of the information channel. *Contrast with:* **out-of-band signaling**. *Syn:* **in-channel signaling**. (From IEEE Std 610.7-1995 [B38].)

1.4.360 Infofield: A 16-octet frame transmitted at regular intervals containing messages for startup operation by certain PHYs. (See IEEE Std 802.3, Clause 55, Clause 113, and Clause 126.) Also a 12-octet frame transmitted at regular intervals containing messages for startup operation by certain PHYs. (See IEEE Std 802.3, Clause 97 and Clause 149.)

1.4.361 intermediate hub (IH): A hub that occupies any level below the header hub in a hierarchy of hubs. (See IEEE Std 802.3, 12.2.1 for details.)

1.4.362 interpacket gap (IPG): A delay or time gap between Ethernet packets intended to provide inter-frame recovery time for other Ethernet sublayers and for the Physical Medium. (See IEEE Std 802.3, 4.2.3.2.1 and 4.2.3.2.2.) The minimum length of IPG at the transmitting MAC is enforced by the MAC parameter interPacketGap; the actual interpacket gap may change between the transmitting MAC and receiving MAC.

1.4.363 Inter-Repeater Link (IRL): A mechanism for connecting two and only two repeater sets.

1.4.364 intersymbol interference penalty: The power penalty due to the finite bandwidth of the link. (See IEEE Std 802.3, Clause 38.)

1.4.365 jabber: A condition wherein a station transmits for a period of time longer than the maximum permissible packet length, usually due to a fault condition.

1.4.366 Jabber function: A mechanism for controlling abnormally long transmissions (i.e., jabber).

1.4.367 jitter: The variations of signal transitions from their ideal positions in time. Jitter may be characterized by its spectral properties and its distribution in time.

1.4.368 jumper cable assembly: An electrical or optical assembly, used for the bidirectional transmission and reception of information, consisting of a pair of transmission lines terminated at their ends with plug connectors. This assembly may or may not contain additional components, located between the plug connectors, to perform equalization. (See IEEE Std 802.3, Clause 39.)

1.4.369 Kojiri-safe: A property of the mechanical design for receptacles and mated plugs to protect sensitive functional elements, especially fiber optic ferrules and receptacles. Also called scoop-proof.

1.4.370 lane: A logical subset of the data and control information transmitted from one sublayer (e.g., PCS, PMA) to an adjacent sublayer across the inter-sublayer interface or from one PHY to another across the transmission medium (e.g. optical fiber, optical wavelength, wire pair). Lanes are transmitted in parallel and combine to deliver the full set of data and control information across the interface.

1.4.371 LDPC(1723,2048) frame: 64B/65B transmission code blocks mapped into a low density parity check (LDPC) frame with 1723 coded bits, 325 check bits and 1536 uncoded bits. (See IEEE Std 802.3, Clause 55.)

1.4.372 link: The transmission path between any two interfaces of generic cabling. (From ISO/IEC 11801.)

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1.4.373 Link codeword: The 16 bits of data encoded into a Fast Link Pulse (FLP) Burst. (See IEEE Std 802.3, Clause 28.)

1.4.374 Link Layer Discovery Protocol (LLDP): A media-independent protocol intended to run on any IEEE 802® LAN station and to allow an LLDP agent to learn the connectivity and management information from adjacent stations (see IEEE Std 802.1AB-2009).

1.4.375 link partner: The device at the opposite end of a link segment from the local station. The link partner device may be either a DTE or a repeater. (See IEEE Std 802.3, Clause 28.)

1.4.376 link penalties: For fiber optic links, the power penalties of a link not attributed to link attenuation. These power penalties include modal noise, relative intensity noise (RIN), intersymbol interference (ISI), mode partition noise, extinction ratio, and eye-opening penalties.

1.4.377 link pulse: Communication mechanism used in 10BASE-T and 100BASE-T networks to indicate link status and (in Auto-Negotiation-equipped devices) to communicate information about abilities and negotiate communication methods. 10BASE-T uses Normal Link Pulses (NLPs), which indicate link status only. 10BASE-T and 100BASE-T nodes equipped with Auto-Negotiation exchange information using a Fast Link Pulse (FLP) mechanism that is compatible with NLP. (See IEEE Std 802.3, Clause 14 and Clause 28.)

1.4.378 link section: The portion of the link between the PSE Power Interface (PI) and the PD PI.

1.4.379 link segment: The point-to-point full-duplex medium connection between two and only two Medium Dependent Interfaces (MDIs).

1.4.380 Link Segment Delay Value (LSDV): A number associated with a given segment that represents the delay on that segment used to assess path delays for 100 Mb/s CSMA/CD networks. LSDV is similar to SDV; however, LSDV values do not include the delays associated with attached end stations and/or repeaters. (See IEEE Std 802.3, 29.3.)

1.4.381 local ability: *See:* **ability**.

1.4.382 local device: The local device that may attempt to perform Auto-Negotiation with a link partner. The local device may be either a DTE or repeater. (See IEEE Std 802.3, Clause 28.)

1.4.383 Logical Link Identifier (LLID): A numeric identifier assigned to a P2MP association between an OLT and ONU established through the Point-to-Point Emulation sublayer. Each P2MP association is assigned a unique LLID. The P2MP association is bound to an ONU DTE, where the ONU MAC is to observe a private association. In Nx25G-EPON, an LLID is also a collective term that refers to a Physical Layer ID (PLID), management link ID (MLID), user link ID (ULID), and a group link ID (GLID).

1.4.384 Low Power Idle (LPI) mode: An optional mode intended to save power that may be enabled during periods of low link utilization in which either side of a link may disable portions of device or system functionality.

1.4.385 MAC frame: Consists of the Destination Address, Source Address, Length/Type field, MAC Client Data, Pad (if required), and Frame Check Sequence.

1.4.386 MAC Merge sublayer: An optional sublayer that supports interspersing express traffic with preemptable traffic by attaching an express Media Access Control (eMAC) and a preemptable Media Access Control (pMAC) to a single Physical Signaling Sublayer (PLS) service. (See IEEE Std 802.3, Clause 99.)

1.4.387 Management Information Base (MIB): A repository of information to describe the operation of a specific network device.

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1.4.388 management interface: An interface provided by both the Media Independent Interface (MII) or Gigabit Media Independent Interface (GMII) that provides access to management parameters and services.

1.4.389 master Physical Layer device (PHY): Within IEEE 802.3, in a 100BASE-T2, 1000BASE-T, 10BASE-T1L, 100BASE-T1, 1000BASE-T1, or any MultiGBASE-T link containing a pair of PHYs, the PHY that uses an external clock for generating its clock signals to determine the timing of transmitter and receiver operations. It also uses the master transmit scrambler generator polynomial for side-stream scrambling. Master and slave PHY status is determined during the Auto-Negotiation process that takes place prior to establishing the transmission link, or in the case of a PHY where Auto-Negotiation is optional and not used, master and slave PHY status is determined by management or hardware configuration. *See also:* **slave Physical Layer device (PHY).**

NOTE—Annex K defines optional alternative terminology for “master” and “slave”.

1.4.390 maximum differential input: The largest value of peak-to-peak differential (ppd) amplitude at which a receiver is expected to operate, under worst-case conditions, without exceeding the objective bit error ratio.

1.4.391 MCRS channel: In IEEE Std 802.3, Clause 143, an MCRS channel represents one of a number of defined paths along which data passes in an MCRS.

1.4.392 Media Access Control (MAC): The data link sublayer that is responsible for transferring data to and from the Physical Layer.

1.4.393 Media Independent Interface (MII): A transparent signal interface at the bottom of the Reconciliation sublayer. (See IEEE Std 802.3, Clause 22.)

1.4.394 Medium Attachment Unit (MAU): A device containing an Attachment Unit Interface (AUI), Physical Medium Attachment (PMA), and Medium Dependent Interface (MDI) that is used to connect a repeater or data terminal equipment (DTE) to a transmission medium.

1.4.395 Medium Dependent Interface (MDI): The mechanical and electrical or optical interface between the transmission medium and the MAU (e.g., 10BASE-T) or the PHY (e.g., 1000BASE-T) and also between the transmission medium and any associated (optional per IEEE Std 802.3, Clause 33, Clause 104, and Clause 145) Powered Device (PD) or Endpoint Power Sourcing Equipment (PSE).

1.4.396 Message Code (MC): The predefined 12-bit code contained in an Auto-Negotiation Message Page. (See IEEE Std 802.3, Clause 28.)

1.4.397 Message Page (MP): An Auto-Negotiation Next Page encoding that contains a predefined 12-bit Message Code. (See IEEE Std 802.3, Clause 28.)

1.4.398 midspan: An entity located within a link segment that is distinctly separate from and between the Medium Dependent Interfaces (MDIs).

1.4.399 Midspan PSE: Power Sourcing Equipment (PSE) that is located in the midspan.

1.4.400 Midspan PSE, 1000BASE-T: A Midspan PSE that results in a link that can support 10BASE-T, 100BASE-TX, and 1000BASE-T operation (see IEEE 802.3, Clause 33).

1.4.401 Midspan PSE, 10BASE-T/100BASE-TX: A Midspan PSE that results in a link that can only support 10BASE-T and 100BASE-TX operation (see IEEE 802.3, Clause 33).

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1.4.402 minimum differential sensitivity: The smallest value of peak-to-peak differential (ppd) amplitude at which a receiver is expected to operate, under worst-case conditions, without exceeding the objective bit error ratio.

1.4.403 mixing segment: A medium that may be connected to more than two Medium Dependent Interfaces (MDIs).

1.4.404 modulation error ratio (MER): The ratio of average signal constellation power to average constellation error power—that is, digital complex baseband signal-to-noise ratio—expressed in decibels.

1.4.405 Multi-Channel Reconciliation Sublayer (MCRS): The MCRS provides a mapping function that reconciles the signals at a specific Media Independent Interface (xMII) to a specific Media Access Control (MAC) Physical Signaling Sublayer (PLS) service definitions.

1.4.406 MultiGBASE-T: PHYs that belong to the set of specific BASE-T PHYs at speeds in excess of 1000 Mb/s, including 2.5GBASE-T, 5GBASE-T, 10GBASE-T, 25GBASE-T, and 40GBASE-T. [See IEEE Std 802.3, Clause 126 (for both 2.5GBASE-T and 5GBASE-T), Clause 55 (10GBASE-T) and Clause 113 (for both 25GBASE-T and 40GBASE-T).]

1.4.407 MultiGBASE-T1: PHYs that belong to the set of specific BASE-T1 PHYs at speeds in excess of 1000 Mb/s, including 2.5GBASE-T1, 5GBASE-T1, and 10GBASE-T1. (See IEEE Std 802.3, Clause 149.)

1.4.408 multi-level coset code (MLCC): A forward error correcting technique consisting of splitting the information bit stream among several levels, for each one a binary component code (possibly none) is employed with an error correction capability according to the reliability of each level in data transmission over noisy channels. (See IEEE Std 802.3, Clause 115.)

1.4.409 multiport device: A device with multiple instances of MDI. (See IEEE Std 802.3, Clause 40 and Clause 42.)

1.4.410 network control host: A network management central control center that is used to configure agents, communicate with agents, and display information collected from agents.

1.4.411 network interface device (NID): A device that contains a MDI or a PI.

1.4.412 Next Page: General class of pages optionally transmitted by Auto-Negotiation able devices following the base link codeword negotiation. (See IEEE Std 802.3, Clause 28.)

1.4.413 Next Page algorithm (NPA): The algorithm that governs Next Page communication. (See IEEE Std 802.3, Clause 28.)

1.4.414 Next Page bit: A bit in the Auto-Negotiation base link codeword or Next Page encoding(s) that indicates that further link codeword transfer is required. (See IEEE Std 802.3, Clause 28.)

1.4.415 nibble: A group of four data bits. The unit of data exchange on the Media Independent Interface (MII). (See IEEE Std 802.3, Clause 22.)

1.4.416 NLP: *See:* **Normal Link Pulse (NLP).**

1.4.417 Non-Return-to-Zero, Invert on Ones (NRZI): An encoding technique used in FDDI (ISO/IEC 9314-1:1989, ISO/IEC 9314-2:1989, ISO/IEC 9314-3:1989) where a polarity transition represents a logical ONE. The absence of a polarity transition denotes a logical ZERO.

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1.4.418 Non-Return-to-Zero, Invert on Ones (NRZI)-bit: A code-bit transferred in NRZI format. The unit of data passed across the Physical Medium Dependent (PMD) service interface in 100BASE-X.

1.4.419 normalized amplitude: The amplitude of a signal when driving its steady-state value; i.e., not under the influence of ringing or other dynamic influences.

1.4.420 Normal Link Pulse (NLP): An out-of-band communications mechanism used in 10BASE-T to indicate link status. (See IEEE Std 802.3, Figure 14–13.)

1.4.421 Normal Link Pulse (NLP) Receive Link Integrity Test function: A test function associated with Auto-Negotiation that allows backward compatibility with the 10BASE-T Link Integrity Test function of IEEE Std 802.3 Figure 14–6. (See IEEE Std 802.3, Clause 28.)

1.4.422 Normal Link Pulse (NLP) sequence: A Normal Link Pulse sequence, defined in IEEE Std 802.3, 14.2.1.1 as TP_IDL.

1.4.423 nPPI: The term “nPPI” denotes either XLPPI or CPPI or both. (See IEEE Std 802.3, Annex 86A.)

1.4.424 NRZI: *See:* **Non-Return-to-Zero, Invert on Ones**.

1.4.425 Nx25G-EPON: An EPON architecture operating at a number of different downstream and upstream speeds. This term collectively refers to 25/10G-EPON, 25/25G-EPON, 50/10G-EPON, 50/25G-EPON, and 50/50G-EPON architectures. (See IEEE Std 802.3, Clause 56.)

1.4.426 OAM Discovery: Process that detects the presence and configuration of the OAM sublayer in the remote DTE.

1.4.427 OFDM channel: See orthogonal frequency division multiplexing (OFDM) channel.

1.4.428 offline: In 1000BASE-X, a DTE in its nonfunctional state. (See IEEE Std 802.3, Clause 37.)

1.4.429 Operations, Administration, and Maintenance (OAM): A group of network support functions that monitor and sustain segment operation, activities that are concerned with, but not limited to, failure detection, notification, location, and repairs that are intended to eliminate faults and keep a segment in an operational state and support activities required to provide the services of a subscriber access network to users/subscribers.

1.4.430 optical distribution network (ODN): An optical distribution plant composed of fiber optic cabling and a passive optical splitter or cascade of splitters.

1.4.431 optical fiber: A filament-shaped optical waveguide made of dielectric materials.

1.4.432 Optical Fiber Cable Interface: *See:* **Fiber Optic Medium Dependent Interface (FOMDI)**.

1.4.433 optical fiber cable link segment: A length of optical fiber cable that contains two optical fibers and is composed of one or more optical fiber cable sections and their means of interconnection, with each optical fiber terminated at each end in the optical connector plug. (See IEEE Std 802.3, 9.9.5.1 and 9.9.5.1.)

1.4.434 Optical Idle Signal: The signal transmitted by the Fiber Optic Medium Attachment Unit (FOMAU) into its transmit optical fiber during the idle state of the DO circuit. (See IEEE Std 802.3, Clause 9.)

1.4.435 optical interface: The optical input and output connection interface to a 10BASE-FP Star. (See IEEE Std 802.3, Clause 15.)

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1.4.436 Optical Line Terminal (OLT): The network-end DTE for an optical access network. The OLT is the master entity in a P2MP network with regard to the MPCP protocol.

1.4.437 Optical Modulation Amplitude (OMA): The absolute difference between the optical power of a logic one level and the optical power of a logic zero level.

1.4.438 Optical Network Unit (ONU): The subscriber-end DTE to an optical access network. An ONU is a slave entity in a P2MP network with regard to the MPCP protocol.

1.4.439 ordered set: A single special code-group, a combination of special and data code-groups, or a combination of a control character and data characters that are used to send control and status information such as remote fault and local fault status over the link. Also used by the 1000BASE-X and 10GBASE-X PCS for delineation of a packet and synchronization between the transmitter and receiver circuits at opposite ends of a link. (See IEEE Std 802.3, Clause 36, Clause 48, Clause 49, Clause 55, and Clause 82.)

1.4.440 Organizationally Unique Identifier (OUI): A 24-bit unique number that identifies a manufacturer or other organization. While an OUI may be used as a globally unique identifier on its own, its primary purpose is to be extended to form universally administered, globally unique MAC addresses or other extended globally-unique identifiers. It may also be used as part of a context dependent identifier, as part of a protocol identifier, in other management data, etc. OUI and CID (see 1.4.267) are non-overlapping and therefore mutually unique.

NOTE—See https://standards.ieee.org/develop/regauth/

1.4.441 orthogonal frequency division multiplexing (OFDM) channel: A data transmission channel in which the transmitted data is carried over a number of orthogonal subcarriers.

1.4.442 out-of-band signaling: The transmission of a signal using a frequency that is within the pass band of the transmission facility but outside a frequency range normally used for data transmission. *Contrast with:* **in-band signaling**. (From IEEE Std 610.7-1995 [B38].)

1.4.443 overfilled launch: The overfilled launch condition that excites both radial and azimuthal modes defined in Annex D of ANSI/EIA/TIA-455-204-2013.

1.4.444 P2MP Discovery: Process by which the OLT finds a newly attached and active ONU in the P2MP network, and by which the OLT and ONU exchange registration information. The OLT sends a GATE flagged for discovery.

1.4.445 P2MP Discovery window: A time period in a given wavelength band used by the OLT exclusively for the discovery process.

1.4.446 P2MP Timestamp: The timestamp used to synchronize slaves (e.g., ONUs) with the master (OLT) and for the ranging process.

1.4.447 packet: Consists of a MAC frame as defined previously, preceded by the Preamble and the Start Frame Delimiter, encoded, as appropriate, for the Physical Layer type.

1.4.448 page: In Auto-Negotiation, the encoding for a link codeword. Auto-Negotiation can support an arbitrary number of link codeword encodings. The Base Page has a constant encoding as defined in 28.2.1.2. Additional pages may have a predefined encoding *(see:* **Message Page**) or may be custom encoded *(see:* **Unformatted Page**).

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1.4.449 pairset: Either of the two valid 4-conductor connections, Alternative A or Alternative B, as listed in IEEE Std 802.3, 145.2.4. The PSE Alternative A and Alternative B connections are referred to as Mode A and Mode B, respectively, at the PD.

1.4.450 PAM5×5: Within IEEE 802.3, a block coding technique utilizing a 5×5 matrix (representing two 5-level signals) to generate pairs of quinary codes representing data nibbles and control characters. In 100BASE-T2, PAM5×5 code pairs are sent in parallel across two wire pairs. (See IEEE Std 802.3, Clause 32.)

1.4.451 parallel detection: In Auto-Negotiation, the ability to detect 100BASE-TX and 100BASE-T4 technology specific link signaling while also detecting the Normal Link Pulse (NLP) sequence or Fast Link Pulse (FLP) Burst sequence. (See IEEE Std 802.3, Clause 28.)

1.4.452 Passive-Star Coupler: A component of a 10BASE-FP fiber optic mixing segment that divides optical power received at any of N input ports among all N output ports. The division of optical power is approximately uniform. (See IEEE Std 802.3, Clause 15.)

1.4.453 patch cord: Flexible cable unit or element with connector(s) used to establish connections on a patch panel. (From ISO/IEC 11801:1995.)

1.4.454 patch panel: A cross-connect designed to accommodate the use of patch cords. It facilitates administration for moves and changes. (From ISO/IEC 11801:1995.)

1.4.455 path: The sequence of segments and repeaters providing the connectivity between two DTEs in a single collision domain. In CSMA/CD networks there is one and only one path between any two DTEs.

1.4.456 Path Delay Value (PDV): The sum of all Segment Delay Values for all segments along a given path. (See IEEE Std 802.3, Clause 13 and Clause 29.)

1.4.457 Path Variability Value (PVV): The sum of all Segment Variability Values for all the segments along a given path. (See IEEE Std 802.3, Clause 13.)

1.4.458 pause: A mechanism for full duplex flow control. (See IEEE Std 802.3, Annex 31B.)

1.4.459 pause_quantum: The unit of measurement for pause time specified; 512 MAC bit times.

NOTE—See IEEE Std 802.3, Annex 31B.

1.4.460 payload pointer: An indicator of the location of the beginning of the synchronous payload envelope. This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.461 PCS lane (PCSL): In 40GBASE-R, 50GBASE-R, 100GBASE-R, 200GBASE-R, and 400GBASE-R, the PCS distributes encoded data to multiple logical lanes, these logical lanes are called PCS lanes. One or more PCS lanes can be multiplexed and carried on a physical lane together at the PMA service interface. (See IEEE Std 802.3, Clause 83, Clause 120, and Clause 135.)

1.4.462 Physical Coding Sublayer (PCS): Within IEEE 802.3, a sublayer used in certain port types to couple the Media Independent Interface (MII), Gigabit Media Independent Interface (GMII) or 10 Gigabit Media Independent Interface (XGMII) and the Physical Medium Attachment (PMA). The PCS contains the functions to encode data bits for transmission via the PMA and to decode the received conditioned signal from the PMA. There are several PCS structures. (For example, See IEEE Std 802.3, Clause 23, Clause 24, Clause 32, Clause 36, Clause 40, Clause 48, Clause 49, Clause 82, and Clause 96.)

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1.4.463 physical data block (PDB): The minimum data unit of 65 bits used to encode the GMII data stream. (See IEEE Std 802.3, Clause 115.)

1.4.464 physical header data (PHD): Side information block embedded inside a Transmit Block that is used to exchange control and for negotiation of PCS and PMA parameters between two link partners. (See IEEE Std 802.3, Clause 115.)

1.4.465 physical header subframe (PHS): Block of symbols that are the result of adding error detection and error correction parities plus modulation to PHD. (See IEEE Std 802.3, Clause 115.)

1.4.466 Physical Layer Collision Avoidance (PLCA): A method for generating transmit opportunities for 10BASE-T1S operating on mixing segments. (See IEEE Std 802.3, Clause 148.)

1.4.467 Physical Layer device (PHY): Within IEEE 802.3, the portion of the Physical Layer between the Medium Dependent Interface (MDI) and the media independent interface specific to the data rate (e.g., MII, GMII, XGMII). The PHY contains the functions that transmit, receive, and manage the encoded signals that are impressed on and recovered from the physical medium.

1.4.468 Physical Layer entity: *Syn:* **Physical Layer device.**

1.4.469 Physical Medium Attachment (PMA) sublayer: Within 802.3, that portion of the Physical Layer that contains the functions for transmission, reception, and (depending on the PHY) collision detection, clock recovery and skew alignment. (For example, See IEEE Std 802.3, Clauses 7, 12, 14, 16, 17, 18, 23, 24, 32, 36, 40, 51, 62, 63, 66, 83, and Clause 96.)

1.4.470 Physical Medium Dependent (PMD) sublayer: Within 802.3, that portion of the Physical Layer responsible for interfacing to the transmission medium. The PMD is located just above the Medium Dependent Interface (MDI). (For example, See IEEE Std 802.3, Clause 25, Clause 26, Clause 38, Clause 39, Clause 54, Clauses 58 to 60, Clause 62, Clause 63, and Clauses 84 to 89.)

1.4.471 Physical Signaling Sublayer (PLS): In 10BASE-T, that portion of the Physical Layer contained within the data terminal equipment (DTE) that provides the logical and functional coupling between the Medium Attachment Unit (MAU) and the Data Link Layer.

1.4.472 PoDL PD: A Powered Device that is intended to receive power from a link section consisting of a single twisted pair. (See IEEE Std 802.3, Clause 104.)

1.4.473 PoDL PSE: A device that provides power to a PoDL PD, connected via a link section consisting of a single twisted pair. DTE powering is intended to provide a single 100BASE-T1 or 1000BASE-T1 device with a unified interface for both the reception and transmission of data as well as the power to operate. (See IEEE Std 802.3, Clause 104.)

1.4.474 PoDL Regulated PSE: A PoDL PSE that is required to regulate the dc voltage at the PSE MDI/PI over the required range of PD load current.

1.4.475 PoDL Unregulated PSE: A PoDL PSE that is not required to regulate the voltage at the PSE MDI/PI over the required range of PD load current.

1.4.476 pointer: *See:* **payload pointer.**

1.4.477 Point-to-Multipoint network (P2MP): A network topology based on a centralized station connected to a number of end stations. Frames transit the network between the central station and the end stations and do not transit directly from end station to end station. (See IEEE Std 802.3, Clause 64, Clause 65, Clause 76, Clause 77, Clause 101, and Clause 103).

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1.4.478 Point-to-point emulation (P2PE): Emulation of private communication between two end-stations (e.g., ONU) in a P2MP. Emulation creates the equivalent of a star topology with the OLT in the nexus, and is required for compliance with IEEE 802.1Q bridging.

1.4.479 polarization dependent loss: The variation of insertion loss due to a variation of the state of polarization of an optical signal over all states of polarization within the channel frequency or wavelength range.

1.4.480 port: A segment or Inter-Repeater Link (IRL) interface of a repeater unit.

1.4.481 postamble: In 10BROAD36, the bit pattern appended after the last bit of the Frame Check Sequence by the Medium Attachment Unit (MAU). The Broadband End-of-Frame Delimiter (BEOFD). (See IEEE Std 802.3, Clause 11.)

1.4.482 power budget: The minimum optical power available to overcome the sum of attenuation plus power penalties of the optical path between the transmitter and receiver calculated as the difference between the transmitter launch power (min) and the receive power (min).

1.4.483 Powered Device (PD): A device that is either drawing power or requesting power from a PSE.

1.4.484 Power Interface (PI): The mechanical and electrical interface between the Power Sourcing Equipment (PSE) or Powered Device (PD) and the transmission medium. In an Endpoint PSE and in a PD the Power Interface is the MDI.

1.4.485 Power Sourcing Equipment (PSE): A DTE or midspan device that provides power to a single link section, which may also carry data (for 2 or 4 pair systems, see IEEE Std 802.3, Clause 33 and Clause 145; for single pair systems, see IEEE Std 802.3, Clause 104).

1.4.486 preemptable Media Access Control (pMAC): The instance of a Media Access Control sublayer (IEEE Std 802.3, Annex 4A) that is the client of a MAC Merge sublayer service interface that handles preemptable traffic. (See IEEE Std 802.3, Clause 99.)

1.4.487 preemptable traffic: Frames transmitted through a preemptable Media Access Control (pMAC) sublayer (See IEEE Std 802.3, Clause 99.)

1.4.488 prepend: To append to the beginning. For example, a Media Access Control (MAC) frame is prepended with a preamble, and appended with a frame check sequence (FCS).

1.4.489 Priority-based Flow Control (PFC): A mechanism for applying flow control to frames with a given priority on a full duplex link. (See IEEE Std 802.1Q.)

1.4.490 priority resolution: A mechanism that allows a local device and its link partner to resolve to a single mode of operation given a set of prioritized rules governing resolution. (See IEEE Std 802.3, Clause 28 and Clause 37.)

1.4.491 Priority Resolution Table: The look-up table used by Auto-Negotiation to select the network connection type where more than one common network ability exists (100BASE-TX, 100BASE-T4, 10BASE-T, etc.) The priority resolution table defines the relative hierarchy of connection types from the highest common denominator to the lowest common denominator. (See IEEE Std 802.3, Clause 28.)

1.4.492 PSE Group: A PSE or a collection of PSEs that can be related to the logical arrangement for management within an encompassing system.

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1.4.493 Q: In the context of a fiber optic communication system, one-half of the ratio of peak-to-peak signal to rms noise.

1.4.494 Q-tagged frame: A MAC frame with a specific EtherType value, and that has a maximum length of 1522 octets. (See IEEE Std 802.3, 3.2.7 and IEEE Std 802.1Q, Annex G.)

1.4.495 QTag Prefix: The first four octets of an Ethernet-encoded Tag Header. The Ethernet-encoded Tag Header is defined in IEEE Std 802.1Q.

1.4.496 quad: *See:* **star quad**.

1.4.497 quadrature amplitude modulation (QAM) symbol: The amplitude-phase representation of the bits of data that modulate a carrier signal or that modulate each of the subcarriers in OFDM.

1.4.498 quinary: Five-level.

1.4.499 quinary symbol: In 1000BASE-T, one of five numeric values corresponding to five voltage levels on a single balanced twisted pair. The values come from the set {2, 1, 0, –1, –2}. Table 40–1 lists groups of four quinary symbols. Idle is a special case where numeric values are limited to the set {2, 0, and –2}. (See IEEE Std 802.3, Clause 40.)

1.4.500 radial overfilled launch: A launch condition created when a multimode optical fiber is illuminated by the coherent optical output of a source operating in its lowest-order transverse mode in a manner that excites predominantly the radial modes of the multimode fiber.

1.4.501 ranging: A procedure by which the propagation delay between a master (e.g., OLT) and slave (e.g., ONU) is measured. The round trip delay computation is performed by the OLT, using the timestamp in MPCP messages from the ONU.

1.4.502 receiver training: Within IEEE 802.3, a startup routine in 100BASE-T2, 1000BASE-T, and 100BASE-T1 used to acquire receiver parameters and synchronize the scramblers of two connected Physical Layers (PHYs).

1.4.503 Reconciliation Sublayer (RS): A mapping function that reconciles the signals at the Media Independent Interface (MII) to the Media Access Control (MAC)-Physical Signaling Sublayer (PLS) service definitions. (See IEEE Std 802.3, Clause 22.)

1.4.504 reflectance: Ratio of reflected to incident power. This is the inverse of return loss.

1.4.505 relative intensity noise: The ratio of the variance in the optical power to the average optical power.

1.4.506 remote fault: The generic ability of a link partner to signal its status even in the event that it may not have an operational receive link. (See IEEE Std 802.3, Clause 28 and Clause 37.)

1.4.507 renegotiation: Restart of the Auto-Negotiation algorithm caused by management or user interaction. (See IEEE Std 802.3, Clause 28.)

1.4.508 repeater: Within IEEE 802.3, a device as specified in Clause 9 and Clause 27 that is used to extend the length, topology, or interconnectivity of the physical medium beyond that imposed by a single segment, up to the maximum allowable end-to-end transmission line length. Repeaters perform the basic actions of restoring signal amplitude, waveform, and timing applied to the normal data and collision signals. For wired star topologies, repeaters provide a data distribution function. In 100BASE-T, a device that allows the interconnection of 100BASE-T Physical Layer network segments using similar or dissimilar PHY

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implementations (e.g., 100BASE-X to 100BASE-X, 100BASE-X to 100BASE-T4). Repeaters are only for use in half duplex mode networks. (See IEEE Std 802.3, Clause 9 and Clause 27.)

1.4.509 repeater port: *See:* **port**.

1.4.510 repeater set: A repeater unit plus its associated Physical Layer interfaces [Medium Attachment Units (MAUs) or PHYs] and, if present, Attachment Unit (AU) or Media Independent (MI) interfaces (i.e., AUIs, MIIs).

1.4.511 repeater unit: The portion of a repeater that is inboard of its Physical Medium Attachment (PMA)/Physical Signaling Sublayer (PLS), or PMA/Physical Coding Sublayer (PCS) interfaces.

1.4.512 reserved: A key word indicating an object (bit, register, connector pin, encoding, interface signal, enumeration, etc.) to be defined only by this standard. A reserved object shall not be used for any user-defined purpose such as a user- or device-specific function; and such use of a reserved object shall render the implementation noncompliant with this standard.

1.4.513 retraining: Within IEEE 802.3, the process of re-acquiring receiver parameters and synchronizing the scramblers of two connected 100BASE-T2, 1000BASE-T, or 100BASE-T1 PHYs. *See:* **receiver training, blind mode.**

1.4.514 return loss: In 10BROAD36, the ratio in decibels of the power reflected from a port to the power incident to the port. An indicator of impedance matching in a broadband system. (See IEEE Std 802.3, Clause 11.)

1.4.515 RIN_xOMA: Relative intensity noise. Laser noise in dB/Hz with x dB optical return loss, with respect to the optical modulation amplitude.

1.4.516 rising edge: A rising edge for a differential signal pair, e.g., signal(P,N) is when, signal(P) transitions from logic low to high and signal(N) transitions from logic high to low.

1.4.517 RMS spectral width: A measure of the optical wavelength range as defined by IEC 61280-1-3.

1.4.518 router: A layer 3 interconnection device that appears as a Media Access Control (MAC) to a CSMA/CD collision domain. (See IEEE Std 610.7-1995 [B38].)

1.4.519 run length: The number of consecutive identical bits in a code-group. For example, the pattern 0011111010 has a run length of five. (See IEEE Std 802.3 Clause 36.)

1.4.520 run-length-limited code: Any transmission code that has limited run-length for its transmission. (See IEEE Std 802.3 Clause 36.)

1.4.521 running disparity: A binary parameter having a value of + or –, representing the imbalance between the number of ones and zeros in a sequence of 8B/10B code-groups. (See IEEE Std 802.3, 36.2.4.3.)

1.4.522 scrambler: A randomizing mechanism that is used to eliminate long strings of consecutive identical transmitted symbols and avoid the presence of spectral lines in the signal spectrum without changing the signaling rate. A self-synchronous scrambler is one in which the current state of the scrambler is the prior n bits of the scrambled output. Therefore, the descrambler can acquire the correct state directly from the received stream. A side-stream scrambler is one in which the current state of the scrambler is dependent only on the prior state of the scrambler and not on the transmitted data. Therefore, the descrambler has to acquire state either by searching for a state that decodes a known pattern or by agreement to start at a known state in synchronization with the scrambler. A frame-synchronous scrambler is a side-stream scrambler that begins each

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frame in a known state. This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.523 Seed: In 10BROAD36, the 23 bits residing in the scrambler shift register prior to the transmission of a packet. (See IEEE Std 802.3, Clause 11.)

1.4.524 segment: The medium connection, including connectors, between Medium Dependent Interfaces (MDIs) in a CSMA/CD local area network.

1.4.525 Segment Delay Value (SDV): A number associated with a given segment that represents the delay on that segment including repeaters and end stations, if present, used to assess path delays for 10 Mb/s CSMA/CD networks. (See IEEE Std 802.3, 13.4.)

1.4.526 Segment Variability Value (SVV): A number associated with a given segment that represents the delay variability on that segment (including a repeater) for 10 Mb/s CSMA/CD networks. The SVVs for different segment types are specified in IEEE Std 802.3, Table 13–3. (See IEEE Std 802.3, 13.4.)

1.4.527 shared service: A CSMA/CD network in which the collision domain consists of more than two DTEs so that the total network bandwidth is shared among them.

1.4.528 shielded twisted-pair (STP) cable: An electrically conducting cable, comprising one or more elements, each of which is individually shielded. There may be an overall shield, in which case the cable is referred to as shielded twisted-pair cable with an overall shield (from ISO/IEC 11801:1995). Specifically for IEEE 802.3 100BASE-TX, 150 Ω balanced inside cable with performance characteristics specified to 100 MHz (i.e., performance to Class D link standards as per ISO/IEC 11801:1995). In addition to the requirements specified in ISO/IEC 11801:1995, IEEE Std 802.3, Clause 23 and Clause 25, provide additional performance requirements for 100BASE-T operation over STP.

1.4.529 simplex fiber optic link segment: A single fiber path between two Medium Attachment Units (MAUs) or PHYs, including the terminating connectors, consisting of one or more fibers joined serially with appropriate connection devices, for example, patch cables and wall plates. (See IEEE Std 802.3, Clause 15.)

1.4.530 simplex link segment: A path between two Medium Dependent Interfaces (MDIs), including the terminating connectors, consisting of one or more segments of twisted pair cable joined serially with appropriate connection devices, for example, patch cords and wall plates. (See IEEE Std 802.3, Figure 14–2.)

1.4.531 single-port device: A device with a single instance of MDI. (See IEEE Std 802.3, Clause 40.)

1.4.532 single-signature PD: A PD that simultaneously shares the same detection signature, class signature, and maintain power signature between both pairsets. (See IEEE Std 802.3, Clause 145.)

1.4.533 single twisted-pair copper cable: Two insulated conductors twisted together in a regular fashion to form a balanced transmission line.

1.4.534 skew between pairs: The difference in arrival times of two initially coincident signals propagated over two different pairs, as measured at the receiving end of the cable. Total skew includes contributions from transmitter circuits as well as the cable.

1.4.535 slave Physical Layer device (PHY): Within IEEE 802.3, in a 100BASE-T2, 1000BASE-T, 10BASE-T1L, 100BASE-T1, 1000BASE-T1, or any MultiGBASE-T link containing a pair of PHYs, the PHY that recovers its clock from the received signal and uses it to determine the timing of transmitter operations. It also uses the slave transmit scrambler generator polynomial for side-stream scrambling. Master and slave PHY status is determined during the Auto-Negotiation process that takes place prior to establishing the transmission link, or in the case of a PHY where Auto-Negotiation is optional and not used,

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master and slave PHY status is determined by management or hardware configuration. *See also:* **master Physical Layer device (PHY).**

NOTE—Annex K defines optional alternative terminology for “master” and “slave”.

1.4.536 sliver: A pulse with a duration less than that specified for that signal (e.g., truncated clock signal).

1.4.537 special link (SL): A transmission system that replaces the normal medium. (See IEEE Std 802.3, 12.8.)

1.4.538 spectral width, full-width half maximum (FWHM): The absolute difference between the wavelengths at which the spectral radiant intensity is 50% of the maximum. (See IEEE Std 802.3, Clause 15.)

1.4.539 spectrum mask: A graphic representation of the required power distribution as a function of frequency for a modulated transmission.

1.4.540 star quad: A cable element that comprises four insulated connectors twisted together. Two diametrically facing conductors form a transmission pair.

NOTE—Cables containing star quads can be used interchangeably with cables consisting of pairs, provided the electrical characteristics meet the same specifications. (From ISO/IEC 11801.)

1.4.541 Start_of_Packet Delimiter (SPD): In 1000BASE-X, a single code-group 8B/10B ordered set used to delineate the starting boundary of a data transmission sequence for a single packet. (See IEEE Std 802.3, Clause 36.)

1.4.542 Start-of-Stream Delimiter (SSD): Within IEEE 802.3, a pattern of defined codewords used to delineate the boundary of a data transmission sequence on the Physical Layer stream. The SSD is unique in that it may be recognized independent of previously defined code-group boundaries and it defines subsequent code-group boundaries for the stream it delimits. For 100BASE-T4, SSD is a pattern of three predefined sosb code-groups (one per wire pair) indicating the positions of the first data code-group on each wire pair. For 100BASE-X, SSD consists of the code-group sequence /J/K/. For 100BASE-T2, the SSD is indicated by two consecutive pairs of predefined PAM5×5 symbols (±2, ±2) (±2, 0) which are generated using unique SSD/ESD coding rules. For 1000BASE-T, the SSD is indicated by two consecutive vectors of four quinary symbols as specified in Table 40–1. For 100BASE-T1, the SSD consists of three code-groups, as defined in 96.3.3.3.5.

1.4.543 stream: The Physical Layer encapsulation of a Media Access Control (MAC) frame. Depending on the particular PHY, the MAC frame may be modified or have information appended or prepended to it to facilitate transfer through the Physical Medium Attachment (PMA). Any conversion from a MAC frame to a PHY stream and back to a MAC frame is transparent to the MAC. (See IEEE Std 802.3, Clause 23 and Clause 24.)

1.4.544 switch: *Syn:* **bridge.**

1.4.545 symbol: Within IEEE 802.3, the smallest unit of data transmission on the medium. Symbols are unique to the coding system employed. For example, 100BASE-T4 and 100BASE-T1 use ternary symbols; 10BASE-T uses Manchester symbols; 100BASE-X uses binary symbols or code-bits; 100BASE-T2 and 1000BASE-T uses quinary symbols. For 1000BASE-X PMDs operating at 1.25 GBd, a symbol corresponds to a code-bit after the 8B/10B encoding operation i.e., has the duration of 0.8 ns. For 10GBASE-R PMDs operating at 10.3125 GBd, a symbol corresponds to a code-bit after the 64B/66B encoding operation i.e., has the duration of approximately 0.097 ns.

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1.4.546 symbol period: In 1000BASE-T, the time interval for transmission of one code-group. This is equivalent to 8 ns. In 100BASE-T1, this is equivalent to 15 ns with a code-group of 30 ns. (See IEEE Std 802.3, Clause 40 and Clause 96.)

1.4.547 symbol rate (SR): Within IEEE 802.3, the total number of symbols per second transferred to or from the Medium Dependent Interface (MDI) on a single wire pair. For 100BASE-T4, the symbol rate is 25 MBd; for 100BASE-X, the symbol rate is 125 MBd; for 100BASE-T2, the symbol rate is 25 MBd; for 1000BASE-T, the symbol rate is 125 MBd; for 100BASE-T1, the symbol rate is $66.66\overline{6}$ MBd.

1.4.548 symbol time (ST): The duration of one symbol as transferred to and from the Medium Dependent Interface (MDI) via a single wire pair. The symbol time is the reciprocal of the symbol rate.

1.4.549 Synchronous Payload Envelope (SPE): A 125 μs frame structure composed of STS Path Overhead and bandwidth for payload (payload capacity). The equivalent SDH term is Virtual Container (VC). This definition is derived from ATIS-0600416.1999(R2010) and ATIS-0900105.2008, which take precedence.

1.4.550 ternary symbol: In 10BASE-T1L, 100BASE-T4, and 100BASE-T1, a ternary data element. A ternary symbol can have one of three values: –1, 0, or +1. (See IEEE Std 802.3, Clause 23, Clause 96, and Clause 146.)

1.4.551 time_quantum: The unit of measurement for time related parameters specified in Multipoint MAC Control.

NOTE—See Clause 64, Clause 77, and Clause 103. The value of time_quantum is defined in 64.2.2.1.

1.4.552 Time Synchronization Service Interface (TSSI): Time Synchronization Service Interface (TSSI) between the generic Reconciliation Sublayer and a TimeSync client. (See IEEE Std 802.3, Clause 90.)

1.4.553 Tomlinson-Harashima precoder (THP): A precoding technique for intersymbol interference mitigation. (See IEEE Std 802.3, Clause 55 and Clause 115.)

1.4.554 transition density: The number of times the stream of bits within an 8B/10B code-group changes its value. (See IEEE Std 802.3, Clause 36.)

1.4.555 translation: In a single-cable 10BROAD36 system, the process by which incoming transmissions at one frequency are converted into another frequency for outgoing transmission. The translation takes place at the headend. (See IEEE Std 802.3, Clause 11.)

1.4.556 transmitter and dispersion penalty: A measure of the performance of a transmitter relative to an ideal transmitter. (See IEEE Std 802.3, 52.9.10 and 58.7.9.)

1.4.557 truncation loss: In a modulated data waveform, the power difference before and after implementation filtering necessary to constrain its spectrum to a specified frequency band.

1.4.558 trunk cable: The main (often large diameter) cable of a coaxial cable system. *See also:* **drop cable**.

1.4.559 twinaxial cable: A cable similar to coaxial cable in construction but containing two insulated inner conductors rather than one.

1.4.560 twinaxial cable assembly: An assembly containing multiple twinaxial cables, terminated in a connector at each end, for use as a link segment between MDIs, such as that used in 10GBASE-CX4.

1.4.561 twisted pair: A cable element that consists of two insulated conductors twisted together in a regular fashion to form a balanced transmission line. (From ISO/IEC 11801:1995.)

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1.4.562 twisted-pair cable: A bundle of multiple twisted pairs within a single protective sheath. The bundle may be unshielded or enclosed by an overall shield.

1.4.563 twisted-pair cable binder group: A group of twisted pairs within a cable that are bound together. Large telephone cables have multiple binder groups with high interbinder group near-end crosstalk loss.

1.4.564 twisted-pair link: A twisted-pair cable plus connecting hardware. (From ISO/IEC 11801:1995.) (See also IEEE Std 802.3, 14.1.2.)

1.4.565 twisted-pair link segment: In 100BASE-T, a twisted-pair link for connecting two Physical Layer devices (PHYs). (See also IEEE Std 802.3, 14.1.2.)

1.4.566 Twisted Pair Medium Dependent Interface (TP MDI): The mechanical and electrical interface between the transmission medium and the Medium Attachment Unit (MAU) or PHY, e.g., 10BASE-T, 100BASE-TX, or 1000BASE-T.

1.4.567 Type 1 PD: A PD that requests Class 0 to Class 3 during Physical Layer classification, and that is not a PoDL PD. (See IEEE Std 802.3, Clause 33.)

1.4.568 Type 1 PSE: A PSE that supports Class 0 to Class 3 power levels and provides power over 2 pairs. (See IEEE Std 802.3, Clause 33.)

1.4.569 Type 2 PD: A PD that requests Class 4 during Physical Layer classification, supports 2-Event Classification, and supports Data Link Layer classification. (See IEEE Std 802.3, Clause 33.)

1.4.570 Type 2 PSE: A PSE that supports Class 0 to Class 4 power levels and provides power over 2 pairs. (See IEEE Std 802.3, Clause 33.)

1.4.571 Type 3 PD: A single-signature PD that requests Class 1 to Class 6, or a dual-signature PD that requests Class 1 to Class 4 on both Modes, during Physical Layer classification. Additionally, the PD implements Multiple-Event classification and accepts power on both Modes simultaneously. (See IEEE Std 802.3, Clause 145.)

1.4.572 Type 3 PSE: A PSE that supports up to Class 6 power levels, supports short MPS, and may support 4-pair power. (See IEEE Std 802.3, Clause 145.)

1.4.573 Type 4 PD: A single-signature PD that requests Class 7 or Class 8, or a dual-signature PD that request Class 5 on at least one Mode, during Physical Layer classification. Additionally, the PD implements Multiple-Event classification, is capable of Data Link Layer classification, and accepts power on both Modes simultaneously. (See IEEE Std 802.3, Clause 145.)

1.4.574 Type 4 PSE: A PSE that supports at least Class 7 power levels, in addition to lower PD Classes, short MPS, and 4-pair power. (See IEEE Std 802.3, Clause 145.)

1.4.575 Type A PoDL System: A system comprising a PoDL PSE, link section, and PD that are compatible with 100BASE-T1 PHYs.

1.4.576 Type B PoDL System: A system comprising a PoDL PSE, link section, and PD that are compatible with 1000BASE-T1 PHYs.

1.4.577 Type C PoDL System: A PoDL PSE, link section, and PD that are compatible with both 100BASE-T1 and 1000BASE-T1 PHYs.

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1.4.578 Type D PoDL System: A PoDL PSE, link section, and PD that lack a data entity or are incompatible with IEEE 802.3 PHYs.

1.4.579 Type E PoDL System: A system comprising a PoDL PSE, link section, and PD that are compatible with 10BASE-T1L PHYs.

1.4.580 Type F PoDL System: A system comprising a PoDL PSE, link section, and PD that are compatible with 2.5GBASE-T1, 5GBASE-T1, and 10GBASE-T1.

1.4.581 type, length, value (TLV): A short, variable length encoding of an information element consisting of sequential type, length, and value fields where the type field identifies the type of information, the length field indicates the length of the information field in octets, and the value field contains the information, itself. (See IEEE Std 802.3, 57.5.2 and 57.5.3.)

1.4.582 uncorrelated jitter: Jitter that is not associated with the sequence being transmitted. (See IEEE Std 802.3, 68.6.8.)

1.4.583 Unformatted Page (UP): A Next Page encoding that contains an unformatted 12-bit message field. Use of this field is defined through message codes and information contained in the UP. (See IEEE Std 802.3, 28.2.1.2.)

1.4.584 unit interval (UI): A period of time, usually allocated for the transmission of one symbol on one channel; the inverse of the modulation rate. Generally not the same as bit time (BT).

1.4.585 unshielded twisted-pair cable (UTP): An electrically conducting cable, comprising one or more pairs, none of which are shielded.

1.4.586 upstream: In an access network, transmission away from the subscriber end of the link. Applicable to networks where there is a clear indication in each deployment as to which end of a link is closer to a subscriber.

1.4.587 WAN Interface Sublayer (WIS): Within 10GBASE-W, a sublayer used to couple the Physical Coding Sublayer (PCS) and the Physical Medium Attachment (PMA) sublayer. The WIS contains functions to perform SONET STS-192c/SDH VC-4-64c framing and scrambling. (See IEEE Std 802.3, Clause 50.)

1.4.588 weight of 6T code group: The algebraic sum of the logical ternary symbol values listed in the 100BASE-T4 8B6T code table. (See IEEE Std 802.3, Clause 23.)

1.4.589 worst-case modal bandwidth (WCMB): The lowest value of the modal bandwidth found when measured using either an overfilled launch (OFL) or a radial overfilled launch (ROFL).

1.4.590 zero dispersion wavelength: That wavelength where the chromatic dispersion of a fiber is zero.

1.5 Abbreviations

This standard contains the following abbreviations:

100GAUI	100 Gb/s Attachment Unit Interface
10P	label to indicate “pertains to 10PASS-TS port-type”
10P/2B	label to indicate “pertains to 10PASS-TS and 2BASE-TL port-types”
2.5GPII	2.5 Gb/s PCS Internal Interface
2.5GSEI	2.5 Gb/s Storage Enclosure Interface
200GAUI-n	200 Gb/s Attachment Unit Interface over n lanes

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