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IEEE Std 802.3™-2018
(Revision of
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IEEE Computer Society

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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 (PHY) 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; 100 Gigabit Ethernet; 200 Gigabit Ethernet; 400 Gigabit Ethernet; attachment unit interface; AUI; Auto-Negotiation; Backplane Ethernet; data processing; DTE Power via the MDI; Energy Efficient Ethernet; EPoC; EPON; EPON Protocol over Coax; Ethernet; Ethernet in the First Mile; Ethernet passive optical network; express traffic; Fast Ethernet; Gigabit Ethernet; IEEE 802.3™; information exchange; LAN; local area network; management; MDI; medium dependent interface; media independent interface; MIB; MII; MPMC; multi-point MAC control; PCS; PHY; physical coding sublayer; Physical Layer; physical medium attachment; physical medium dependent; PMA; PMD; PoDL; Power over Data Lines; Power over Ethernet; reconciliation sublayer; repeater; RS; type field; VLAN tag

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Participants

The following individuals were officers and members of the IEEE 802.3 working group at the beginning of the IEEE 802.3cj working group ballot.

David J. Law, *IEEE 802.3 Working Group Chair*
Adam Healey, *IEEE 802.3 Working Group Vice-Chair*
Pete Anslow, *IEEE 802.3 Working Group Secretary*
Steven B. Carlson, *IEEE 802.3 Working Group Executive Secretary*
Valerie Maguire, *IEEE 802.3 Working Group Treasurer*

Adam Healey, *IEEE P802.3 (IEEE 802.3cj) Task Force Chair* and *Editor-in-Chief*
Pete Anslow, *IEEE P802.3 (IEEE 802.3cj) Task Force Section Editor*
Marek Hajduczenia, *IEEE P802.3 (IEEE 802.3cj) Task Force Section Editor*

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	Working Group officers, Task Force Chair, and Task Force Editors as listed in the document
IEEE Std 802.3-1985, Original 10 Mb/s standard, MAC, PLS, AUI, 10BASE5	23 June 1983	**Donald C. Loughry,** *Working Group Chair*
IEEE Std 802.3b-1985 (Clause 11), 10 Mb/s Broadband MAU, 10BROAD36	19 September 1985	**Donald C. Loughry,** *Working Group Chair* **Menachem Abraham,** *Task Force Chair*
IEEE Std 802.3a-1988 (Clause 10), 10 Mb/s MAU 10BASE2	15 November 1985	**Donald C. Loughry,** *Working Group Chair* **Alan Flatman,** *Task Force Chair*
IEEE Std 802.3c-1985 (9.1–9.8), 10 Mb/s Baseband Repeater	12 December 1985	**Donald C. Loughry,** *Working Group Chair* **Geoffrey O. Thompson,** *Task Force Chair*
IEEE Std 802.3e-1987 (Clause 12), 1 Mb/s MAU and Hub 1BASE5	11 June 1987	**Donald C. Loughry,** *Working Group Chair* **Robert Galin,** *Task Force Chair*
IEEE Std 802.3d-1987 (9.9), 10 Mb/s Fiber MAU, FOIRL	10 December 1987	**Donald C. Loughry,** *Working Group Chair* **Steven Moustakas,** *Task Force Chair*
IEEE Std 802.3h-1990 (Clause 5), 10 Mb/s Layer Management, DTEs	28 September 1990	**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	**Donald C. Loughry**, *Working Group Chair* **Patricia Thaler,** *Task Force Chair (initial)* **Richard Anderson,** *Task Force Chair (final)*
IEEE Std 802.3k-1993 (Clause 19), 10 Mb/s Layer Management, Repeaters	17 September 1992	**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	**Patricia Thaler,** *Working Group Chair* **Mike Armstrong,** *Task Force Chair* and *Editor* **Paul Nikolich,** *Vice Chair* **William Randle,** *Editorial Coordinator*

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IEEE Std 802.3p-1993 (Clause 20), Management, 10 Mb/s Integrated MAUs	17 June 1993	**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)	**Patricia Thaler,** *Working Group Chair* **Joseph S. Skorupa,** *Task Force Chair* **Geoffrey O. Thompson,** *Vice Chair* and *Editor*
IEEE Std 802.3j-1993 (Clauses 15–18), 10 Mb/s Fiber MAUs 10BASE-FP, 10BASE-FB, and 10BASE-FL	15 September 1993	**Patricia Thaler,** *Working Group Chair* **Keith Amundsen,** *Task Force Chair (initial)* **Frederick Scholl,** *Task Force Chair (final)* **Michael E. Lee,** *Technical Editor*
IEEE Std 802.3t-1995, 120 Ω informative annex to 10BASE-T	14 June 1995	**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	**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)*
IEEE Std 802.3m-1995, Maintenance 2	21 September 1995	**Patricia Thaler,** *Working Group Chair* **Gary Robinson,** *Maintenance Chair*
IEEE Std 802.3n-1995, Maintenance 3	21 September 1995	**Patricia Thaler,** *Working Group Chair* **Gary Robinson,** *Maintenance Chair*
IEEE Std 802.3s-1995, Maintenance 4	21 September 1995	**Geoffrey O. Thompson,** *Working Group Chair* **Gary Robinson,** *Maintenance Chair*
IEEE Std 802.3v-1995, 150 Ω informative annex to 10BASE-T	12 December 1995	**Geoffrey O. Thompson,** *Working Group Chair* **Larry Nicholson,** *Task Force Chair*
IEEE Std 802.3r-1996 (8.8), Type 10BASE5 Medium Attachment Unit PICS proforma	29 July 1996	**Patricia Thaler,** *Working Group Chair* **Imre Juhász**, *Task Force Chair* **William Randle,** *Task Force Editor*
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	**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	**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	**Geoffrey O. Thompson,** *Working Group 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	**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 802.3ab-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	**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*

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IEEE Std 802.3ad-2000 (Clause 43), Aggregation of Multiple Link Segments	30 March 2000	**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 Co-Editor*
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	**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	**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*
IEEE Std 802.3af-2003, (Clause 33) Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)	12 June 2003	**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)*
IEEE Std 802.3aj-2003, Maintenance 7	11 September 2003	**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	**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*
IEEE Std 802.3ah-2004, Media Access Control Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks	6 April 2005	**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*
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	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Chair, Task Force Chief Editor* **Wael W. Diab,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary*
IEEE Std 802.3an-2006, Physical Layer and Management Parameter for 10 Gb/s Operation, Type 10GBASE-T	8 June 2006	**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*
IEEE Std 802.3-2005/Cor 1-2006 (IEEE 802.3au), DTE Power via MDI Isolation corrigendum	8 June 2006	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Chair,* and *Task Force Editor* **Wael W. Diab**, *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary*

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IEEE Std 802.3aq-2006, Physical Layer and Management Parameters for 10 Gb/s Operation, Type 10GBASE-LRM	15 September 2006	**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*
IEEE Std 802.3as-2006, Frame format extensions	15 September 2006	**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 802.3ap-2007, Ethernet Operation over Electrical Backplanes	22 March 2007	**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* **Schelto vanDoorn,** *Task Force Editor-in-Chief (Phase 1)* **Ilango S. Ganga,** *Task Force Editor-in-Chief (Phase 2)*
IEEE Std 802.3-2005/Cor 2-2007 (IEEE 802.3aw), 10GBASE-T corrigendum	7 June 2007	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Chair,* and *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	**Robert M. Grow,** *Working Group Chair* **David J. Law,** *Working Group Vice Chair, Task Force Chair,* and *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	**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*
IEEE Std 802.3av-2009 Physical Layer Specifications and Management Parameters for 10 Gb/s Passive Optical Networks	11 September 2009	**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*
IEEE Std 802.3bc-2009 Ethernet Organizationally Specific Type, Length, Value (TLVs)	11 September 2009	**David J. Law,** *Working Group Chair* and *Task Force Editor* **Wael W. Diab,** *Working Group Vice Chair* and *Task Force Chair* **Steven B. Carlson,** *Working Group Executive Secretary* **Adam Healey,** *Working Group Secretary* **Bradley Booth,** *Working Group Treasurer*
IEEE Std 802.3-2008/Cor 1-2009 (IEEE 802.3bb) Pause Reaction Delay Corrigendum.	9 December 2009	**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 802.3 document	Date approved by IEEE	Working Group officers, Task Force Chair, and Task Force Editors as listed in the document
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	**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 802.3az-2010 Media Access Control Parameters, Physical Layers, and Management Parameters for Energy-Efficient Ethernet	30 September 2010	**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 802.3bg-2011 Physical Layer and Management Parameters for Serial 40 Gb/s Ethernet Operation Over Single-Mode Fiber	31 March 2011	**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 802.3bf-2011 Media Access Control (MAC) Service Interface and Management Parameters to Support Time Synchronization Protocols	16 May 2011	**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 802.3bd-2011 MAC Control Frame for Priority-based Flow Control	16 June 2011	**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 802.3-2012 (IEEE 802.3ah), Maintenance #10 (Revision of the base), Standard for Ethernet	28 December 2012	**David J. Law,** *Working Group Chair* **Wael William Diab,** *Working Group Vice-Chair, Task Force Chair,* and *Task Force Editor-in-Chief* **Adam Healey,** *Working Group Secretary* **Steven B. Carlson,** *Working Group Executive Secretary* **Valerie Maguire,** *Working Group Treasurer*
IEEE Std 802.3bk-2013 Physical Layer Specifications and Management Parameters for Extended Ethernet Passive Optical Networks	23 August 2013	**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*
IEEE Std 802.3bj-2014 Physical Layer Specifications and Management Parameters for 100 Gb/s Operation Over Backplanes and Copper Cables	12 June 2014	**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),* and *Task Force Chair (final)* **Peter 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	**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*

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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*
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*

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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 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*

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Introduction

This introduction is not part of IEEE Std 802.3-2018, 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. Ethernet at 10 Mb/s was approved as an IEEE standard by the IEEE Standards Board in 1983 and subsequently published in 1985 as IEEE Std 802.3-1985. Since 1985, new media options, new speeds of operation, and new capabilities have been added to IEEE Std 802.3. A full duplex MAC protocol was added in 1997.

Some of the major additions to IEEE Std 802.3 are identified in the marketplace with their project number. This is most common for projects adding higher speeds of operation or new protocols. For example, IEEE Std 802.3u™ added 100 Mb/s operation (also called Fast Ethernet), IEEE Std 802.3z added 1000 Mb/s operation (also called Gigabit Ethernet), IEEE Std 802.3ae added 10 Gb/s operation (also called 10 Gigabit Ethernet), IEEE Std 802.3ah™ specified access network Ethernet (also called Ethernet in the First Mile) and IEEE Std 802.3ba added 40 Gb/s operation (also called 40 Gigabit Ethernet) and 100 Gb/s operation (also called 100 Gigabit Ethernet). These major additions are all now included in and are superseded by IEEE Std 802.3-2015 and are not maintained as separate documents.

At the date of IEEE Std 802.3-2018 publication, IEEE Std 802.3 is composed of the following documents:

IEEE Std 802.3-2018

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

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

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

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

Section Five—Includes Clause 56 through Clause 77 and Annex 57A through Annex 76A. Clause 56 through Clause 67 and Clause 75 through Clause 77, as well as associated annexes, specify subscriber access and other Physical Layers and sublayers for operation from 512 kb/s to 10 Gb/s, and defines 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 126 and Annex 119A through Annex 120E. Clause 116 through Clause 124 and associated annexes include general information on 200 Gb/s and 400 Gb/s operation as well as 200 Gb/s and 400 Gb/s Physical Layer specifications. Clause 125 and Clause 126 include general information on 2.5 Gb/s and 5 Gb/s operation as well as 2.5 Gb/s and 5 Gb/s Physical Layer specifications.

A companion document IEEE Std 802.3.1 describes Ethernet management information base (MIB) modules for use with the Simple Network Management Protocol (SNMP). IEEE Std 802.3.1 is updated to add management capability for enhancements to IEEE Std 802.3 after approval of the 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.

Acknowledgments

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IEEE Standard for Ethernet

SECTION ONE

This section includes Clause 1 through Clause 20, Annex A through Annex H, and Annex 4A.

Contents

IEEE Standard for Ethernet

Section One: This section includes Clause 1 through Clause 20, Annex A through Annex H, and Annex 4A.

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 entities (PHY). 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.