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**IEEE Std 802.3x-1997 and
IEEE Std 802.3y-1997**
(Supplements to ISO/IEC 8802-3: 1996
[ANSI/IEEE Std 802.3, 1996 Edition])

IEEE Standards for Local and Metropolitan Area Networks:

Supplements to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications—

Specification for 802.3 Full Duplex Operation and Physical Layer Specification for 100 Mb/s Operation on Two Pairs of Category 3 or Better Balanced Twisted Pair Cable (100BASE-T2)

Sponsor

**LAN MAN Standards Committee
of the
IEEE Computer Society**

Approved 20 March 1997

IEEE Standards Board

Approved 5 September 1997

American National Standards Institute

Abstract for 802.3x-1997: Necessary changes and additions are made to provide for an additional, full duplex mode of operation on a speed-independent basis. Changes are made to the MAC and selected Physical Layer implementations (10BASE-T, 10BASE-FL, 100BASE-T) to support full duplex. A mechanism for pause-based flow control is also added.

Abstract for 802.3y-1997: Changes and additions to the 100BASE-T portion of IEEE Std 802.3 are provided to specify an additional 100 Mb/s transceiver type 100BASE-T, which can support full duplex operation over two pairs of Category 3 or better cabling.

Keywords: 100BASE-T2, Category 3, flow control, full duplex, MAC Control, management, Media Independent Interface (MII), pause, repeater

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ISBN 1-55937-905-7

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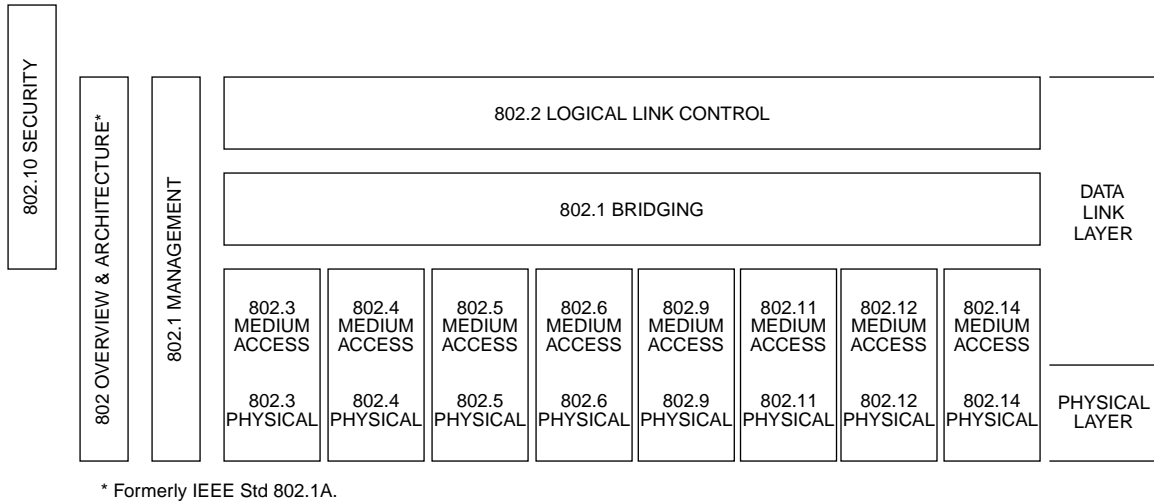
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Introduction

(This introduction is not part of IEEE Std 802.3x-1997 and IEEE Std 802.3y-1997.)

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.)



This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Open Systems Interconnection Basic Reference Model (ISO/IEC 7498-1: 1994). The access standards define several 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. This document forms part of the 802.1 scope of work.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] *LAN/MAN Management.* Defines an Open Systems Interconnection (OSI) management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D [ISO/IEC 10038] *MAC Bridging.* Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/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.
- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2] *Logical Link Control*
- ANSI/IEEE Std 802.3 [ISO/IEC 8802-3] *CSMA/CD Access Method and Physical Layer Specifications*

- ANSI/IEEE Std 802.4 [ISO/IEC 8802-4] *Token Passing Bus Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.5 [ISO/IEC 8802-5] *Token Ring Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.6 [ISO/IEC 8802-6] *Distributed Queue Dual Bus Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.9 [ISO/IEC DIS 8802-9] *Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers*
- ANSI/IEEE Std 802.10 *Interoperable LAN/MAN Security*
- IEEE Std 802.11 *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*
- ANSI/IEEE Std 802.12 *Demand Priority Access Method, Physical Layer and Repeater Specifications*

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*

The following additional working group has authorized standards projects under development:

- IEEE 802.14 *Standard Protocol for Cable-TV Based Broadband Communication Network*

The reader of this standard is urged to become familiar with the complete family of standards.

Conformance test methodology

An additional standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the 802 family of standards. Thus the conformance test documents for 802.3 are numbered 1802.3.

IEEE Std 802.3x-1997 and IEEE Std 802.3y-1997

This is a supplement to the IEEE 802.3 standard. At the time this supplement (IEEE Std 802.3x-1997 and IEEE Std 802.3y-1997) was published, the complete IEEE 802.3 standard consisted of the following published documents:

- ISO/IEC 8802-3: 1996 *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.*

Known as “the International Standard,” containing Clauses 1–20.
- IEEE Std 802.3u-1995 *Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation, Type 100BASE-T.*

Supplement to the International Standard containing changes to Clauses 1, 2, 4, 5, 14, 19, 20 and adding new Clauses 21–30.
- IEEE Std 802.3r-1996 *Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications—Type 10BASE5 Medium Attachment Unit (MAU) Protocol Implementation Conformance Statement (PICS) Proforma (Subclause 8.8).*

A supplement to the International Standard containing the 10BASE5 MAU PICS Proforma, Subclause 8.8.
- IEEE Std 802.3x-1997 *Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications—Specification for 802.3 Full-Duplex Operation.*

and

IEEE Std 802.3y-1997 *Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications—Physical Layer Specification for 100 Mb/s Operation On Two Pairs Of Category 3 Or Better Balanced Twisted Pair Cable (100BASE-T2): Parts 1 and 2.*

This supplement to the International Standard includes changes to Clauses 1–30, which are contained in the above documents, and adds new Clauses 31 and 32. Note that the changes to existing clauses contained in this supplement are in addition to the changes previously defined in IEEE Std 802.3u-1995.

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Changes to

Change the heading of clause 3 to read as follows:

3. MAC Media access control frame structure

Change the text of 3.1 to read as follows:

3.1 Overview

This clause defines in detail the frame structure for data communication systems using the ~~LAN MAC procedures~~ CSMA/CD MAC. It defines the syntax and semantics of the various components of the MAC frame.

Change the text of 3.1.1 to read as follows:

3.1.1 MAC frame format

Figure 3-1 shows the eight fields of a frame: the preamble, Start Frame Delimiter (SFD), the addresses of the frame’s source and destination, a length/type field to indicate the length or protocol type of the following field containing the ~~LLC MAC Client~~ data to be transmitted, a field that contains padding if required, and the frame check sequence field containing a cyclic redundancy check value to detect errors in received frames. Of these eight fields, all are of fixed size except the ~~LLC~~ data and PAD fields, which may contain any integer number of octets between the minimum and maximum values determined by the specific implementation of the CSMA/CD ~~Media Access mechanism~~ MAC. See 4.4 for particular implementations.

Replace Figure 3-1 with new Figure 3-1 as shown below.

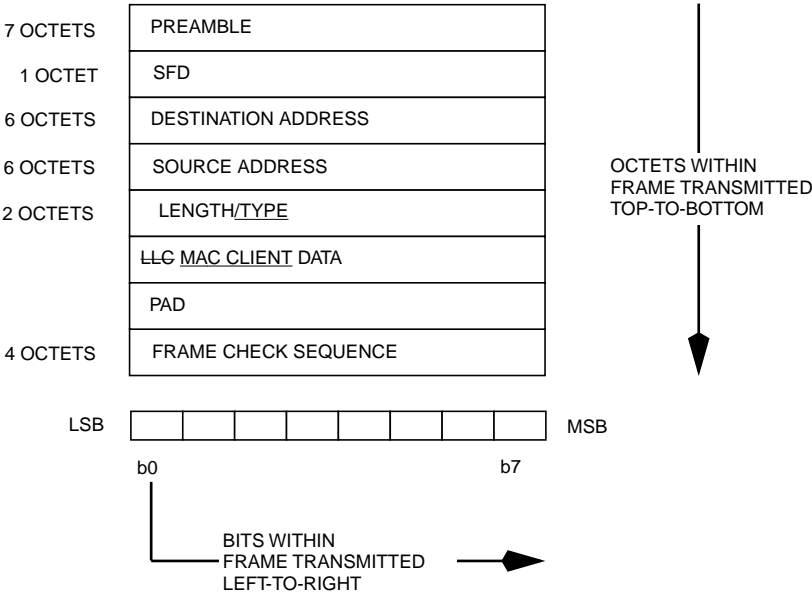


Figure 3-1—MAC frame format

The minimum and maximum frame size limits in 4.4 refer to that portion of the frame from the destination address field through the frame check sequence field, inclusive.

Relative to Figure 3-1, the octets of a frame are transmitted from top to bottom, and the bits of each octet are transmitted from left to right.

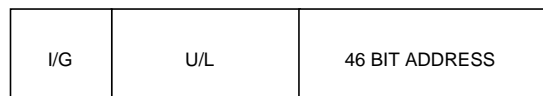
Change the text of the lettered list in 3.2.3 to read as follows:

3.2.3 Address fields

Each MAC frame shall contain two address fields: the Destination Address field and the Source Address field, in that order. The Destination Address field shall specify the destination addressee(s) for which the frame is intended. The Source Address field shall identify the station from which the frame was initiated. The representation of each address field shall be as follows (see Figure 3-2):

- a) ~~Each address field shall contain either 16 bits or be 48 bits in length. However, at any given time, the Source and Destination Address size shall be the same for all stations on a particular LAN. While IEEE 802 specifies the use of either 16 or 48 bit addresses, no conformant implementation of IEEE 802.3 uses 16 bit addresses. The use of 16 bit addresses is specifically excluded by this International Standard.~~
- b) ~~The support of 16 or 48 bit address length for Source and Destination Address shall be left to the manufacturer as an implementation decision. There is no requirement that manufacturers support both sizes.~~
- e) b) The first bit (LSB) shall be used in the Destination Address field as an address type designation bit to identify the Destination Address either as an individual or as a group address. If this bit is 0, it shall indicate that the address field contains an individual address. If this bit is 1, it shall indicate that the address field contains a group address that identifies none, one or more, or all of the stations connected to the LAN. In the Source Address field, the first bit is reserved and set to 0.
- d) c) ~~For 48 bit addresses,~~ The second bit shall be used to distinguish between locally or globally administered addresses. For globally administered (or U, universal) addresses, the bit is set to 0. If an address is to be assigned locally, this bit shall be set to 1. Note that for the broadcast address, this bit is also a 1.
- e) d) Each octet of each address field shall be transmitted least significant bit first.

Replace Figure 3-2 with new Figure 3-2 as shown:



I/G = 0 INDIVIDUAL ADDRESS
 I/G = 1 GROUP ADDRESS
 U/L = 0 GLOBALLY ADMINISTERED ADDRESS
 U/L = 1 LOCALLY ADMINISTERED ADDRESS

Figure 3-2—Address field format

Change the text of 3.2.3.1 to read as follows:

3.2.3.1 Address designation

A MAC sublayer address is of one of two types:

- a) *Individual Address.* The address associated with a particular station on the network.
- b) *Group Address.* A multidestination address, associated with one or more stations on a given network. There are two kinds of multicast address:
 - 1) *Multicast-Group Address.* An address associated by higher-level convention with a group of logically related stations.
 - 2) *Broadcast Address.* A distinguished, predefined multicast address that always denotes the set of all stations on a given LAN.

All 1's in the Destination Address field (~~for 16 or 48 bit address size LANs~~) shall be predefined to be the Broadcast address. This group shall be predefined for each communication medium to consist of all stations actively connected to that medium; it shall be used to broadcast to all the active stations on that medium. All stations shall be able to recognize the Broadcast address. It is not necessary that a station be capable of generating the Broadcast address.

The address space shall also be partitioned into locally administered and globally administered addresses. The nature of a body and the procedures by which it administers these global (U) addresses is beyond the scope of this International Standard.⁶

Change the text of 3.2.6 to read as follows, and delete old Footnote 6 from ISO/IEC 8802-3:

3.2.6 Length/Type field

~~The Length field is a 2-octet field whose value⁶ indicates the number of LLC data octets in the data field. This two-octet field takes one of two meanings, depending on its numeric value. For numerical evaluation, the first octet is the most significant octet of this field.~~

- a) If the value of this field is less than or equal to the value of maxValidFrame (as specified in 4.2.7.1), then the Length/Type field indicates the number of MAC client data octets contained in the subsequent data field of the frame (Length interpretation).
- b) If the value of this field is greater than or equal to 1536 decimal (equal to 0600 hexadecimal), then the Length/Type field indicates the nature of the MAC client protocol (Type interpretation). The Length and Type interpretations of this field are mutually exclusive.

When used as a Type field, it is the responsibility of the MAC client to ensure that the MAC client operates properly when the MAC sublayer pads the supplied data, as discussed in 3.2.7.

⁶ For information on how to use MAC addresses, see IEEE Std 802-1990, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture (ANSI). To apply for an Organizationally-Unique Identifier for building a MAC address, contact the Registration Authority, IEEE Standards Department, P.O. Box 1331, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA; +1 732 562 3813; fax +1 732 562 1571. URL: <http://standards.ieee.org/>

~~⁶ Packets with a length field value greater than those specified in 4.4.2 may be ignored, discarded, or used in a private manner. The use of such packets is beyond the scope of this International Standard.~~

⁷ Type field assignments are administered by the Registration Authority, IEEE Standards Department, P.O. Box 1331, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA; +1 732 562 3813; fax +1 732 562 1571. URL: <http://standards.ieee.org/>

~~If the value~~ Regardless of the interpretation of the Length/Type field, if the length of the data field is less than the minimum required for proper operation of the protocol, a PAD field (a sequence of octets) will be added at the end of the data field but prior to the FCS field, specified below. The procedure that determines the size of the PAD field is specified in 4.2.8. The Length/Type field is transmitted and received with the high order octet first.

Change the text of 3.2.7 to read as follows:

3.2.7 Data and PAD fields

The data field contains a sequence of n octets. Full data transparency is provided in the sense that any arbitrary sequence of octet values may appear in the data field up to a maximum number specified by the implementation of the International Standard that is used. A minimum frame size is required for correct CSMA/CD protocol operation and is specified by the particular implementation of the International Standard. If necessary, the data field is extended by appending extra bits (that is, a pad) in units of octets after the ~~LLC~~ data field but prior to calculating and appending the FCS. The size of the pad, if any, is determined by the size of the data field supplied by the ~~LLC~~ MAC client and the minimum frame size and address size parameters of the particular implementation. The maximum size of the data field is determined by the maximum frame size and address size parameters of the particular implementation.

The length of PAD field required for ~~LLC~~ MAC client data that is n octets long is $\max(0, \text{minFrameSize} - (8 \times n + 2 \times \text{addressSize} + 48))$ bits. The maximum possible size of the ~~LLC~~ data field is $\text{maxFrameSize} - (2 \times \text{addressSize} + 48)/8$ octets. See 4.4 for a discussion of implementation parameters; see 4.2.3.3 for a discussion of the minFrameSize.

Change the text of 3.2.8 to read as follows:

3.2.8 Frame check sequence (FCS) field

A cyclic redundancy check (CRC) is used by the transmit and receive algorithms to generate a CRC value for the FCS field. The FCS field contains a 4-octet (32-bit) cyclic redundancy check (CRC) value. This value is computed as a function of the contents of the source address, destination address, length/type, ~~LLC~~ data and pad (that is, all fields except the preamble, SFD, and FCS). The encoding is defined by the following generating polynomial.

$$G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

Mathematically, the CRC value corresponding to a given frame is defined by the following procedure:

- The first 32 bits of the frame are complemented.
- The n bits of the frame are then considered to be the coefficients of a polynomial $M(x)$ of degree $n-1$. (The first bit of the Destination Address field corresponds to the $x^{(n-1)}$ term and the last bit of the data field corresponds to the x^0 term.)
- $M(x)$ is multiplied by x^{32} and divided by $G(x)$, producing a remainder $R(x)$ of degree ≤ 31 . (EDITORIAL NOTE—This is a change from less than ($<$) to less than or equal to (\leq).)
- The coefficients of $R(x)$ are considered to be a 32-bit sequence.
- The bit sequence is complemented and the result is the CRC.

The 32 bits of the CRC value are placed in the frame check sequence field so that the x^{31} term is the left-most bit of the first octet, and the x^0 term is the rightmost bit of the last octet. (The bits of the CRC are thus transmitted in the order $x^{31}, x^{30}, \dots, x^1, x^0$.) See reference [A23].

Change the text of 3.4 to read as follows and insert new Footnote 8:

3.4 Invalid MAC frame

An invalid MAC frame shall be defined as one that meets at least one of the following conditions:

- a) The frame length is inconsistent with ~~the~~ a length field value specified in the length/type field. If the length/type field contains a type value as defined by 3.2.6, then the frame length is assumed to be consistent with this field and should not be considered an invalid frame on this basis.
- b) It is not an integral number of octets in length.
- c) The bits of the incoming frame (exclusive of the FCS field itself) do not generate a CRC value identical to the one received.

The contents of invalid MAC frames shall not be passed to the LLC or MAC Control sublayers.⁸ The occurrence of invalid MAC frames may be communicated to network management.

⁸ Invalid MAC frames may be ignored, discarded, or used in a private manner by MAC clients other than LLC or MAC control. The use of such frames is beyond the scope of this International Standard.