

802.3™

IEEE Standard for
Information technology—

Telecommunications and information
exchange between systems—

Local and metropolitan area networks—

Specific requirements

**Part 3: Carrier sense multiple access with
collision detection (CSMA/CD) access
method and physical layer specifications**

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee



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Abstract: The media access control characteristics for the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method for shared medium local area networks are described. The control characteristics for full duplex dedicated channel use are also described. Specifications are provided for MAU types 1BASE5 at 1 Mb/s; Attachment Unit Interface (AUI) and MAU types 10BASE5, 10BASE2, FOIRL (fiber optic inter-repeater link), 10BROAD36, 10BASE-T, 10BASE-FL, 10BASE-FB, and 10BASE-FP at 10 Mb/s; Media Independent Interface (MII) and PHY types 100BASE-T4, 100BASE-TX, 100BASE-FX, and 100BASE-T2 at 100 Mb/s; and the Gigabit MII (GMII) and 1000BASE-X PHY types, 1000BASE-SX, 1000BASE-LX, and 1000BASE-CX, which operate at 1000 Mb/s (Gigabit Ethernet) as well as PHY type 1000BASE-T. Repeater specifications are provided at each speed. Full duplex specifications are provided at the Physical Layer for 10BASE-T, 10BASE-FL, 100BASE-TX, 100BASE-FX, 100BASE-T2, and Gigabit Ethernet. System considerations for multisegment networks at each speed and management information base (MIB) specifications and additions to support Virtual Bridged Local Area Networks (VLANs) as specified in IEEE P802.1Q are also provided. Also specified is an optional Link Aggregation sublayer which multiple physical links to be aggregated together to form a single logical link.

Keywords: Aggregated Link; Aggregator; Auto Negotiation; Category 5; copper; data processing; Ethernet; gigabit; information interchange; Link Aggregation; local area networks, management; MASTER-SLAVE; medium dependent interface; mode of data transmission; models; network interconnection; physical coding sublayer; Physical Layer; physical medium attachment; repeater; type field; VLAN TAG

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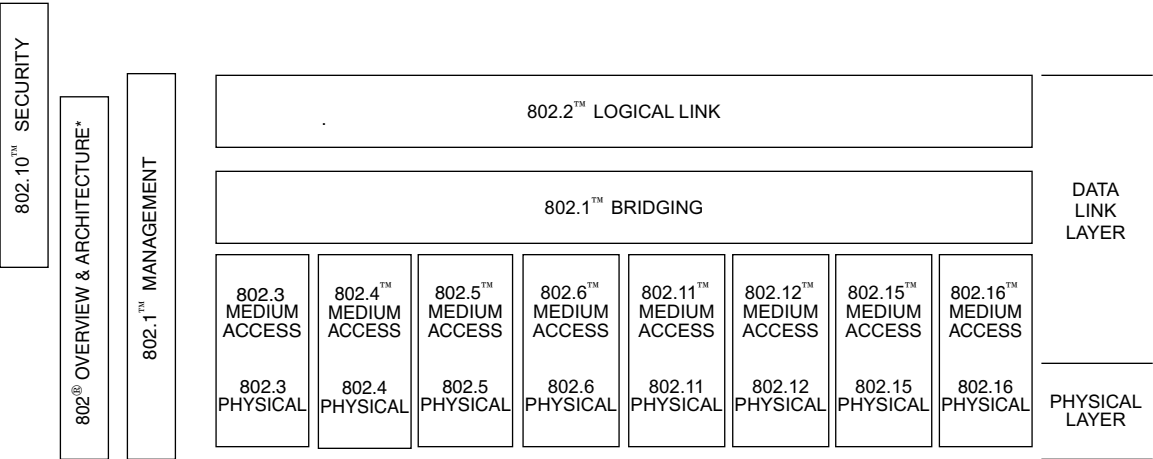
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¹Interpretations provided by 802.3 since November 1996 are available at <http://www.ieee802.org/3/interp/index.html>



Introduction to IEEE Std 802.3-2002

This standard is part of a family of standards for local and metropolitan area networks. The relationship between the standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.¹)



* Formerly IEEE Std 802.1A™

This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model (ISO/IEC 7498-1: 1994). The access standards define seven types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining the technologies noted above are as follows:

- IEEE Std 802 *Overview and Architecture.* This standard provides an overview to the family of IEEE 802 Standards.
- IEEE Std 802.1B™ and 802.1k™ [ISO/IEC 15802-2] *LAN/MAN Management.* Defines an OSI management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- IEEE Std 802.1D™ *Media Access Control (MAC) Bridges.* Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- IEEE Std 802.1E™ [ISO/IEC 15802-4] *System Load Protocol.* Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- IEEE Std 802.1F™ *Common Definitions and Procedures for IEEE 802 Management Information*
- IEEE Std 802.1G™ [ISO/IEC 15802-5] *Remote Media Access Control (MAC) Bridging.* Specifies extensions for the interconnection, using non-LAN communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.
- IEEE Std 802.1H™ [ISO/IEC TR 11802-5] *Media Access Control (MAC) Bridging of Ethernet V2.0 in Local Area Networks.*

¹The IEEE standards referred to in the above figure and list are trademarks of the Institute of Electrical and Electronics Engineers, Inc.

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- IEEE Std 802.2 [ISO/IEC 8802-2] *Logical Link Control.*
- IEEE Std 802.3 *CSMA/CD Access Method and Physical Layer Specifications.*
- IEEE Std 802.4 [ISO/IEC 8802-4] *Token Passing Bus Access Method and Physical Layer Specifications.*
- IEEE Std 802.5 [ISO/IEC 8802-5] *Token Ring Access Method and Physical Layer Specifications.*
- IEEE Std 802.6 [ISO/IEC 8802-6] *Distributed Queue Dual Bus Access Method and Physical Layer Specifications.*
- IEEE Std 802.10 *Interoperable LAN/MAN Security.*
- IEEE Std 802.11 [ISO/IEC DIS 8802-11] *Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications.*
- IEEE Std 802.12 [ISO/IEC 8802-12] *Demand Priority Access Method, Physical Layer and Repeater Specifications.*
- IEEE Std 802.15 *Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for: Wireless Personal Area Networks.*
- IEEE Std 802.16 *Standard Air Interface for Fixed Broadband Wireless Access Systems.*

In addition to the family of standards, the following is a recommended practice for a common Physical Layer technology:

- IEEE Std 802.7™ *IEEE Recommended Practice for Broadband Local Area Networks.*

Conformance test methodology

An additional standard, IEEE Std 1802.3™ provides conformance test information for 10BASE-T.

IEEE Std 802.3-2002

IEEE Std 802.3-2002 has been divided into three sections. The division is as follows:

Section One— Includes Clause 1 through Clause 20 and Annexes A through H.

Section Two—Includes Clause 21 through Clause 33 and Annexes 22A through 32A.

Section Three—Includes Clause 34 through Clause 43 and Annexes 36A through 43C.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are anticipated to this standard within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material. Details on the contents of this standard are provided on the following pages.

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

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The final conditions for approval of this standard were met on 14 January 2002. This standard was conditionally approved by the IEEE-SA Standards Board on 7 December 2001, with the following membership:

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Officers

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IEEE Std 802.3 document	Date approved by IEEE and ANSI	Officers at the time of working group ballot
802.3-1985, Original 10 Mb/s standard, MAC, PLS, AUI, 10BASE5	23 June 1983 (IEEE) 31 December 1984 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i>
802.3a™-1988 (Clause 10), 10 Mb/s MAU 10BASE2	15 November 1985 (IEEE) 28 December 1987 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Alan Flatman , <i>Task Force Chair</i>
802.3b™-1985 (Clause 11), 10 Mb/s Broadband MAU, 10BROAD36	19 September 1985 (IEEE) 28 February 1986 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Menachem Abraham , <i>Task Force Chair</i>
802.3c™-1985 (9.1–9.8), 10 Mb/s Baseband Repeater	12 December 1985 (IEEE) 4 June 1986 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Geoffrey O. Thompson , <i>Task Force Chair</i>
802.3d™-1987 (9.9), 10 Mb/s Fiber MAU, FOIRL	10 December 1987 (IEEE) 9 February 1989 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Steven Moustakas , <i>Task Force Chair</i>
802.3e™-1987 (Clause 12), 1 Mb/s MAU and Hub 1BASE5	11 June 1987 (IEEE) 15 December 1987 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Robert Galin , <i>Task Force Chair</i>
802.3h™-1990 (Clause 5), 10 Mb/s Layer Management, DTEs	28 September 1990 (IEEE) 11 March 1991 (ANSI)	Donald C. Loughry , <i>Working Group Chair</i> Andy J. Luque , <i>Task Force Chair</i>
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 , <i>Working Group Chair</i> Patricia Thaler , <i>Task Force Chair (initial)</i> Richard Anderson , <i>Task Force Chair (final)</i>
802.3j™-1993 (Clauses 15–18), 10 Mb/s Fiber MAUs 10BASE-FP, FB, and FL	15 September 1993 (IEEE) 15 March 1994 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Keith Amundsen , <i>Task Force Chair (initial)</i> Frederick Scholl , <i>Task Force Chair (final)</i> Michael E. Lee , <i>Technical Editor</i>
802.3k™-1993 (Clause 19), 10 Mb/s Layer Management, Repeaters	17 September 1992 (IEEE) 8 March 1993 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Joseph S. Skorupa , <i>Task Force Chair</i> Geoffrey O. Thompson , <i>Vice Chair and Editor</i>
802.3l™-1992 (14.10), 10 Mb/s PICS Proforma 10BASE-T MAU	17 September 1992 (IEEE) 23 February 1993 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Mike Armstrong , <i>Task Force Chair and Editor</i> Paul Nikolich , <i>Vice Chair</i> William Randle , <i>Editorial Coordinator</i>
802.3m™-1995, Maintenance 2	21 September 1995 (IEEE) 16 July 1996 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Gary Robinson , <i>Maintenance Chair</i>
802.3n™-1995, Maintenance 3	21 September 1995 (IEEE) 4 April 1996 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Gary Robinson , <i>Maintenance Chair</i>
802.3p™-1993 (Clause 20), Management, 10 Mb/s Integrated MAUs	17 June 1993 (IEEE) 4 January 1994 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Joseph S. Skorupa , <i>Task Force Chair</i> Geoffrey O. Thompson , <i>Vice Chair and Editor</i>
802.3q™-1993 (Clause 5), 10 Mb/s Layer Management, GDMO Format	17 June 1993 (IEEE) 4 January 1994 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Joseph S. Skorupa , <i>Task Force Chair</i> Geoffrey O. Thompson , <i>Vice Chair and Editor</i>
802.3r™-1996 (8.8), Type 10BASE5 Medium Attachment Unit PICS proforma	29 July 1996 (IEEE) 6 January 1997 (ANSI)	Patricia Thaler , <i>Working Group Chair</i> Imre Juhász , <i>Task Force Chair</i> William Randle , <i>Task Force Editor</i>

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802.3s™-1995, Maintenance 4	21 September 1995 (IEEE) 8 April 1996 (ANSI)	Geoffrey O. Thompson, <i>Working Group Chair</i> Gary Robinson, <i>Maintenance Chair</i>
802.3t™-1995, 120 Ω informative annex to 10BASE-T	14 June 1995 (IEEE) 12 January 1996 (ANSI)	Geoffrey O. Thompson, <i>Working Group Chair</i> Jacques Christ, <i>Task Force Chair</i>
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, <i>Working Group Chair</i> Peter Tarrant, <i>Task Force Chair (Phase 1)</i> Howard Frazier, <i>Task Force Chair (Phase 2)</i> Paul Sherer, <i>Editor-in-Chief (Phase 1)</i> Howard Johnson, <i>Editor-in-Chief (Phase 2)</i> Colin Mick, <i>Comment Editor</i>
802.3v™-1995, 150 Ω informative annex to 10BASE-T	12 December 1995 (IEEE) 16 July 1996 (ANSI)	Geoffrey O. Thompson, <i>Working Group Chair</i> Larry Nicholson, <i>Task Force Chair</i>
802.3x™-1997 and 802.3y™-1997 (Revisions to 802.3, Clauses 31 and 32), Full Duplex Operation and Type 100BASE-T2	20 March 1997 (IEEE) 5 September 1997 (ANSI)	Geoffrey O. Thompson, <i>Chair</i> David J. Law, <i>Vice Chair</i> Rich Seifert, <i>Task Force Chair and Editor (802.3x)</i> J. Scott Carter, <i>Task Force Chair (802.3y)</i> Colin Mick, <i>Task Force Editor (802.3y)</i>
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, <i>Chair</i> David J. Law, <i>Vice Chair</i> Howard M. Frazier, Jr., <i>Task Force Chair and Editor</i> Howard W. Johnson, <i>Task Force Editor</i>
802.3aa™-1998, Maintenance 5	25 June 1998 (IEEE)	Geoffrey O. Thompson, <i>Chair</i> Colin Mick, <i>Task Force Editor (100BASE-T Maintenance)</i>
802.3ac™-1998, Frame Extensions for Virtual Bridged Local Area Network (VLAN) Tagging on 802.3 Networks	16 September 1998 (IEEE)	Geoffrey O. Thompson, <i>Chair</i> David J. Law, <i>Vice Chair</i> Andy J. Luque, <i>Secretary</i> Ian Crayford, <i>Task Force Chair</i> Rich Seifert, <i>Task Force Editor</i>
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, <i>Chair</i> David J. Law, <i>Vice Chair</i> Robert M. Grow, <i>Secretary</i> George Eisler, <i>Task Force Chair</i> Colin Mick, <i>Task Force Editor</i>
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ISO/IEC status

Certain portions of this standard have been approved at the international level and form standard ISO/IEC 8802-3, 2000 Edition. The remainder of IEEE Std 802.3 will be forwarded to ISO/IEC and will begin the process of ISO/IEC approval via the “fast-track” process. Any comments on the fast-track DIS will be handled in ISO/IEC JTC 1/SC 6.

For up-to-date information on the ISO/IEC approval status of this edition, see <http://www.ieee802.org/3/ISO-status.html>

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SUPERSEDED

Information technology —

Telecommunications and information exchange between systems —

Local and metropolitan area networks — Specific requirements —

Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications

SECTION ONE: This section includes Clauses 1 through 20 and Annexes A through H.

1. Introduction

1.1 Overview

This is a comprehensive International Standard for Local Area Networks (LANs) employing CSMA/CD as the access method. This International Standard is intended to encompass several media types and techniques for signal rates from 1 Mb/s to 1000 Mb/s. This edition of the standard provides the necessary specifications for the following families of systems: a 1 Mb/s baseband system, 10 Mb/s baseband and broadband systems, a 100 Mb/s baseband system, and a 1000 Mb/s baseband system. In addition, it specifies a method for linearly incrementing a system's data rate by aggregating multiple physical links of the same speed into one logical link.

1.1.1 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.

1.1.1.1 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.

Half duplex operation can be used with all media and configurations allowed by this standard.

1.1.1.2 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.

1.1.2 Architectural perspectives

There are two important ways to view local area network (LAN) design corresponding to

- 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: 1994.¹) The Logical Link Control (LLC) sublayer and MAC sublayer together encompass the functions intended for the Data Link Layer as defined in the OSI model.

1.1.2.1 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 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.

1.1.2.2 Compatibility interfaces

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

¹For information about references, see 1.3.

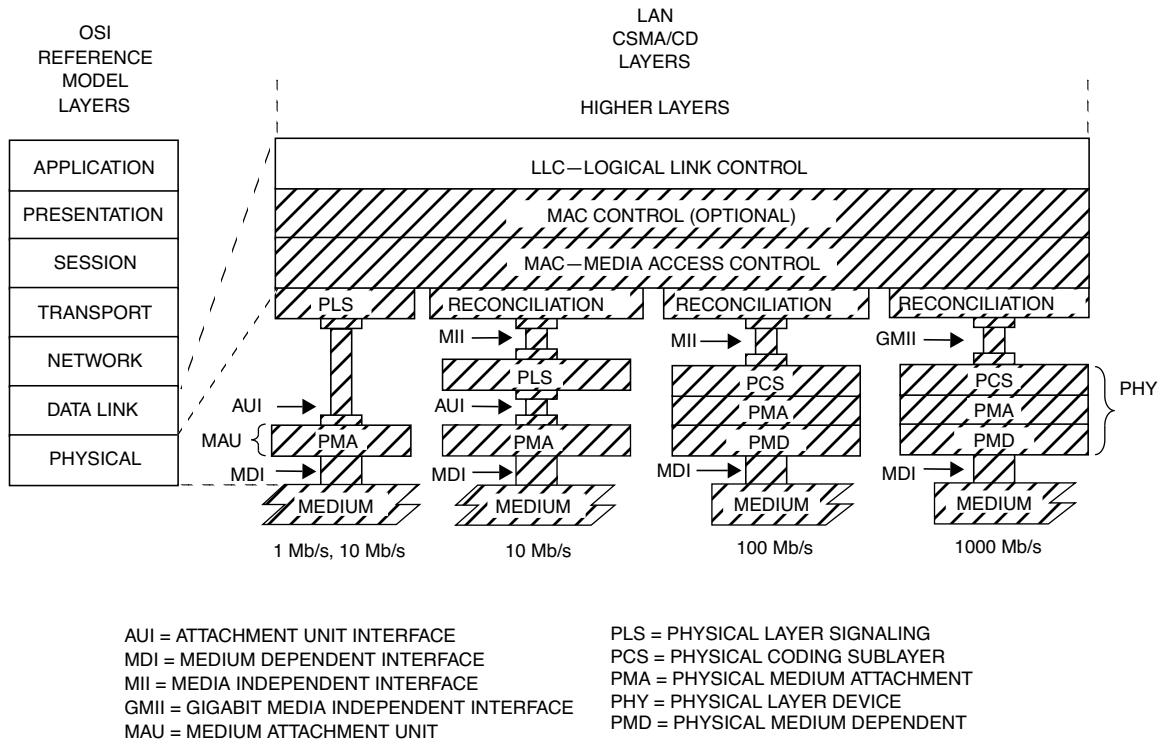


Figure 1-1—LAN standard relationship to the ISO/IEC Opens Systems Interconnection (OSI) reference model

- 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 Clause 8 (and beyond) 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 should not be taken as detracting from this point; communication by way of the ISO/IEC 8802-3 [IEEE Std 802.3] Local Area Network requires complete compatibility at the Physical Medium interface (that is, the physical cable interface).
- Attachment Unit Interface (AUI).** It is anticipated that most DTEs will be 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 highly 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.
- 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 communication, it is highly 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 gigabit-capable MAC or repeater unit to a gigabit PHY. While conformance with implementation of this interface is not strictly necessary to ensure communication, it is highly recommended, since it allows maximum flexibility in intermixing PHYs and DTEs at gigabit 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 highly 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.

1.1.3 Layer interfaces

In the architectural model used here, the layers interact by way of well-defined interfaces, providing services as specified in Clauses 2 and 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 will be discussed in Clause 30.

1.1.4 Application areas

The applications environment for the LAN is intended to be commercial and light industrial. Use of CSMA/CD LANs in home or heavy industrial environments, while not precluded, is not considered within the scope of this standard.

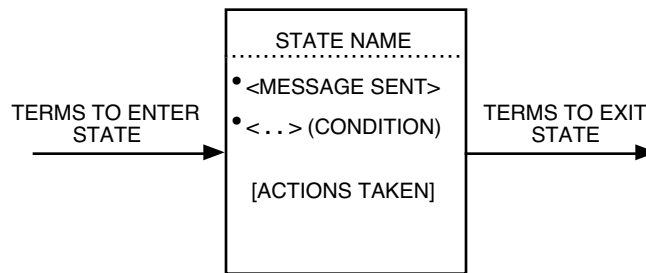
1.2 Notation

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 1–2.)

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 must be fulfilled before



Key: () = condition, for example, (if no_collision)
 [] = action, for example, [reset PLS functions]
 * = logical AND
 + = logical OR
 Tw = Wait Time, implementation dependent
 Td = Delay Timeout
 Tb = Backoff Timeout
 UCT = unconditional transition

Figure 1-2—State diagram notation example

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 qualifier notation that allows testing for conditions at multiple ports. The notation used is a term that includes a description in parentheses of which ports must 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 convention is 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 must 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 1-3).

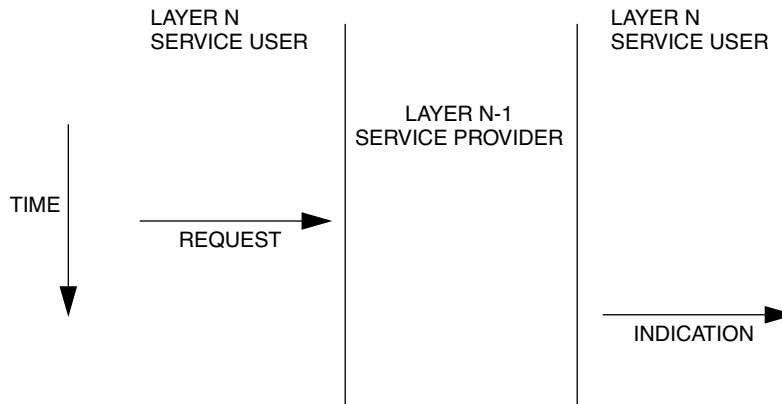


Figure 1-3—Service primitive notation

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:

- 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 in Mb/s> <medium type> <maximum segment length (× 100 m)>

For example, the standard contains a 10 Mb/s baseband specification identified as “TYPE 10BASE5,” meaning a 10 Mb/s baseband medium whose maximum segment length is 500 m. Each successive Physical Layer specification will state its own unique TYPE identifier along similar lines.

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*).

1.3 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties 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.

ANSI T1.601-1992, Telecommunications—Integrated Services Digital Network (ISDN)—Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT (Layer 1 Specification).²

ANSI T1.605-1991, Telecommunications—Integrated Services Digital Network (ISDN)—Basic Access Interface for S and T Reference Point (Layer 1 Specification).

ANSI X3.237-1995, Rev 2.1 (1 January 1995), FDDI Low-Cost Fibre Physical Layer—Medium Dependent (LCF-PMD) (ISO/IEC CD 9314-9).

ANSI X3.263-1995, Revision 2.2 (1 March 1995), FDDI Twisted Pair—Physical Medium Dependent (TP-PMD) (ISO/IEC CD 9314-10).

ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard.

CISPR 22: 1993, Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment.³

IEC 60060 (all parts), High-voltage test techniques.⁴

IEC 60068, Basic environmental testing procedures.

IEC 60096-1: 1986, Radio-frequency cables, Part 1: General requirements and measuring methods and Amd. 2: 1993.

IEC 60169-8: 1978 and -16: 1982, Radio-frequency connectors, Part 8: R.F. coaxial connectors with inner diameter of outer conductor 6.5 mm (0.256 in) with bayonet lock—Characteristic impedance 50 ohms (Type

²ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (www.ansi.org/).

³CISPR documents are available from the International Electrotechnical Commission, 3 rue de Varembe, Case Postale 131, CH 1211, Genève 20, Switzerland/Suisse (www.iec.ch/). CISPR documents are also available in the United States from the American National Standards Institute.

⁴In the 2002 edition of this standard, IEC publications have been renumbered in accordance with IEC's revised numbering system. In 1997, all existing publications were issued a designation in the 60000 series. Thus IEC 60 became IEC 60060, IEC 169-8 became IEC 60169-8, etc. IEC publications are available from IEC Sales Department, Case Postale 131, 3 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (www.iec.ch/). IEC publications are also available in the United States from the American National Standards Institute.

BNC); Part 16: R.F. coaxial connectors with inner diameter of outer conductor 7 mm (0.276 in) with screw coupling—Characteristic impedance 50 ohms (75 ohms) (Type N).

IEC 60603-7: 1990, Connectors for frequencies below 3 MHz for use with printed boards, Part 7: Detail specification for connectors, 8-way, including fixed and free connectors with common mating features, with assessed quality.

IEC 60793-1: 1995, Optical fibres—Part 1: Generic specification.

IEC 60793-2: 1992, Optical fibres—Part 2: Product specifications.

IEC 60794-1: 1996, Optical fibre cables—Part 1: Generic specification.

IEC 60794-2: 1989, Optical fibre cables—Part 2: Product specifications.

IEC 60807-2: 1992, Rectangular connectors for frequencies below 3 MHz, Part 2: Detail specification for a range of connectors with assessed quality, with trapezoidal shaped metal shells and round contacts—Fixed solder contact types.

IEC 60807-3: 1990, Rectangular connectors for frequencies below 3 MHz, Part 3: Detail specification for a range of connectors with trapezoidal shaped metal shells and round contacts—Removable crimp contact types with closed crimp barrels, rear insertion/rear extraction.

IEC 60825-1: 1993, Safety of laser products—Part 1: Equipment classification, requirements and user's guide.

IEC 60825-2: 1993, Safety of laser products—Part 2: Safety of optical fibre communication systems.

IEC 60874-1: 1993, Connectors for optical fibres and cables—Part 1: Generic specification.

IEC 60874-2: 1993, Connectors for optical fibres and cables—Part 2: Sectional specification for fibre optic connector, Type F-SMA.

IEC 60874-10: 1992, Connectors for optical fibres and cables—Part 10: Sectional specification, Fibre optic connector type BFOC/2,5.

IEC 60950: 1991, Safety of information technology equipment.

IEC 61000-4-3, Electromagnetic Compatibility (EMC)—Part 4: Testing and measurement techniques—Section 3: Radiated, radio-frequency, electromagnetic field immunity test.

IEC 61076-3-101: 1997, Connectors with assessed quality, for use in d.c., low-frequency analogue and in digital high-speed data applications—Part 3: Rectangular connectors—Section 101: Detail specification for a range of shielded connectors with trapezoidal shaped shells and non-removable rectangular contacts on a 1.27 mm × 2.54 mm centre-line.

IEC 61076-3-103 (48B/574/NP), Detail specification for rectangular connectors, with assessed quality, 6 and 8 way, fixed and free shielded connectors with ribbon contacts for high speed data applications.

IEC 61196-1: 1995, Radio-frequency cables—Part 1: Generic specification—General, definitions, requirements and test methods.

IEC 61754-4: 1997, Fibre optic connector interfaces—Part 4: Type SC connector family.

IEEE Std 802[®]-2001, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.⁵

IEEE Std 802.1F™-1993 (Reaff 1998), IEEE Standards for Local and Metropolitan Area Networks: Common Definitions and Procedures for IEEE 802 Management Information.

IEEE P 802.1Q™/D11 (July 30, 1998), Draft Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks.⁶

IETF RFC 1155, *Structure and Identification of Management Information for TCP/IP-based Internets*, Rose, M., and K. McCloghrie, May 1990.⁷

IETF RFC 1157, *A Simple Network Management Protocol (SNMP)*, Case, J., Fedor, M., Schoffstall, M., and J. Davin, May 1990.

IETF RFC 1212, *Concise MIB Definitions*, Rose, M., and K. McCloghrie, March 1991.

IETF STD 17, RFC 1213, *Management Information Base for Network Management of TCP/IP-based internets: MIB-II*, McCloghrie K., and M. Rose, Editors, March 1991.

IETF RFC 1215, *A Convention for Defining Traps for use with the SNMP*, M. Rose, March 1991.

IETF RFC 1901, *Introduction to Community-based SNMPv2*, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, January 1996.

IETF RFC 1902, *Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2)*, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, January 1996.

IETF RFC 1903, *Textual Conventions for Version 2 of the Simple Network Management Protocol (SNMPv2)*, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, January 1996.

IETF RFC 1904, *Conformance Statements for Version 2 of the Simple Network Management Protocol (SNMPv2)*, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, January 1996.

IETF RFC 1905, *Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)*, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, January 1996.

IETF RFC 1906, *Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2)*, Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, January 1996.

IETF RFC 2233, *The Interfaces Group MIB using SMIv2*, McCloghrie, K., and F. Kastenholz, November 1997.

IETF RFC 2271, *An Architecture for Describing SNMP Management Frameworks*, Harrington, D., Presuhn, R., and B. Wijnen, January 1998.

IETF RFC 2272, *Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)*, Case, J., Harrington D., Presuhn R., and B. Wijnen, January 1998.

IETF RFC 2273, *SNMPv3 Applications*, Levi, D., Meyer, P., and B. Stewart, January 1998.

⁵IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (standards.ieee.org/).

⁶Numbers preceded by P are IEEE authorized standards projects that were not approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining drafts, contact the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

⁷IETF RFCs are available from the Internet Engineering Task Force website at <http://www.ietf.org/rfc.html>.

IETF RFC 2274, *User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)*, Blumenthal, U., and B. Wijnen, January 1998.

IETF RFC 2275, *View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*, Wijnen, B., Presuhn, R., and K. McCloghrie, January 1998.

ISO/IEC 15802-1: 1995, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 1: Medium Access Control (MAC) service definition.⁸

ISO/IEC 2382-9: 1995, Information technology—Vocabulary—Part 9: Data communication.

ISO/IEC 7498-1: 1994, Information technology—Open Systems Interconnection—Basic Reference Model: The Basic Model.

ISO/IEC 7498-4: 1989, Information processing systems—Open Systems Interconnection—Basic Reference Model—Part 4: Management Framework.

ISO/IEC 8824: 1990, Information technology—Open Systems Interconnection—Specification of Abstract Syntax Notation One (ASN.1).

ISO/IEC 8825: 1990, Information technology—Open Systems Interconnection—Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1).

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

ISO/IEC 9314-2: 1989, Information processing systems—Fibre Distributed Data Interface (FDDI)—Part 2: Token Ring Media Access Control (MAC).

ISO/IEC 9314-3: 1990, Information processing systems—Fibre Distributed Data Interface (FDDI)—Part 3: Physical Layer Medium Dependent (PMD).

ISO/IEC 9646-1: 1994, Information technology—Open Systems Interconnection—Conformance testing methodology and framework—Part 1: General concepts.

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

ISO/IEC 10040: 1992, Information technology—Open Systems Interconnection—Systems management overview.

ISO/IEC 10164-1: 1993, Information technology—Open Systems Interconnection—Systems management—Part 1: Object Management Function.

ISO/IEC 10165-1: 1993, Information technology—Open Systems Interconnection—Management information services—Structure of management information—Part 1: Management Information Model.

ISO/IEC 10165-2: 1992, Information technology—Open Systems Interconnection—Structure of management information: Definition of management information.

⁸ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

ISO/IEC 10165-4: 1992, Information technology—Open Systems Interconnection—Management information services—Structure of management information—Part 4: Guidelines for the definition of managed objects.

ISO/IEC 10742: 1994, Information technology—Telecommunications and information exchange between systems—Elements of management information related to OSI Data Link Layer standards.

ISO/IEC 11801: 1995, Information technology—Generic cabling for customer premises.

ISO/IEC 15802-2: 1995 [ANSI/IEEE Std 802.1B™-1992 and IEEE Std 802.1k™-1993], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 2: LAN/MAN Management.

ISO/IEC 15802-3: 1998 [IEEE Std 802.1D™, 1998 Edition), Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 3: Media Access Control (MAC) bridges.

ITU-T Recommendation G.957 (1995) Digital line systems—Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.⁹

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

MATLAB Matrix Laboratory Software.¹⁰

NOTES

1—Local and national standards such as those supported by ANSI, EIA, IEEE, MIL, NPFA, 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 referenced as resource material; these bibliographical references are located in the bibliography in Annex A.

2—The IEEE standards referred to in 1.2 are trademarks of the Institute of Electrical and Electronics Engineers, Inc.

1.4 Definitions

The definitions used in this standard are consistent with ISO 2382-9: 1984.

EDITORIAL NOTE—A more specific Part 25 pertaining to LAN systems has been approved since the definitions in this standard were established. This standard is ISO/IEC 2382-25: 1992, Information technology—Vocabulary—Part 25: Local area networks.

1.4.1 10BASE2: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over RG 58 coaxial cable. (See IEEE 802.3 Clause 10)

1.4.2 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 802.3 Clause 8.)

1.4.3 10BASE-F: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over fiber optic cable. (See IEEE 802.3 Clause 15.)

1.4.4 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 802.3 Clause 9, Figure 15-1b and Figure 17.3.)

⁹ITU-T publications are available from the International Telecommunications Union, Place des Nations, CH-1211, Geneva 20, Switzerland (www.itu.int/).

¹⁰For information on MatLab contact: The MathWorks, 24 Park Way, Natick, MA, (www.mathworks.com).

1.4.5 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 802.3 Figure 15-1b and Figure 15-2.)

1.4.6 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 802.3 Figure 15-1c and Figure 15-2.)

1.4.7 10BASE-FP segment: A fiber optic mixing segment, including one 10BASE-FP Star and all of the attached fiber pairs. (See IEEE 802.3 Figure 15-1a, Figure 1-3, and mixing segment.)

1.4.8 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 comprised of a passive-star coupler, fiber optic connectors, and a suitable mechanical housing. (See IEEE 802.3, 16.5.)

1.4.9 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 802.3 Clause 14.)

1.4.10 100BASE-FX: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network over two optical fibers. (See IEEE 802.3 Clauses 24 and 26.)

1.4.11 100BASE-T: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network. (See IEEE 802.3 Clauses 22 and 28.)

1.4.12 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 802.3 Clause 32.)

1.4.13 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 unshielded twisted-pair (UTP) wire. (See IEEE 802.3 Clause 23.)

1.4.14 100BASE-TX: IEEE 802.3 Physical Layer specification for a 100 Mb/s CSMA/CD local area network over two pairs of Category 5 unshielded twisted-pair (UTP) or shielded twisted-pair (STP) wire. (See IEEE 802.3 Clauses 24 and 25.)

1.4.15 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 802.3 Clause 24.)

1.4.16 1000BASE-CX: 1000BASE-X over specialty shielded balanced copper jumper cable assemblies. (See IEEE 802.3 Clause 39.)

1.4.17 1000BASE-LX: 1000BASE-X using long wavelength laser devices over multimode and single-mode fiber. (See IEEE 802.3 Clause 38.)

1.4.18 1000BASE-SX: 1000BASE-X using short wavelength laser devices over multimode fiber. (See IEEE 802.3 Clause 38.)

1.4.19 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 802.3 Clause 40.)

1.4.20 1000BASE-X: IEEE 802.3 Physical Layer specification for a 1000 Mb/s CSMA/CD LAN that uses a Physical Layer derived from ANSI X3.230-1994 (FC-PH) [B20]¹¹. (See IEEE 802.3 Clause 36.)

1.4.21 10BROAD36: IEEE 802.3 Physical Layer specification for a 10 Mb/s CSMA/CD local area network over single broadband cable. (See IEEE 802.3 Clause 11.)

1.4.22 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 802.3 Clause 12.)

1.4.23 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 802.3 Clause 40.)

1.4.24 8B/10B transmission code: A dc-balanced octet-oriented data encoding specified in Table 36–1a–e and Table 36–2.

1.4.25 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 802.3 Clause 40.)

1.4.26 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 802.3, 28.2.1.2.2.)

1.4.27 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 Code Word. This bit is only set after an identical Link Code Word has been received three times in succession. (See IEEE 802.3, 28.2.1.2.4.)

1.4.28 Actor: The local entity in a Link Aggregation Control Protocol exchange. (See IEEE 802.3 Clause 43.)

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

1.4.30 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 802.3 Clause 30.)

1.4.31 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 802.3 Clause 30.)

1.4.32 Aggregation Key: A parameter associated with each port and with each aggregator of an Aggregation System identifying those ports that can be aggregated together. Ports in an Aggregation System that share the same Aggregation Key value are potentially able to aggregate together. (See IEEE 802.3 Clause 43.)

1.4.33 Aggregation Link: An instance of a MAC-Physical Layer-Medium Physical Layer-MAC entity between a pair of Aggregation Systems. (See IEEE 802.3 Clause 43.)

1.4.34 Aggregation Port: An instance of a MAC-Physical Layer entity within an Aggregation System. (See IEEE 802.3 Clause 43.)

¹¹The numbers in brackets preceded by the letter B correspond to those of the bibliography in Annex A.

1.4.35 Aggregation System: A uniquely identifiable entity comprising (among other things) an arbitrary grouping of one or more ports for the purpose of aggregation. An instance of an aggregated link always occurs between exactly two Aggregation Systems. A physical device may comprise a single Aggregation System or more than one Aggregation System. (See IEEE 802.3 Clause 43.)

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

1.4.37 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 802.3 Clauses 36 and 37.)

1.4.38 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 802.3 Clauses 7 and 8.)

1.4.39 Auto-Negotiation: The algorithm that allows two devices at either end of a link segment to negotiate common data service functions. (See IEEE 802.3 Clause 28.)

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

1.4.41 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.

1.4.42 Base Link Code Word: The first 16-bit message exchanged during IEEE 802.3 Auto-Negotiation. (See IEEE 802.3, 28.2.1.2.)

1.4.43 Base Page: *See: Base Link Code Word.*

1.4.44 baud: 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 [B26].)

1.4.45 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 802.3 Clause 11.)

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

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

1.4.48 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).

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

1.4.50 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 rate is 10^{-8} s or 10 ns.

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

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

1.4.53 bridge: A layer 2 interconnection device that does not form part of a CSMA/CD collision domain but conforms to the ISO/IEC 15802-3: 1998 [ANSI/IEEE 802.1D™, 1998 Edition] International Standard. 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.)

1.4.54 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 802.3 Clause 11.)

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

1.4.56 carrier extension: The addition of nondata 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.

1.4.57 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.

1.4.58 Category 3 balanced cabling: Balanced 100 Ω and 120 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 802.3 Clauses 14, 23, and 32 specify additional requirements for cabling when used with 10BASE-T, 100BASE-TX, and 1000BASE-T.

1.4.59 Category 4 balanced cabling: Balanced 100 Ω and 120 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 802.3 Clauses 14, 23, and 32 specify additional requirements for this cabling when used with 10BASE-T, 100BASE-T4, and 100BASE-T2, respectively.

1.4.60 Category 5 balanced cabling: Balanced 100 Ω and 120 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). In addition to the requirements outlined in ISO/IEC 11801: 1995, IEEE 802.3 Clauses 14, 23, 25, and 40 specify additional requirements for this cabling when used with 10BASE-T and 100BASE-T.

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

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

1.4.63 channel: A band of frequencies dedicated to a certain service transmitted on the broadband medium. (See IEEE 802.3 Clause 11.)

1.4.64 channel insertion loss: As used in IEEE 802.3 Clause 38 for fiber optic links, the static loss of a link between a transmitter and receiver. It includes the loss of the fiber, connectors, and splices.

1.4.65 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.

1.4.66 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 802.3 Clause 27.)

1.4.67 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 802.3 Clause 27.)

1.4.68 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 802.3 Clause 12.)

1.4.69 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 802.3 Clause 12.)

1.4.70 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 802.3 Clause 12.)

1.4.71 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 802.3 Clause 12.)

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

1.4.73 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).

1.4.74 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.

1.4.75 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.

1.4.76 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 802.3, Clause 24.)

1.4.77 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. (See IEEE 802.3, Clauses 23, 24, 32, 36, and 40.)

1.4.78 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 802.3 Clause 36)

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

1.4.80 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 802.3, 16.3.1.1.)

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

1.4.82 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 802.3.)

1.4.83 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 802.3 Clauses 8 and 12.)

1.4.84 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 802.3 Clause 36)

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

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

1.4.87 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.

1.4.88 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 802.3 Clause 11.)

1.4.89 compatibility interfaces: The Medium Dependent Interface (MDI) cable, the Attachment Unit Interface (AUI) branch cable, and the Media Independent Interface (MII); the three points at which hardware compatibility is defined to allow connection of independently designed and manufactured components to a baseband transmission medium. (See IEEE 802.3 Clause 8.)

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

1.4.91 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. (See IEEE 802.3 Clause 40.)

1.4.92 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 802.3 Clause 12.)

1.4.93 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 802.3 Clause 12.)

1.4.94 Conversation: A set of MAC frames transmitted from one end station to another, where all of the MAC frames form an ordered sequence, and where the communicating end stations require the ordering to be maintained among the set of MAC frames exchanged. (See IEEE 802.3 Clause 43.)

1.4.95 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.

1.4.96 data frame: Consists of the Destination Address, Source Address, Length Field, logical link control (LLC) Data, PAD, and Frame Check Sequence.

1.4.97 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. (See IEEE 802.3 Clause 40.)

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

1.4.99 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 802.3 Clause 11.)

1.4.100 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.

1.4.101 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.

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

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

1.4.104 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**.)

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

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

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

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

1.4.109 End_of_Packet Delimiter (EPD): In 100BASE-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 802.3 Clause 36)

1.4.110 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 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 100BASE-T, the ESD is indicated by two consecutive vectors of four quinary symbols as specified in Table 40–1. (See IEEE 802.3, Clauses 22, 23, 32, and 40.)

1.4.111 end station: A system attached to a LAN that is an initial source or a final destination of MAC frames transmitted across that LAN. A Network layer router is, from the perspective of the LAN, an end station; a MAC Bridge, in its role of forwarding MAC frames from one LAN to another, is not an end station. (See IEEE 802.3 Clause 43.)

1.4.112 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.

1.4.113 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.

1.4.114 Extinction Ratio: The ratio of the low optical power level to the high optical power level on an optical segment. (See IEEE 802.3 Clause 15.)

1.4.115 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.

1.4.116 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 14–14, IEEE 802.3 Clause 14 and Figure 28–4, IEEE 802.3 Clause 28)

1.4.117 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 802.3 Clause 28)

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

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

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

1.4.121 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 802.3 Clause 9)

1.4.122 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 802.3 Clause 9)

1.4.123 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.*

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

1.4.125 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 802.3 Clause 9)

1.4.126 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 802.3 Clause 9)

1.4.127 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 802.3 Clause 9.)

1.4.128 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 802.3 Clause 9)

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

1.4.130 Fibre Channel (FC-PH): Name used to refer to ANSI X3.230-1994 [B20]. (See IEEE 802.3 Clause 36)

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

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

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

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

1.4.135 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 802.3.)

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

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

1.4.138 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 802.3 Clause 11.)

1.4.139 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 802.3.)

1.4.140 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 802.3 Clause 11.)

1.4.141 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 802.3 12.2.1.)

1.4.142 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 802.3 Clause 12)

1.4.143 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 802.3, 7.3 and 12.3.2.4.4 for additional details.)

1.4.144 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 start-up 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 802.3 Clause 40.)

1.4.145 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 [B26].)

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

1.4.147 Inter-Packet Gap (IPG): A delay or time gap between CSMA/CD packets intended to provide interframe recovery time for other CSMA/CD sublayers and for the Physical Medium. (See IEEE 802.3, 4.2.3.2.1 and 4.2.3.2.2.) For example, for 10BASE-T, the IPG is 9.6 μ s (96 bit times); for 100BASE-T, the IPG is 0.96 μ s (96 bit times).

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

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

1.4.150 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.

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

1.4.152 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 802.3 Clause 39.)

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

1.4.154 Link Aggregation Group: A group of links that appear to a MAC Client as if they were a single link. All links in a Link Aggregation Group connect between the same pair of Aggregation Systems. One or more conversations may be associated with each link that is part of a Link Aggregation Group. (See IEEE 802.3 Clause 43.)

1.4.155 Link Code Word: The 16 bits of data encoded into a Fast Link Pulse (FLP) Burst. (See IEEE 802.3 Clause 28.)

1.4.156 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 802.3 Clause 28.)

1.4.157 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.

1.4.158 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 802.3 Clauses 14 and 28.)

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

1.4.160 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 802.3, 29.3.)

1.4.161 local ability: *See: ability.*

1.4.162 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 802.3 Clause 28.)

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

1.4.164 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.

1.4.165 master Physical Layer (PHY): Within IEEE 802.3, in a 100BASE-T2 or 1000BASE-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. *See also: slave Physical Layer (PHY) .*

1.4.166 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.

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

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

1.4.169 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.

1.4.170 Medium Dependent Interface (MDI): The mechanical and electrical interface between the transmission medium and the Medium Attachment Unit (MAU) (10BASE-T) or PHY (100BASE-T, 1000BASE-X, or 1000BASE-T).

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

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

1.4.173 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.

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

1.4.175 multiport device: A device with multiple instances of MDI. (See IEEE 802.3 Clause 40.)

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

1.4.177 Next Page: General class of pages optionally transmitted by Auto-Negotiation able devices following the base Link Code Word negotiation. (See IEEE 802.3 Clause 28.)

1.4.178 Next Page Algorithm (NPA): The algorithm that governs Next Page communication. (See IEEE 802.3 Clause 28.)

1.4.179 Next Page Bit: A bit in the Auto-Negotiation base Link Code Word or Next Page encoding(s) that indicates that further Link Code Word transfer is required. (See IEEE 802.3 Clause 28.)

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

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

1.4.182 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.

1.4.183 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.

1.4.184 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.

1.4.185 Normal Link Pulse (NLP): An out-of-band communications mechanism used in 10BASE-T to indicate link status. (See IEEE 802.3 Figure 14–12.)

1.4.186 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 802.3 Figure 14–6. (See IEEE 802.3 Clause 28)

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

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

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

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

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

1.4.192 Optical Fiber Cable Link Segment: A length of optical fiber cable that contains two optical fibers and is comprised 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 802.3, 9.9.5.1 and 9.9.5.1.)

1.4.193 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 802.3 Clause 9)

1.4.194 Optical Interface: The optical input and output connection interface to a 10BASE-FP Star. (See IEEE 802.3 Clause 15.)

1.4.195 ordered_set: As used in the 1000BASE-X PCS, a single special code-group, or a combination of special and data code-groups, used for the delineation of a packet and synchronization between the transmitter and receiver circuits at opposite ends of a link. (See IEEE 802.3 Clause 36.)

1.4.196 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 [B26].)

1.4.197 overfilled launch: The overfilled launch condition that excites both radial and azimuthal modes defined in ANSI/EIA/TIA 455-54A-1990 [B5].

1.4.198 packet: Consists of a data frame as defined previously, preceded by the Preamble and the Start Frame Delimiter, encoded, as appropriate, for the Physical Layer (PHY) type.

1.4.199 page: In Auto-Negotiation, the encoding for a Link Code Word. Auto-Negotiation can support an arbitrary number of Link Code Word 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*).

1.4.200 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 802.3, Clause 32.)

1.4.201 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 802.3 Clause 28.)

1.4.202 Partner: The remote entity in a Link Aggregation Control Protocol exchange. (See IEEE 802.3 Clause 43.)

1.4.203 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 802.3 Clause 15.)

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

1.4.205 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.)

1.4.206 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.

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

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

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

1.4.210 Physical Coding Sublayer (PCS): Within IEEE 802.3, a sublayer used in 100BASE-T, 1000BASE-X, and 1000BASE-T to couple the Media Independent Interface (MII) or Gigabit Media Independent Interface (GMII) and the Physical Medium Attachment (PMA). The PCS contains the functions to encode data bits into code-groups that can be transmitted over the physical medium. Three PCS structures are defined for 100BASE-T—one for 100BASE-X, one for 100BASE-T4, and one for 100BASE-T2. (See IEEE 802.3, Clauses 23, 24, and 32.) One PCS structure is defined for 1000BASE-X and one PCS structure is defined for 1000BASE-T. (See IEEE 802.3 Clauses 36 and 40.)

1.4.211 Physical Layer entity (PHY): Within IEEE 802.3, the portion of the Physical Layer between the Medium Dependent Interface (MDI) and the Media Independent Interface (MII), or between the MDI and GMII, consisting of the Physical Coding Sublayer (PCS), the Physical Medium Attachment (PMA), and, if present, the Physical Medium Dependent (PMD) sublayers. The PHY contains the functions that transmit, receive, and manage the encoded signals that are impressed on and recovered from the physical medium. (See IEEE 802.3 Clauses 23–26, 32, 36, and 40.)

1.4.212 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. (See IEEE 802.3, Clauses 7, 12, 14, 16, 17, 18, 23, 24, 32, 36, and 40.)

1.4.213 Physical Medium Dependent (PMD) sublayer: In 100BASE-X, that portion of the Physical Layer responsible for interfacing to the transmission medium. The PMD is located just above the Medium Dependent Interface (MDI). (See IEEE 802.3 Clause 24.)

1.4.214 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.

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