

LINDA HALL LIBRARY
5109 CHERRY STREET
KANSAS CITY, MISSOURI
64110-2498
PHONE (816) 363-4600
FAX: (816) 926-8785



6/13/13 DocServ #: 702678

SUPER RUSH

12:54

SHIP TO:

027019
Attn: Goodwin Procter
Goodwin Procter
53 State Street
Floor 23, Library
Boston MA 02109
US

Shelved as:

Location:

Title: IEEE Standard 802.3

Volume:

Issue:

Date: 1993

Author:

Article Title:

Pages:

294

Accept Non English? No

Fax: 617-523-1231
Phone: 617-305-6868
Ariel:
Email: ill@goodwinprocter.com

Super

ElecDel

LHL

SupplierWillPay

Max Cost: \$150

Reference Number: #100790-212511

Account Number:

FEDEX Account Number:

**Notes: Please direct any questions to:
Brooke Raymond 212-459-7463**

*PG IEEE
\$32.50
C*

DOCSERV / WEB / PULL SLIP

402A

INTERNATIONAL LIBRARY
OF STANDARDS
COMMISSION

INTERNATIONAL
STANDARD

~~ISO/IEC~~

IEEE

~~8802-3~~

ANSI/IEEE
Std 802.3

SPECIFICATION

Fourth edition
1993-07-08

AUG 5 1993

LINDA HALL LIBRARY

For supplements
see:
IEEE 802.3u
1995
IEEE 802.3j-
1993
IEEE 802.3p-1993

Information technology — Local and metropolitan
area networks —

Part 3:

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

Technologie de l'information — Réseaux locaux et métropolitains —

*Partie 3: Accès multiple par surveillance du signal et détection de collision et
spécifications pour la couche physique*



Reference number
ISO/IEC 8802-3:1993 (E)
ANSI/IEEE
Std 802.3, 1993 Edition

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

Copyright © 1993 by the
Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 1993
Printed in the United States of America

ISBN 1-55337-324-5

*No part of this publication may be reproduced in any form,
in an electronic retrieval system or other wise,
without the prior written permission of the publisher.*

July 8, 1993

SII16337

**International Standard ISO/IEC 8802-3 : 1993
ANSI/IEEE Std 802.3, 1993 Edition**

(This edition contains ANSI/IEEE Std 802.3-1988,
ANSI/IEEE Std 802.3c-1985, ANSI/IEEE Std 802.3d-1987,
ANSI/IEEE Std 802.3b-1985, ANSI/IEEE Std 802.3e-1987,
ANSI/IEEE Std 802.3h-1990, ANSI/IEEE Std 802.3i-1990, and
corrections resulting from Maintenance Ballot #1)

**Information technology—
Local and metropolitan area networks—
Part 3:
Carrier sense multiple access with
collision detection (CSMA/CD)
access method and
physical layer specifications**

Sponsor

**Technical Committee on Computer Communications
of the
IEEE Computer Society**

Abstract: This Local and Metropolitan Area Network standard, ISO/IEC 8802-3 : 1993 [ANSI/IEEE Std 802.3, 1993 Edition], specifies the media access control characteristics for the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method. It also specifies the media, Medium Attachment Unit (MAU) and physical layer repeater unit for 10 Mb/s baseband and broadband systems, and it provides a 1 Mb/s baseband implementation. Specifications for MAU types 10BASE5, 10BASE2, FOIRL (fiber optic inter-repeater link), 10BROAD36, 1BASE5, and 10BASE-T are included. System considerations for multisegment 10 Mb/s baseband networks are provided. Layer and sublayer interface specifications are aligned to the ISO Open Systems Interconnection Basic Reference Model and 8802 models. The 8802-3 internal model is defined and used.

Keywords: data processing, information interchange, local area networks, mode of data transmission, network interconnection, models



Adopted as an International Standard by the
International Organization for Standardization
and by the
International Electrotechnical Commission



Published by
The Institute of Electrical and Electronics Engineers, Inc.



International Standard ISO/IEC 8802-3 : 1993

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and nongovernmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75% of the national bodies casting a vote.

In 1985, IEEE Standard 802.3-1985 was adopted by ISO Technical Committee 97, *Information processing systems*, as draft International Standard ISO/DIS 8802-3. Following the procedures described above, the Standard was subsequently approved by ISO and published as ISO 8802-3 : 1989, incorporating ISO 8802-3/DAD 1 which had resulted from the adoption by ISO in 1987 of ANSI/IEEE Std 802.3a.

A further revision was subsequently approved by ISO/IEC JTC 1 in 1990, incorporating ISO/IEC 8802-3/Amendments 2 and 5.

A third edition, published in 1992, incorporated ISO/IEC 8802-3/Amendments 3 and 4.

This fourth edition cancels and replaces ISO/IEC 8802-3 : 1992 and incorporates ISO/IEC 8802-3/Amendment 6, *Maintenance Ballot*; Amendment 7, *Layer management*; and Amendment 9, *System considerations for multisegment 10 Mb/s baseband networks and Twisted-pair medium attachment unit (MAU) and baseband medium, type 10BASE-T*. These amendments were approved in 1992.

For the purpose of assigning organizationally unique identifiers, the Institute of Electrical and Electronics Engineers, Inc., USA, has been designated by the ISO Council as the Registration Authority. Communications on this subject should be addressed to

Registration Authority for ISO/IEC 8802-3
c/o The Institute of Electrical and Electronics Engineers, Inc.
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

During the preparation of this International Standard, information was gathered on patents upon which application of this standard might depend. Relevant patents were identified as belonging to Xerox Corporation. However, ISO and IEC cannot give authoritative or comprehensive information about evidence, validity or scope of patent and like rights. The patent-holder has stated that licenses will be granted under reasonable terms and conditions and communications on this subject should be addressed to

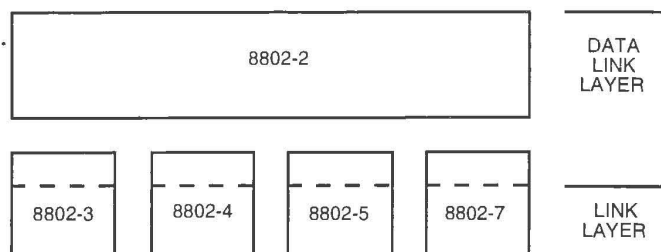
Xerox Corporation
P.O. Box 1600
Stamford, CT 06904
USA



International Organization for Standardization/International Electrotechnical Commission
Case postale 56 • CH-1211 Genève 20 • Switzerland

Foreword to International Standard ISO/IEC 8802-3 : 1993

This standard is part of a family of standards for Local and Metropolitan Area Networks. The relationship between this standard and the other members of the family is shown below. (The numbers in the figure refer to ISO standard numbers.)



This family of standards deals with the Physical and Data Link layers as defined by the ISO Open Systems Interconnection Basic Reference Model (ISO 7498 : 1984). The access standards define four 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 these technologies are as follows:

- (1) ISO/IEC 8802-3 [ANSI/IEEE Std 802.3, 1993 Edition], a bus utilizing CSMA/CD as the access method,
- (2) ISO/IEC 8802-4 [ANSI/IEEE Std 802.4-1990], a bus utilizing token passing as the access method,
- (3) ISO/IEC 8802-5 [ANSI/IEEE Std 802.5-1992], a ring utilizing token passing as the access method,
- (4) ISO 8802-7, a ring utilizing slotted ring as the access method.

ISO 8802-2 [ANSI/IEEE Std 802.2-1989], *Logical Link Control protocol*, is used in conjunction with the medium access standards.

ISO/IEC 10038 [ANSI/IEEE Std 802.1D, 1993 Edition], *Media access control (MAC) bridges*, specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.

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

The main body of this standard serves for both the ISO/IEC 8802-3 and ANSI/IEEE Std 802.3 standards. ISO/IEC and IEEE each have unique foreword sections. The Annex applies to the IEEE standard only. The Appendixes serve as useful reference material to both standards.

ANSI/IEEE Std 802.3, 1993 Edition

IEEE Standards documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE which have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least once every five years for revision or reaffirmation. When a document is more than five years old, and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

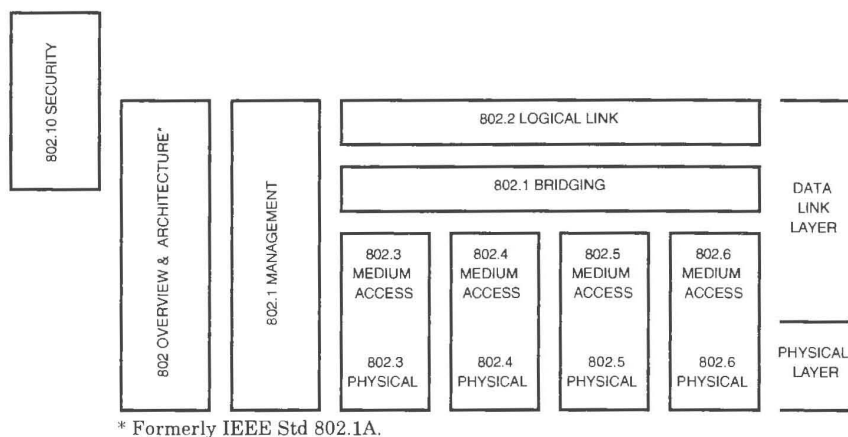
Secretary, IEEE Standards Board
345 East 47th Street
New York, NY 10017
USA

IEEE Standards documents are adopted by the Institute of Electrical and Electronics Engineers without regard to whether their adoption may involve patents on articles, materials, or processes. Such adoptions does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standards documents.

Foreword to ANSI/IEEE Std 802.3, 1993 Edition

(This Foreword is not a part of this International Standard or of ANSI/IEEE 802.3, 1993 Edition.)

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 (ISO) Open Systems Interconnection Basic Reference Model (ISO 7498 : 1984). 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 these technologies 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.
- IEEE Std 802.1B: LAN/MAN Management. Defines an Open System Interconnection (OSI) management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ISO/IEC 10038 : 1993 [ANSI/IEEE Std 802.1D] MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- IEEE Std 802.1E: 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.
- ISO 8802-2 [ANSI/IEEE Std 802.2]: Logical Link Control
- ISO/IEC 8802-3 [ANSI/IEEE Std 802.3]: CSMA/CD Access Method and Physical Layer Specifications

[†]The 802 Architecture and Overview Specification, originally known as IEEE Std 802.1A, has been renumbered as IEEE Std 802. This has been done to accommodate recognition of the base standard in a family of standards. References to IEEE Std 802.1A should be considered as references to IEEE Std 802.

- ISO/IEC 8802-4 [ANSI/IEEE Std 802.4]: Token Bus Access Method and Physical Layer Specifications
- ISO/IEC 8802-5 [ANSI/IEEE Std 802.5]: Token Ring Access Method and Physical Layer Specifications
- IEEE Std 802.6: Metropolitan Area Network Access Method and Physical Layer Specifications
- IEEE Std 802.10: Interoperable Local Area Network Security, *Currently Contains Secure Data Exchange (SDE)*

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

- IEEE Std 802.7: IEEE Recommended Practice for Broadband Local Area Networks

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

Conformance Test Methodology

Another standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the 802 family of standards. This makes the correspondence between the various 802 standards and their applicable conformance test requirements readily apparent. Thus the conformance test documents for 802.3 are numbered 1802.3, the conformance test documents for 802.5 will be 1802.5, and so on. Similarly, ISO will use 18802 to number conformance test standards for 8802 standards.

ISO/IEC 8802-3 : 1993 (ANSI/IEEE Std 802.3, 1993 Edition)

This edition of the standard defines 10 Mb/s baseband and broadband implementations and a 1 Mb/s baseband implementation of the Physical Layer using the CSMA/CD access method. It is anticipated that future editions of the standard may provide additional implementations of the physical layer to support different needs (for example, media, and data rates).

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.

Readers wishing to know the state of revisions should contact

Secretary
 IEEE Standards Board
 Institute of Electrical and Electronics Engineers, Inc
 PO Box 1331, 445 Hoes Lane
 Piscataway, NJ 08855-1331
 USA

The IEEE 802.3 Working Group acknowledges and appreciates that many concepts embodied in this standard are based largely upon the CSMA/CD access method earlier described in *The Ethernet* specification as written jointly by individuals from Xerox Corporation, Digital Equipment Corporation, and Intel Corporation. Appreciation is also expressed to Robert M. Metcalfe and David R. Boggs for their pioneering work in establishing the original concepts.

Participants

When the IEEE 802.3 Working Group approved the original standard (ANSI/IEEE Std 802.3-1985) in 1983, it had the following membership:

Donald C. Loughry, *Chair*

Phil L. Arst	Donald E. Kotas	Robert S. Printis
Robert F. Bridge	William P. Lidinsky	Gary S. Robinson
Charles Brill	Laurie Lindsey	Robert Rosenthal
G. J. Clancy	William D. Livingston	Gary Stephens
John Davidson	Andy Luque	Daniel P. Stokesberry
Ralph DeMent	Daniel Maltbie	Ken. F. Sumner
Hank (H. N.) Dorris	Jerry McDowell	Daniel Sze
Judith Estrin	C. Kenneth Miller	Victor J. Tarassov
Richard Fabbri	Robert L. Morrell	P. E. Wainwright
Ingrid Fromm	Wendell Nakamine	Lyle Weiman
Milton C. Harper	W. P. Neblett	Hugh E. White
Bryan Hoover	James Nelson	Choa-Ping Wu
George D. Jelatis	Thomas L. Phinney	Nick Zades
Harold W. Katz	David Potter	Mo R. Zonoun

Additional individuals who contributed actively in the development of the original standard (ANSI/IEEE Std 802.3-1985) throughout its elaboration were

Juan Bulnes	Dean Lindsay	Mark Townsend
Ron Crane	Then. T. Liu	Roger Van Brunt
Dane Elliot	Robert Moles	Bo Vicklund
Alan Flatman	Tony Lauck	Chris Wargo
Maris Graube	Joseph St. Amand	Richard Williams
Guy Harkins	Richard Seifert	Ron Yara
	Nathan Tobol	

The ECMA TC24 Committee on Communication Protocols also provided helpful input in the development of this standard.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3a-1988 (Section 10) in November 1984, it had the following membership:

Donald C. Loughry, *Chair* Alan Flatman, *Chair, Type 10BASE2 Task Force*

Menachem Abraham	Guy Harkins	Joseph Rickert
R. V. Balakrishnan	Greg Hopkins	Gary Robinson
William Belknap	Joe Kennedy	Robert Rosenthal
Charles Brill	Hiroshi Kobayashi	Joseph St. Amand
Juan Bulnes	Tony Lauck	Walter Schreuer
Stephen Cooper	William Livingston	Stephen Soto
Ronald Crane	Hugh Logan	Gary Spencer
John Davidson	Leland Long	Robert Summers
Mark Devon	Andy Luque	Pat Thaler
Phil Edholm	Daniel Maltbie	Geoff Thompson
Gregory Ennis	Steven Moustakas	Wendell Turner
Judy Estrin	Wendell Nakamine	David White
Richard Fransen	Lloyd Oliver	Lawrence White
Ingrid Fromm	Aidan Paul	Rich Williams
Robert Galin	David Potter	Ronald Yara
Rich Graham	Eugene Reilly	Mo Zonoun

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3-1985 for submission to the IEEE Standards Board:

W. Adams
R. Appleby
G. Arnold
Y. Baeg
E. Beauregard
J. Becker
E. Bergaimini
Boorstyn
A. Carrato
G. Carson
S. Chakradarti
S. Chandra
F. Chang
C. Chao
C. Chen
P. Chen
K. Chon
R. Chow
G. Clinque
I. Cotton
D. Cox
R. DeJardins
D. Dickel
C. Eldridge
P. Enslow
J. Fendirch
M. Figuerea
D. Fisher
J. Fletcher
W. Franta
R. Gagliano
D. Gan
M. Graube
M. Greene
R. Gustin
K. Harbaugh
G. Harkins

R. Harrington
H. Heilborn
L. Heselton
D. Hislop
C. Hobbs
S. Hollander
P. Hutton
P. Induiago
T. Ishida
J. Jelemensky
O. Kahn
S. Kak
K. Katzeff
C. Kessler
D. Kirschen
R. Kolm
T. Kuki
R. Kunkel
W. Lai
V. Lasker
N. Lau
R. Laughlin
F. Lim
T. Liu
J. Loo
K. Loughner
D. Loughry
T. Louhenkillbi
D. Manchester
M. Marco
D. Matters
D. McInode
D. Michels
L. Moraes
D. Morriss
J. Murayama
R. Nelson
D. Ofsevit

C. Ostereicher
M. Papa
S. Peter
D. Phuoc
T. Phinney
G. Power
A. Reddi
M. Repko
F. Restivo
L. Rich
D. Rine
R. Rosenthal
P. Ruosadri
S. Samoylenko
B. Sashi
A. Sauer
N. Schneidewind
O. Serlin
D. Shepard
D. Sloyer
H. Solomon
G. Stephens
C. Stillebroer
K. Sumner
E. Sykas
A. Tantawi
D. Tether
J. Tourret
K. Tu
D. Umbaugh
J. Vorhies
A. Weissberger
W. Wenker
T. Wicklund
T. Wolf
F. Wolff
R. Youg

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3a-1988 (Section 10) for submission to the IEEE Standards Board:

Marshall Abrams	Keith W. Harbaugh	Marco Meli
John Adams	S. M. Harris	David S. Millman
William B. Adams	J. Scott Haugdahl	Aditya N. Mishra
S. R. Ahuja	Sharon Healy	Richard J. Moff
Kit Athol	C. W. Hobbs	David E. Morgan
William Ayen	Jim P. Hong	Mike Morganti
Yong-Myung Baeg	Paul L. Hutton	Kinji Mori
Wesley A. Ballenger, Jr.	Richard Iliff	D. J. Morris
Edwardo W. Bergamini	George D. Jelatis	H. T. Mouftah
Henk F. Boley	Guy Juanelo	Dale A. Murray
Betty Brannick	Siegel L. Junker	Ruth Nelson
George S. Carson	Karl H. Kellermayr	J. Duane Northcutt
Po Chen	Mladen Kezunovic	Charles Ostereicher
L. Y. Cheung	Samuel Kho	David Ofsevit
Kilnam Chon	David Kofin	Young Oh
T. Ricky Chow	Sastri L. Kota	George Parowski
David Cohen	Hirayr M. Kodyan	Thomas L. Phinney
Allen F. Conrad	Takahiko Kuki	Nikitas Pimopoulos
Ira W. Cotton	Lee LaBarre	David Potter
Robert S. Crowder	Wai-Sum Lai	John Potvoek
Michel Diaz	Valerie Laaker	Gary S. Robinson
Mitchell G. Duncan	Lance M. Leach	Marya Repko
Philip H. Enslow, Jr.	Edward Y. S. Lee	Robert Rosenthal
Judith Estrin	Stephen E. Levin	Gian Paolo Rossi
John W. Feadrich	F. C. Lim	David J. Rypka
Harvey A. Freeman	Don C. Loughry	S. I. Samoylenko
Patrick Gonia	Joseph F. P. Luhukay	Norman F. Schneidewind
Ambuj Goyal	Wo-Shun Luk	Oscar Sepulveda
Michael D. Graebner	Marco Marsan	Omri Serlin
Maris Graube	Joseph Massi	D. Sheppard
Nobuhiro Hamada	Darroll B. McIndoe	R. M. Simmons
Joseph L. Hammond	Patrick S. McIntosh	David W. Sloyer

When the IEEE Standards Board approved ANSI/IEEE Std 802.3-1988 on June 9, 1988, and ANSI/IEEE Std 802.3a-1988 (Section 10) on October 20, 1988, it had the following membership:

Donald C. Fleckenstein, Chair

Andrew G. Salem, Secretary

Marco Migliaro, Vice Chair

Arthur A. Blaisdell
Fletcher J. Buckley
James M. Daly
Stephen R. Dillon
Eugene P. Fogarty
Jay Forster*
Thomas L. Hannan
Kenneth D. Hendrix
Theodore W. Hissey, Jr.

John W. Horch
Jack M. Kinn
Frank D. Kirschner
Frank C. Kitzantides
Joseph L. Koepfinger*
Irving Kolodny
Edward Lohse
John E. May, Jr.
Lawrence V. McCall

L. Bruce McClung
Donald T. Michael*
Richard E. Mosher
L. John Rankine
Gary S. Robinson
Frank L. Rose
Helen M. Wood
Karl H. Zaininger
Donald W. Zipse

*Member emeritus

ANSI/IEEE Std 802.3-1988 and ANSI/IEEE Std 802.3a-1988 were approved by the American National Standards Institute on January 12, 1989.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3c-1985 (9.1-9.8) in July 1985, it had the following membership:

Donald C. Loughry, Chair
Geoffrey O. Thompson, Chair, Repeater Task Force

Menachem Abraham
Keith Albright
R. V. Balakrishnan
William Belknap
Richard Bennett
Charles Brill
Juan Bulnes
Stephen Cooper
Paul Eastman
Phil Edholm
Gregory Ennis
Alan Flatman
Richard Fransen
Ingrid Fromm
Robert Galin
Sharad Gandhi
Rich Graham
Richard Gumpertz

Hacene Hariti
Guy Harkins
Fred Huang
Stephen Janshego
Donald Johnson
Kwi-Yung Jung
Paul Kellam
Joe Kennedy
Hiroshi Kobayashi
Lee LaBarre
Tony Lauck
John Laynor
William Livingston
Terry Lockyer
James Lucas
Andy Luque
Daniel Maltbie
Steven Moustakas
Lloyd Oliver

Aidan Paul
David Potter
Eric Rawson
Joseph Rickert
Gary Robinson
Timothy Rock
David Roos
Robert Rosenthal
Joseph St. Amand
Walter Schreuer
Semir Sirazi
David Smith
Stephen Soto
Robert Summers
Pat Thaler
Wendell Turner
Marc Warshaw
Ronald Yara

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3c-1985 (9.1-9.8) for submission to the IEEE Standards Board:

Marshall Abrams
John Adams
William B. Adams
S. R. Ahuja
P. D. Amer
Kit Athul
William Ayen
Yong-Myung Baeg
Wesley A. Ballenger, Jr.
Edwardo W. Bergamini
H. F. Boley
Paul W. Campbell, Jr.
George S. Carson
Po Chen
L. Y. Cheung
Kilnam Chon
T. Ricky Chow
W. F. Chow
David Cohen
Allen F. Conrad
Robert S. Crowder
Michel Diaz
Philip H. Enslow, Jr.
Judith Estrin
John W. Fendrich
Harvey A. Freeman
R. J. Gagliano
Patrick Gonja
Ambuj Goyal
Michael D. Graebner
Maris Graube
Nobushiro Hamada
Joseph L. Hammond
S. M. Harris
J. Scott Haugdahl
C. W. Hobbs
Jim P. Hong
Paul L. Hutton

Richard Iliff
George D. Jelatis
E.D. Jensen
Guy Juanole
Karl H. Kellermayr
Mladen Kozunovic
Samuel Kho
David Kollm
Sastri L. Kota
Hirayr M. Kudyan
Takahiko Kuki
Lee LaBarre
Wai-Sum Lai
Lanse M. Leach
Stephen E. Levin
F. C. Lim
William Livingston
Don C. Loughry
Joseph F. P. Luhukay
Meli Marco
Marco Marsan
Joseph Massi
Darrell B. McIndoe
Patrick S. McIntosh
David S. Millman
Aditya N. Mishra
David E. Morgan
Mike Morganti
Kinji Mori
D. J. Morris
H. T. Mouftah
Dale A. Murray
Ruth Nelson
J. Duane Northcutt
Charles Oestereicher
Young Oh
George Parowski
Thomas L. Phinney
David Potter

John Potvcek
Gary S. Robinson
Marya Repko
Robert Rosenthal
Gian Paolo Rossi
David J. Rypka
S. I. Samoylenko
Norman F. Schneidewind
Oscar Sepulveda
Omri Serlin
D. Sheppard
R. M. Simmons
L. Sintonen
David W. Sloyer
Stephen Soto
Fred Strauss
Bart W. Stuck
Tatsuya Suda
Efstathios D. Sykas
Daniel T. W. Sze
Ahmed N. Tantaui
Mario Tokoro
H. C. Torng
Donald F. Towsley
Wei-Tek Tsai
M. Tsuchiya
Richard Tung
Stanko Turk
L. David Umbaugh
James Vorhies
Pearl S. C. Wang
Don Weir
Alan J. Weissberger
William J. Wenker
Earl J. Whitaker
Michael Willett
Tsong-Ho Wu
Oren Yuen

When the IEEE Standards Board approved ANSI/IEEE Std 802.3c-1985 (9.1-9.8) on December 12, 1985, it had the following membership:

John E. May, Chair

James H. Beall
Fletcher J. Buckley
Rene Castenschild
Edward Chelotti
Edward J. Cohen
Paul G. Cummings
Donald C. Fleckenstein

Sava I. Sherr, Secretary

Jay Forster
Daniel L. Goldberg
Kenneth D. Hendrix
Irvin N. Howell
Jack Kinn
Joseph L. Koepfinger*
Irving Kolodny
R. F. Lawrence

John P. Riganati, Vice Chair

Lawrence V. McCall
Donald T. Michael*
Frank L. Rose
Clifford O. Swanson
J. Richard Weger
W. B. Wilkens
Charles J. Wylie

*Member emeritus

ANSI/IEEE Std 802.3c-1985 was approved by the American National Standards Institute on June 4, 1986.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3d-1987 (9.9), it had the following membership:

Donald C. Loughry, Chair
Steven Moustakas, Chair, Task Force

Menschem Abraham
Keith Albright
Keith Amundsen
Jean-Pierre Astorg
R. V. Balakrishnan
Richard Bennett
Charles Brill
Juan Bulnes
Robert Campbell
Luigi Canavese
Albert Claessen
Peter Dawe
Peter Desaulniers
Raymond Duley
Jeff Ebeling
Gianfranco Enrico
Alan Flatman
Richard Fransen
Ingrid Fromm
Robert Gatin
Mark Gerhold
Adi Golbert
Rich Graham
Rich Gumpertz
Hacene Hariti

Lloyd Hasley
Hawming Haung
Charles Hoffner
Michael Hughes
Donald Johnson
Mze Johnson
Kwi-Yung Jung
Matt Kaltenbach
Paul Kellam
Scott Kesler
Hiroshi Kobayashi
Hidetane Kurokawa
Lee LaBarre
Ed Lare
Wayne Lindquist
Terry Lockyer
Don Loughry
James Lucas
Andy Luque
Lloyd Oliver
Aiden Paul
Roy Pierce
Eric Rawson
Joseph Rickert
Gary Robinson

Timothy Rock
David Roos
Walter Schruer
Semir Sirazi
David Smith
Robert Summers
Pat Thaler
Geoff Thompson
Nathan Tobol
Carlos Tomaszewski
Wendell Turner
Joseph Wiencko
Bruce Williams

OBSERVERS

Allen Cherin
John Decramer
Paul Eastman
Shinji Emori
Jiro Kashio
Michael Lea
Luciano Marchitto
Jim Montrose
Peter Tarrant

The IEC TC83 Committee on Information Technology Equipment also provided very helpful input to the development of the FOIRL Standard (9.9).

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3d-1987 (9.9) for submission to the IEEE Standards Board:

William B. Adams	M. Kezunovic	Gary S. Robinson
S. R. Ahuja	Samuel Kno	Robert Rosenthal
Kit Athul	S. E. Kille	Gian Paolo Rossi
William Ayen	David Kollm	David J. Rypka
Eduardo W. Bergamini	Takahiko Kuki	S. I. Samaylenko
Paul W. Campbell, Jr.	Lee LaBarre	Norman F. Schneidewind
George S. Carson	Wai-Sum Lai	Omri Serlin
Po Chen	Lanse M. Leach	D. Sheppard
L. Y. Cheung	Edward Y. Lee	Ron Simmons
Kilnam Chon	R. C. Lightburn	J. B. Sinclair
W. F. Chow	F. C. Lim	L. Sintonen
Michael Coden	William D. Livingston	Tom Stack
A. F. Conrad	Don C. Loughry	Carel M. Stillebroer
Robert S. Crowder	Joseph F. P. Luhukay	Fred Strauss
Michel Diaz	Wo-Shun Luk	Tatsuya Suda
N. I. Dimopoulos	Marco Ajmone Marsan	P. Sugar
M. G. Duncan	Joseph Massi	Efstathios D. Sykas
Philip H. Enslow, Jr.	Marco Meli	Daniel T. W. Sze
Judith Estrin	Darrel B. McIndoe	Ahmed N. Tantawi
John W. Fendrich	P. S. McIntosh	H. C. Torng
Harvey A. Freeman	David S. Millman	D. F. Towsley
Patrick S. Gonia	Aditya N. Mishra	Wei-Tek Tsai
R. L. Gordon	David E. Morgan	Stanko Turk
A. Goyal	Mike Morganti	L. David Umbaugh
M. D. Graebner	Kanji Mori	J. T. Vorhies
Maris Graube	David Morris	Pearl S. C. Wang
Joseph L. Hammond	H. H. T. Mouftah	Don Weir
Stephen Harris	Dale N. Murray	Alan J. Weissburger
J. Scott Haugdahl	R. R. Nelson	W. J. Wenker
C. W. Hobbs	J. D. Northcut	Earl J. Whitaker
Paul Hutton	Charles Oestereicher	Bryan Whittle
Richard Illif	Young Oh	Michael Willett
E. D. Jenson	George Parowski	David C. Wood
Guy Juanole	Thomas L. Phinney	Tsong-Hu Wu
Karl H. Kellermayr	J. M. Potucek	Oren Yuen
	Marya Repko	

When the IEEE Standards Board approved ANSI/IEEE Std 802.3d-1987 (9.9) on December 12, 1985, it had the following membership:

Donald C. Fleckenstein, Chair

Andrew G. Salem, Secretary

Marco Migliaro, Vice Chair

James H. Beall	Leslie R. Kerr	Donald T. Michael*
Dennis Bodson	Jack Kinn	L. John Rankine
Marshall L. Cain	Irving Kolodny	John P. Riganati
James M. Daly	Joseph L. Koepfinger*	Gary S. Robinson
Stephen R. Dillon	Edward Lohse	Frank L. Rose
Eugene P. Fogarty	John May	Robert E. Rountree
Jay Forster	Lawrence V. McCall	William R. Tackaberry
Kenneth D. Hendrix	L. Bruce McClung	William B. Wilkens
Irvin N. Howell		Helen M. Wood

*Member emeritus

ANSI/IEEE Std 802.3d-1987 was approved by the American National Standards Institute on February 9, 1989.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3b-1985 (Section 11), it had the following membership:

Donald C. Loughry, Chair
Menachem Abraham, Chair, Type 10BROAD36 Task Force

Keith Albright	Fred Huang	Aidan Paul
R. V. Balakrishnan	Stephen Janshego	David Potter
William Belknap	Donald Johnson	Eric Rawson
Richard Bennett	Kwi-Yung Jung	Eugene Reilly
Charles Brill	Paul Kellam	Joseph Rickert
Juan Bulnes	Joe Kennedy	Anthony Rizzolo
Stephen Cooper	Hiroshi Kobayashi	Gary Robinson
Ronald Crane	Lee LaBarre	Timothy Rock
John Davidson	Ed Lare	David Roos
Mark Devon	Tony Lauck	Robert Rosenthal
Paul Eastman	John Laynor	Joseph St. Amand
Phil Edholm	William Livingston	Walter Schreuer
Gregory Ennis	Terry Lockyer	Semir Sirazi
Judy Estrin	Hugh Logan	David Smith
Alan Flatman	Leland Long	Stephen Soto
Richard Fransen	James Lucas	Gary Spencer
Ingrid Fromm	Andy Luque	Robert Summers
Robert Galin	Daniel Malthie	Pat Thaler
Sharad Gandhi	Joseph Mazer	Geoff Thompson
Rich Graham	Steven Moustakas	Nathan Tobol
Richard Gumpertz	Narayan Murthy	Wendell Turner
Hacene Hariti	Wendell Nakamine	Marc Warshaw
Guy Harkins	Lloyd Oliver	David White
Gregory Hopkins		Mo Zonoun

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3b-1985 (Section 11) for submission to the IEEE Standards Board:

Marshall Abrams	E. Douglas Jensen	George Parowski
John Adams	Guy Juanelo	Thomas L. Phinney
William B. Adams	Siegel L. Junker	Nikitas Pimopoulos
S. R. Ahuja	Karl H. Kellermayr	David Potter
Kit Athul	Mladen Kezunovic	John Potvock
William Ayen	Samuel Kho	Gary S. Robinson
Yong-Myung Baeg	David Kolm	Marya Repko
Wesley A. Ballenger, Jr.	Sastri L. Kota	Robert Rosenthal
Edwardo W. Bergamini	Hirayr M. Kudyan	Gian Paolo Rossi
Henk F. Beley	Takahiko Kuki	David J. Rypka
George S. Carson	Lee LaBarre	S. I. Samoylenko
Po Chen	Wai-Sum Lai	Norman F. Schneidewind
L. Y. Cheung	Valerie Lasker	Oscar Sepulveda
Kilnam Chon	Lanise M. Leach	Omri Serlin
T. Ricky Chow	Edward Y. S. Lee	D. Sheppard
David Cohen	Stephen E. Levin	R. M. Simmons
Allen F. Conrad	F. C. Lim	David W. Sloyer
Ira W. Cotten	Donald C. Loughry	Stephen Soto
Robert S. Crowder	Joseph F. P. Luhukay	Tom Stack
Michel Diaz	Wo-Shun Luk	Carel M. Stillebroer
Mitchell G. Duncan	Marco Marsan	Fred Strauss
Philip H. Enslow, Jr.	Joseph Massi	Bart W. Stuck
Judith Estrin	Darrell B. McIndoe	Tatsuya Suda
John W. Fendrich	Patrick S. McIntosh	Peter Sugar
Harvey A. Freeman	Marco Meli	Efstathios D. Sykas
Patrick Genia	David S. Millman	Daniel T. W. Sze
Ambuj Goyal	Aditya N. Mishra	Ahmed N. Tantaui
Michael D. Grabner	Richard J. Moff	Mario Tokoro
Maris Graube	David E. Morgan	H. C. Torng
Nobuhiro Hamada	Mike Morganti	Donald F. Towsley
Joseph L. Hammond	Kinji Mori	Wei-Tek Tsai
Keith W. Harbaugh	D. J. Morris	M. Tsuchiya
S. M. Harris	H. T. Moustah	Richard Tung
J. Scott Haugdahl	Dale A. Murray	Stanko Turk
Sharon Healy	Ruth Nelson	L. David Umbaugh
C. W. Hobbs	J. Duane Northcutt	James Vorhies
Jim P. Hong	Charles Oestereicher	Paul S. C. Wang
Paul L. Hutton	David Ofsevit	Don Weir
Richard Iliff	Young Oh	Alan J. Weissberger
George D. Jclatiu		William J. Wenker

Earl J. Whitaker
Bryan S. Whittle

Michael Willett
Donald Wittman

George R. Wood
Tseng-Ho Wu

When the IEEE Standards Board approved ANSI/IEEE Std 802.3b-1985 (Section 11) on September 19, 1985, it had the following membership:

John E. May, Chair

Sava I. Sherr, Secretary

John P. Riganati, Vice Chair

James H. Beall
Fletcher J. Buckley
Rene Castenschild
Edward Chelotti
Edward J. Cohen
Paul G. Cummings
Donald C. Fleckenstein

Jay Forster
Daniel L. Goldberg
Kenneth D. Hendrix
Irvin N. Howell
Jack Kinn
Joseph L. Koepfinger*
Irving Kolodny
R. F. Lawrence

Lawrence V. McCall
Donald T. Michael*
Frank L. Rose
Clifford O. Swanson
J. Richard Weger
W. B. Wilkens
Charles J. Wylie

*Member emeritus

ANSI/IEEE Std 802.3b-1985 was approved by the American National Standards Institute on February 28, 1986.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3e-1987 (Section 12) in November 1986, it had the following membership:

Donald C. Loughry, Chair

Robert Galin, Chair, Type 1BASE5 Task Force

Menschem Abraham
Keith Albright
Keith Amundsen
Jean-Pierre Astorg
R. V. Balakrishnan
Ian Barker
Charles Brill
Juan Bulnes
Robert Campbell
Luigi Canavese
Albert Claessen
Michael Coden
Bill Cronin
Peter Dawe
Peter Desaulniers
Raymond Duley
Jeff Ebeling
Gianfranco Enrico
Alan Flatman
Richard Fransen
Mark Gerhold
Adi Gilbert

Rich Graham
Richard Gumpertz
Hacene Hariti
Lloyd Hasley
Haw Ming Haung
Charles Hoffner
Michael Hughes
Donald Johnson
Mize Johnson
Kwi-Yung Jung
Matt Kaltenbach
Paul Kellam
Scott Keeler
Hiroshi Kobayashi
Hidetsune Kurokawa
Michael Lee
Lee LaBarre
Terry Lockyer
James Lucas
Andy Luque
Luciano Marchitto
Steven Moustakas

Lloyd Oliver
Roy Pierce
Bill Poston
Eric Rawson
Joseph Rickert
Gary Robinson
Timothy Rock
David Roos
Ed Sakaguchi
Walter Schreuer
Semir Sirazi
David Smith
Robert Summers
Peter Tarrant
Mark Taylor
Pat Thaler
Geoff Thompson
Nathan Tobol
Carlos Tomaszewski
Jayshree Ullal
Joseph Wiencko
Bruce Williams

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3e-1987 (Section 12) for submission to the IEEE Standards Board:

Marshall D. Abrams
 William B. Adams
 S. R. Ahuja
 P. D. Amer
 Kit Athul
 William Ayen
 Eduardo W. Bergamini
 H. F. Boley
 Paul W. Campbell, Jr.
 George S. Carson
 Po Chen
 L. Y. Cheung
 Kilnam Chon
 W. F. Chow
 Michael Codan
 A. F. Conrad
 Ira Cotton
 D. E. Crotty
 Robert S. Crowder
 Michel Diaz
 N. I. Dimopoulos
 M. G. Duncan
 P. M. Elliot
 Philip H. Enslow, Jr.
 Judith Estrin
 John W. Fendrich
 G. A. Foggiate
 Harvey A. Freeman
 Robert J. Gagliano
 T. F. Gannon III
 Patrick S. Gonias
 R. L. Gordon
 A. Goyal
 M. D. Graebner
 Maris Graube
 Joseph L. Hammond
 Stephen Harris
 J. Scott Haugdahl
 C. W. Hobbs
 Paul Hutton

Richard Diff
 E. D. Jenson
 Guy Juanele
 S. L. Junker
 Karl H. Kellermayr
 M. Kezanovic
 Samuel Kho
 S. E. Kille
 David Kollm
 Takahiko Kuki
 Lee LaBarre
 Wai-Sum Lai
 Lance M. Leach
 Edward Y. Lee
 S. E. Levin
 R. C. Lightburn
 F. C. Lim
 William D. Livingston
 Don C. Loughry
 Joseph F. P. Luhukay
 Wo-Shun Luk
 Marco Ajmone Marsan
 Joseph Massi
 Marco Meli
 Darrel B. McIndoe
 P. S. McIntosh
 David S. Millman
 Aditya N. Mishra
 David E. Morgan
 Mike Morganti
 Kanji Mori
 David Morris
 H. H. T. Mouftah
 Dale N. Murray
 R. R. Nelson
 J. D. Northcut
 Charles Oestereich
 Young Oh
 George Parowski
 Thomas L. Phinney
 David Potter

J. M. Potucek
 Marya Repko
 Gary S. Robinson
 Robert Rosenthal
 Gian Paolo Rossi
 David J. Rypka
 S. I. Samaylenko
 Norman F. Schneidewind
 Omri Serlin
 D. Sheppard
 Ron Simmons
 J. B. Sinclair
 L. Sintona
 Stephen H. Soto
 Tom Stack
 Carel M. Stillebroer
 Fred Strauss
 Bart W. Stuck
 Tatsuya Suda
 P. Sugar
 Efethathios D. Sykas
 Daniel T. W. Sze
 Ahmed N. Tantawi
 H. C. Torng
 D. F. Towsley
 Wei-Tek Tsai
 Masahiro Tsuchiya
 Stanko Turk
 L. David Umbaugh
 J. T. Vorhies
 Pearl S. C. Wang
 Don Weir
 Alan J. Weissburger
 W. J. Wenker
 Earl J. Whitaker
 Bryan Whittle
 Michael Willett
 David C. Wood
 Tsong-Hu Wu
 Oren Yuan

When the IEEE Standards Board approved ANSI/IEEE Std 802.3e-1987 (Section 12) on June 11, 1987, it had the following membership:

Donald C. Fleckenstein, Chair

Marco W. Migliaro, Vice Chair

Andrew G. Salem, Secretary

James H. Beall
 Dennis Bodson
 Marshall L. Cain
 James M. Daly
 Stephen R. Dillon
 Eugene P. Fogarty
 Jay Forster
 Kenneth D. Hendrix
 Irvin N. Howell

Lestie R. Karr
 Jack Kinn
 Irving Kolodny
 Joseph L. Koepfinger*
 Edward Lohse
 John May
 Lawrence V. McCall
 L. Bruce McClung
 Donald T. Michael*

L. John Rankine
 John P. Riganati
 Gary S. Robinson
 Frank L. Rose
 Robert E. Rountree
 Sava I. Sherr*
 William R. Tackaberry
 William B. Wilkens
 Helen M. Wood

*Member emeritus

ANSI/IEEE Std 802.3e-1987 was approved by the American National Standards Institute on December 15, 1987.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3h-1990 (Section 5), it had the following membership:

Donald C. Loughry, Chair
Andy J. Luque, Chair, Layer Management Task Force

Menachem Abraham	W. B. Hatfield	Keith Onodera
John R. Agee	Stephen Haughey	Tony Peatfield
Richard Anderson	Carl G. Hayssen	Peter Rautenberg
Ekkehard Antz	Ariel Hendel	Bill Reysen
Keith Amundsen	Chip Hicks	Gary Robinson
Susie Armstrong	William Hingston	Steven Robinson
R. V. Balakrishnan	Charles Hoffner	Moni Samaan
Mark Bohrer	Ernie Jensen	Fred Sammartino
Richard Brand	Clarence Joh	Stan Sassower
Thomas Butler	Dieter W. Junkers	F. Sarles
Luca Cafiero	Donald C. Johnson	Ronald Schmidt
Robert R. Campbell	Mize Johnson	Tom Schmitt
Luigi Canavese	Scott Kesler	Frederick Scholl
Jacques Christ	Bob Kilgore	Ron Shani
Michael Coden	Yongbum Kim	Semir Sirazi
Robert Conte	Bill Kind	Joseph Skorupa
Bill Cronin	John Kincaid	David A. Smith
Peter Cross	Tadayoshi Kitayama	Bob Smith
John DeCramer	Paul Kopera	Steve Smith
Ian Crayford	David Kung	Robert Snyder
Nabil Damouny	Michael Lee	Graham Starkins
Sanjay Dhawan	Richard Lena	David E. Stein
Raymond S. Duley	Yoseph Linde	Peter Tarrant
Paul Eastman	Wayne Lindquist	Mark Taylor
Richard Ely	T. D. Lockyer	Patricia Thaler
Gianfranco Enrico	James A. Lucas	Douglas Thompson
Norman Erbacher	Ian Lyon	Geoffrey O. Thompson
Steve Evitts	Kenneth MacLeod	Nathan Tobol
Alan V. Flatman	Luciano Marchitto	Carlos Tomaszewski
Ingrid Fromm	Charles Marsh	IHerbert Ulil
Mel Gable	Bob Matthys	Steven Ulrich
Bob Galin	Steven Moustakas	John Visser
Mark Gerhold	Narayan Murthy	William Wager
Rich Graham	Darcy Nelson	Joseph A. Wiencko, Jr.
Andreas Gulle	Bob Norton	Bruce Williams
Richard Gumpertz	Mike O'Connor	Richard Williams
Clive Hallatt	Chris Oliver	Roger Wilmarth
Kevin Hamilton	Lloyd Oliver	Mike Wincn
Benny Hanigal	Kazuyuki Ozawa	Mark Wingrove
Lloyd Hasley		Nobushige Yokota

The following persons were on the balloting committee that approved ANSI/IEEE Std 802.3h-1990 for submission to the IEEE Standards Board:

William Adams	Maris Graube	Darrell B. McIndoe
Kit Athul	Joseph L. Hammond	Richard H. Miller
William E. Ayen	Stephen Harris	David S. Millman
Ali Bahrololoomi	J. Scott Haugdahl	Aditya Mishra
George S. Carson	C.W.L. Hobbs	John E. Montague
Chih-Tsai M. Chen	Chris Hsieh	M. A. F. Morganti
Michael H. Coden	Richard J. Iliff	Kinji Mori
R. A. Conser	Raj Jain	D. J. Morris
R. S. Crowder	M. Kezunovic	M. T. Mouftah
Andrew Davidson	Samuel Kho	Arne A. Nilsson
Luis F. M. De Moraes	Tom Kurihara	Charles Oestereicher
N. I. Dimopoulos	Lee Labarre	Young Oh
Mitchell Duncan	Anthony B. Lake	Thomas L. Phinney
John E. Emrich	Mike Lawler	Rafat Pirzada
John W. Fendrich	Jaiyong Lee	Udo Pooch
Harold C. Folts	F. C. Lim	Robert S. Printis
Harvey Freeman	Randolph S. Little	Marya S. Repko
Ingrid Fromm	William Livingston	John P. Riganati
D. G. Gan	Joseph Loo	Gary S. Robinson
Patrick Gonia	Donald C. Loughry	N. F. Schneidewind
Julio Gonzalez Sanz	Andy J. Luque	Manfred H. Seifert
Michael Graebner	Kelly C. McDonald	D. A. Sheppard

Glan Sherwood
R. M. Simmons
Leo Sintonen
Harry P. Solomon
Robert K. Southard
John Spragins
C. M. Stillebroer

Frank J. Strauss
E. D. Sykas
A. N. Tantawi
Nathan Tobol
Twi-Tek Tsai
David L. Umbaugh
T. A. Varetoni

James Vorhies
Don Weir
A. F. Wheeler
Earl J. Whitaker
D. C. Wood
George B. Wright
Oron Yusa

When the IEEE Standards Board approved ANSI/IEEE Std 802.3h-1990 on September 28, 1990, it had the following membership:

Marco W. Migliaro, *Chairman*

James M. Daly, *Vice Chairman*

Andrew G. Salem, *Secretary*

Dennis Bodson
Paul I. Borrill
Fletcher J. Buckley
Allen L. Clapp
Stephen K. Dillon
Donald C. Fleckenstein
Jay Forster*
Thomas L. Hanna

Kenneth D. Hendrix
John W. Herch
Joseph L. Koepfinger*
Irving Kolodny
Michael A. Lawler
Donald J. Loughry
John K. May, Jr.

Lawrence V. McCall
L. Bruce McClung
Donald T. Michael*
Stig Nilsson
Roy T. Oishi
Gary S. Robinson
Terrance R. Whittemore
Donald W. Zipse

*Member Emeritus

ANSI/IEEE Std 802.3h-1990 was approved by the American National Standards Institute on March 11, 1991.

When the IEEE 802.3 Working Group approved ANSI/IEEE Std 802.3i-1990 (Sections 13 and 14), it had the following membership:

Donald C. Loughry, *Chair**

Patricia Thaler, *Chair, Type 10BASE-T Task Force**

Menachem Abraham
Luc Adriaenssens
John R. Agee
Keith Amundson
Richard Anderson
Stephen J. Anderson
Ekkehard Antz
Susie Armstrong
R. V. Balakrishnan
Roberto Bertoldi
Dava Bethune
Mark Bohrer
Richard Brand
Thomas Butler
Luca Caffero
Robert R. Campbell
Luigi Canavese
Michael Caden
Kevin Cene
Robert Coote
Neil Coote
Ian Crayford
Bill Cronin
Peter Cross
Joe Curcio
Nabil Damouny
Mark Darby
John DeCramer
Tazio M. Denicolo
Sanjay Dawan

Paul (Skip) Ely
Richard Ely
Norman Erbacher
Steve Ewitt
Elden Felst
Alan V. Flatman
Ingrid Fromm
Mel Gable
Robert Galin
Mark Gerhold
Andreas Gulle
Richard Gumpertz
Clive Hallatt
Benny Hanigal
W. B. Hatfield
Stephen Haughey
Carl G. Hayssen
Ernie Jensen
Clarence Job
Donald C. Johnson
Miss Johnson
Imra Juhász
Dieter W. Juckers
Joel S. Kalman
Reiner Kaps
Bob Kilgore
Yongbum Kim
John Kincaid
Bill Kind
Tadayoshi Kitayama

Stevan Koller
Paul Kopera
Leonid Koshevoy
Ted Kummert
David Kung
Michael Lebar
Michael Lee
Richard Lefkowitz
Richard Lena
Yoseph Linds
T. D. Lockyer
Andy J. Luque
Kenneth MacLeod
Luciano Marchitto
Charles Marsh
Steven Moustakas
Narayan Murthy
Darcy Nelson
Bob Norton
Mike O'Connor
Chris Oliver
Lloyd Oliver
Keith Onodera
Kazuyuki Ozawa
Charles Palanzo
Tony Pestfield
Peter Rautenberg
Bill Reysen
Gary Robinson
Stevan Robinson

*Patricia Thaler, *Current Chair*

*Richard Anderson, *Current Chair*

Paul F. Russo
Moni Samaan
F. Sarles
Stan Sasower
Ronald Schmidt
Tom Schmitt
Frederick Scholl
Ron Shani
Joseph Skorupa
David A. Smith

Bob Smith
Steve Smith
Robert Snyder
Graham Starkins
David E. Stein
Peter Tarrant
Mark Taylor
Douglas Thompson
Geoffrey Thompson
Nathan Tobol

Carlos Tomaszewski
Herbert Uhl
John Visser
William Wager
Joseph Wiencko, Jr.
Richard Williams
Roger Wilmarth
Mike Winch
Mark Wingrove
Nobushige Yokota

The following persons were on the balloting committee for ANSI/IEEE Std 802.3i-1990:

Bandula W. Abeyundara
William B. Adams
Don Aelmore
Hassan S. Alkhatib
Jonathan Allan
Sule Arslander
Kit Athul
Michael Atkinson
William E. Ayan
Yong Myung Baeg
Subhash Bhatia
Asa O. Bishop
Alan L. Bridges
Richard Casai
Mehmet U. Caglayan
Anthony L. Carrato
George S. Carson
Brian J. Casey
George C. Chachis
Chih-Tsai Chen
Gerald W. Cichanowski
Michael H. Coden
Keith Collins
Rodney A. Censer
Robert Crowder
Jose A. Cueto
F. Deravi
Ashwani K. Dhuwan
Siyi Terry Dong
Mitchell G. Duncan
Andrew M. Dunn
Sourav Dutta
Ted Daik
Hans Eklund
John E. Emrich
Richard G. Estock
Changxin Fan
John W. Fendrich
John N. Ferguson
Samuel Fineberg
Ernest L. Fogle
Harold C. Folts
Sandra J. Forney
Harvey A. Freeman
Ingrid Fromm
Eithar Froumine
Robert Gagliano
Isaac Ghansah
Patrick Gonis
Michael D. Graebner
Maris Graube
Abraham Grund
Crag Guarnieri
Sandor V. Halasz
Joseph L. Hammond
Clark M. Hay
Lee A. Hollaar
Marsha D. Hopwood
Anne B. Horton
Genasio L. Hubscher
Wing Huen

Bob Jacobsen
Raj Jain
Gerrit K. Janssen
Jack R. Johnson
Reijo Juvonen
Richard H. Karpinski
Julian Kasteley
Gary C. Kessler
Samuel Kho
Jens Kolind
Vijaya Konangi
Peter Kornerup
Jon Kramp
Stephen B. Kruger
Thomas M. Kurihara
Anthony B. Lake
Lak Ming Lam
Glen Langdon
Mike Lawler
Lance M. Leach
John E. Lecky
Jai-Yong Lee
Michael E. Lee
Lewis E. Leinenweber
Kin Fun Lo
F. C. Lim
Ping Liu
Randolph S. Little
William D. Livingston
Mauro Lelli
Wayne M. Loucks
Donald Loughry
Nam C. Low
Andy J. Luque
Carl R. Manson
Eduardo G. Marmol
Gerald M. Masson
Richard McBride
Kelly C. McDonald
William McDonald
Darrell B. McIndoe
Richard H. Miller
David S. Millman
C. B. M. Mishra
Wen Hsien Lim Moh
John E. Montague
Kinji Mori
Gerald Moseley
H. H. T. Meutfah
K. R. S. Murthy
Charles E. Neblock
Ruth Nelson
Arne A. Nilsson
Donal O'Mahony
Frederic Oakland
Charles Oustereicher
Attila Ozgit
Richard J. Paroline
Thomas E. Phillips
Art J. Piao
Rafat Pirzada
Udo W. Pooch

Hardy J. Pottinger
Andria Putnins
Thad L. D. Regulinski
Francisco J. Retivo
John R. Riganati
Saber Risk
Philip T. Robinson
Gary S. Robinson
Robert Rosenthal
Daniel Rosich
Floyd E. Ross
Victor Rosentouler
Chiseki Sagawa
Mark S. Sanders
Ravi Sankar
Julio Gonzalez Sanz
Ambatipudi Sastry
Vidyadhar S. Savant
Manoj Kumar Saxena
Lorne Schachter
Norman Schneidewind
Jeffrey R. Schwab
A. D. Sheppard
Glen Sherwood
William T. Smith
I. A. Socanu
Robert K. Southard
Charles Spurgeon
Michael Stephenson
Fred J. Strauss
Efstathios D. Sykas
Roy S. Syler
Gregory M. Sylvain
Daniel Sze
Nhi P. Ta
Hassan Tahaie
Hao Tang
Ahmed N. Tantawi
Steven R. Taylor
James N. Thomas
Geoffrey O. Thompson
Nathal Tobol
Robert Tripi
L. David Umbaugh
Thomas A. Varettoni
James T. Vorhies
Barry Vornbrock
Clarence M. Weaver
Donald F. Weir
Alan J. Weissberger
Raymond Wenig
William J. Wenker
Earl J. Whitaker
Thomas P. Wiggen
Michael Willett
Paul A. Willis
George B. Wright
Jen-Kun Yang
Oren Yuen
William H. Yundt
Zhao Wei

When the IEEE Standards Board approved ANSI/IEEE Std 802.3i-1990 on September 28, 1990, it had the following membership:

Marco W. Migliaro, *Chairman*

James M. Daly, *Vice Chairman*

Andrew G. Salem, *Secretary*

Dennis Bodson
Paul L. Borrill
Fletcher J. Buckley
Allen L. Clapp
Stephen R. Dillon
Donald C. Fleckenstein
Jay Forster*
Thomas L. Hannan

Kenneth D. Hendrix
John W. Horch
Joseph L. Koepfinger*
Irving Kolodny
Michael A. Lawler
Donald J. Loughry
John E. May, Jr.

Lawrence V. McCall
L. Bruce McClung
Donald T. Michael*
Stig Nilsson
Roy T. Oishi
Gary S. Robinson
Terrance R. Whittemore
Donald W. Zipse

*Member Emeritus

ANSI/IEEE Std 802.3i-1990 was approved by the American National Standards Institute on March 11, 1991.

Contents

SECTION	PAGE
1. Introduction.....	31
1.1 Overview.....	31
1.1.1 Basic Concepts	31
1.1.2 Architectural Perspectives	31
1.1.3 Layer Interfaces	32
1.1.4 Application Areas	33
1.2 Notation.....	33
1.2.1 State Diagram Conventions.....	33
1.2.2 Service Specification Method and Notation.....	34
1.2.3 Physical Layer and Media Notation.....	35
1.2.4 Physical Layer Message Notation	35
1.3 References.....	35
1.4 Definitions.....	36
2. MAC Service Specification.....	37
2.1 Scope and Field of Application.....	37
2.2 Overview of the Service	37
2.2.1 General Description of Services Provided by the Layer.....	37
2.2.2 Model Used for the Service Specification	37
2.2.3 Overview of Interactions	37
2.2.4 Basic Services and Options	37
2.3 Detailed Service Specification	38
2.3.1 MA_DATA.request	38
2.3.2 MA_DATA.indication	38
3. Media Access Control Frame Structure	41
3.1 Overview.....	41
3.1.1 MAC Frame Format.....	41
3.2 Elements of the MAC Frame.....	41
3.2.1 Preamble Field	41
3.2.2 Start Frame Delimiter (SFD) Field	42
3.2.3 Address Fields	42
3.2.4 Destination Address Field	43
3.2.5 Source Address Field	43
3.2.6 Length Field	43
3.2.7 Data and PAD Fields	43
3.2.8 Frame Check Sequence Field	43
3.3 Order of Bit Transmission	44
3.4 Invalid MAC Frame.....	44
4. Media Access Control	45
4.1 Functional Model of the Media Access Control Method	45
4.1.1 Overview	45
4.1.2 CSMA/CD Operation.....	45
4.1.3 Relationships to LLC Sublayer and Physical Layer.....	47
4.1.4 CSMA/CD Access Method Functional Capabilities	47
4.2 CSMA/CD Media Access Control Method (MAC): Precise Specification.....	48
4.2.1 Introduction	48
4.2.2 Overview of the Procedural Model	48
4.2.3 Frame Transmission Model	54
4.2.4 Frame Reception Model	55
4.2.5 Preamble Generation	56
4.2.6 Start Frame Sequence.....	57
4.2.7 Global Declarations.....	57
4.2.8 Frame Transmission	59
4.2.9 Frame Reception	63
4.2.10 Common Procedures.....	65
4.3 Interfaces to/from Adjacent Layers	66

SECTION	PAGE
4.3.1	Overview 66
4.3.2	Services Provided by the MAC Sublayer..... 66
4.3.3	Services Required from the Physical Layer 67
4.4	Specific Implementations 68
4.4.1	Compatibility Overview 68
4.4.2	Allowable Implementations 69
5.	Layer Management 71
5.1	Introduction..... 71
5.1.1	Systems Management Overview 71
5.1.2	Layer Management Model 72
5.2	Management Facilities 73
5.2.1	Introduction 73
5.2.2	MAC Sublayer Management Facilities 73
5.2.3	Physical Layer Management Facilities 77
5.2.4	Layer Management Model 77
6.	PLS Service Specifications..... 83
6.1	Scope and Field of Application 83
6.2	Overview of the Service 83
6.2.1	General Description of Services Provided by the Layer 83
6.2.2	Model Used for the Service Specification 83
6.2.3	Overview of Interactions 83
6.2.4	Basic Services and Options 84
6.3	Detailed Service Specification 84
6.3.1	Peer-to-Peer Service Primitives..... 84
6.3.2	Sublayer-to-Sublayer Service Primitives 85
7.	Physical Signaling (PLS) and Attachment Unit Interface (AUI) Specifications 87
7.1	Scope 87
7.1.1	Definitions 87
7.1.2	Summary of Major Concepts..... 88
7.1.3	Application..... 88
7.1.4	Modes of Operation 88
7.1.5	Allocation of Function 88
7.2	Functional Specification 88
7.2.1	PLS-PMA (DTE-MAU) Interface Protocol..... 89
7.2.2	PLS Interface to MAC and Management Entities..... 94
7.2.3	Frame Structure 95
7.2.4	PLS Functions 96
7.3	Signal Characteristics..... 98
7.3.1	Signal Encoding 98
7.3.2	Signaling Rate 102
7.3.3	Signaling Levels 102
7.4	Electrical Characteristics 103
7.4.1	Driver Characteristics..... 103
7.4.2	Receiver Characteristics 104
7.4.3	AUI Cable Characteristics 108
7.5	Functional Description of Interchange Circuits..... 108
7.5.1	General..... 108
7.5.2	Definition of Interchange Circuits..... 109
7.6	Mechanical Characteristics 111
7.6.1	Definition of Mechanical Interface 111
7.6.2	Line Interface Connector 111
7.6.3	Contact Assignments 113
8.	Medium Attachment Unit and Baseband Medium Specifications, Type 10BASE5 115
8.1	Scope 115
8.1.1	Overview 115
8.1.2	Definitions 116

SECTION	PAGE
8.1.3 Application Perspective: MAU and MEDIUM Objectives.....	116
8.2 MAU Functional Specifications.....	117
8.2.1 MAU Physical Layer Functions.....	118
8.2.2 MAU Interface Messages	120
8.2.3 MAU State Diagrams	121
8.3 MAU-Medium Electrical Characteristics	121
8.3.1 MAU-to-Coaxial Cable Interface	121
8.3.2 MAU Electrical Characteristics.....	125
8.3.3 MAU-DTE Electrical Characteristics	126
8.3.4 MAU-DTE Mechanical Connection	126
8.4 Characteristics of the Coaxial Cable.....	126
8.4.1 Coaxial Cable Electrical Parameters	126
8.4.2 Coaxial Cable Properties	127
8.4.3 Total Segment DC Loop Resistance	128
8.5 Coaxial Trunk Cable Connectors	128
8.5.1 Inline Coaxial Extension Connector.....	129
8.5.2 Coaxial Cable Terminator	129
8.5.3 MAU-to-Coaxial Cable Connector	129
8.6 System Considerations	130
8.6.1 Transmission System Model.....	130
8.6.2 Transmission System Requirements	131
8.6.3 Labeling	134
8.7 Environmental Specifications	134
8.7.1 General Safety Requirements	134
8.7.2 Network Safety Requirements	134
8.7.3 Electromagnetic Environment.....	135
8.7.4 Temperature and Humidity	136
8.7.5 Regulatory Requirements	136
9. Repeater Unit for 10 Mb/s Baseband Networks.....	137
9.1 Overview.....	137
9.2 Definitions	137
9.3 References.....	138
9.4 Compatibility Interface.....	138
9.4.1 AUI Compatibility.....	139
9.4.2 Direct Cable Compatibility	139
9.4.3 Link Segment Compatibility	139
9.5 Basic Functions.....	139
9.5.1 Repeater Set Network Properties.....	139
9.5.2 Signal Amplification.....	140
9.5.3 Signal Symmetry	140
9.5.4 Signal Retiming	140
9.5.5 Data Handling	140
9.5.6 Collision Handling	140
9.5.7 Electrical Isolation	141
9.6 Detailed Repeater Functions and State Diagrams	141
9.6.1 State Diagram Notation	141
9.6.2 Data and Collision Handling	146
9.6.3 Preamble Regeneration	146
9.6.4 Fragment Extension.....	146
9.6.5 MAU Jabber Lockup Protection	146
9.6.6 Auto-Partitioning/Reconnection (Optional)	146
9.7 Electrical Isolation	149
9.7.1 Environment A Requirements	149
9.7.2 Environment B Requirements	149
9.8 Reliability	149
9.9 Medium Attachment Unit and Baseband Medium Specification for a Vendor-Independent FOIRL.....	149
9.9.1 Scope	149
9.9.2 FOMAU Functional Specifications	151

SECTION	PAGE
9.9.3 FOMAU Electrical Characteristics	159
9.9.4 FOMAU/Optical Medium Interface.....	159
9.9.5 Characteristics of the Optical Fiber Cable Link Segment	160
9.9.6 System Requirements	161
9.9.7 Environmental Specifications	162
10. Medium Attachment Unit and Baseband Medium Specifications, Type 10BASE2	165
10.1 Scope	165
10.1.1 Overview	165
10.1.2 Definitions	166
10.1.3 Application Perspective: MAU and Medium Objectives	167
10.2 References.....	167
10.3 MAU Functional Specifications.....	167
10.3.1 MAU Physical Layer Functional Requirements.....	168
10.3.2 MAU Interface Messages	170
10.3.3 MAU State Diagrams	172
10.4 MAU-Medium Electrical Characteristics	172
10.4.1 MAU-to-Coaxial Cable Interface	172
10.4.2 MAU Electrical Characteristics.....	174
10.4.3 MAU-DTE Electrical Characteristics	175
10.5 Characteristics of Coaxial Cable System.....	175
10.5.1 Coaxial Cable Electrical Parameters	175
10.5.2 Coaxial Cable Physical Parameters	175
10.5.3 Total Segment DC Loop Resistance	177
10.6 Coaxial Trunk Cable Connectors	177
10.6.1 In-Line Coaxial Extension Connector	178
10.6.2 Coaxial Cable Terminator	178
10.6.3 MAU-to-Coaxial Cable Connection	178
10.7 System Considerations	178
10.7.1 Transmission System Model	178
10.7.2 Transmission System Requirements	179
10.8 Environmental Specifications	181
10.8.1 Safety Requirements.....	181
10.8.2 Electromagnetic Environment.....	181
10.8.3 Regulatory Requirements	182
11. Broadband Medium Attachment Unit and Broadband Medium Specifications, Type 10BROAD36	183
11.1 Scope	183
11.1.1 Overview	183
11.1.2 Definitions	185
11.1.3 MAU and Medium Objectives	186
11.1.4 Compatibility Considerations	186
11.1.5 Relationship to PLS and AUI	186
11.1.6 Mode of Operation	186
11.2 MAU Functional Specifications.....	187
11.2.1 MAU Functional Requirements.....	187
11.2.2 DTE PLS to MAU and MAU to DTE PLS Messages	189
11.2.3 MAU State Diagrams	190
11.3 MAU Characteristics	194
11.3.1 MAU- to-Coaxial Cable Interface	194
11.3.2 MAU Frequency Allocations	198
11.3.3 AUI Electrical Characteristics.....	198
11.3.4 MAU Transfer Characteristics	199
11.3.5 Reliability.....	205
11.4 System Considerations	205
11.4.1 Delay Budget and Network Diameter.....	205
11.4.2 MAU Operation with Packets Shorter than 512 Bits	206
11.5 Characteristics of the Coaxial Cable System	206
11.5.1 Electrical Requirements	206

SECTION	PAGE
11.5.2 Mechanical Requirements.....	207
11.5.3 Delay Requirements.....	207
11.6 Frequency Translator Requirements for the Single-Cable Version.....	207
11.6.1 Electrical Requirements.....	207
11.6.2 Mechanical Requirements.....	208
11.7 Environmental Specifications.....	208
11.7.1 Safety Requirements.....	208
11.7.2 Electromagnetic Environment.....	208
11.7.3 Temperature and Humidity.....	208
12. Physical Signaling, Medium Attachment, and Baseband Medium Specifications,	
Type 1BASE5.....	209
12.1 Introduction.....	209
12.1.1 Overview.....	209
12.1.2 Scope.....	209
12.1.3 Definitions.....	209
12.1.4 General Characteristics.....	211
12.1.5 Compatibility.....	211
12.1.6 Objectives of Type 1BASE5 Specifications.....	211
12.2 Architecture.....	211
12.2.1 Major Concepts.....	211
12.2.2 Application Perspective.....	213
12.2.3 Packet Structure.....	213
12.3 DTE Physical Signaling (PLS) Specification.....	214
12.3.1 Overview.....	214
12.3.2 Functional Specification.....	214
12.4 Hub Specification.....	221
12.4.1 Overview.....	221
12.4.2 Hub Structure.....	222
12.4.3 Hub PLS Functional Specification.....	222
12.5 Physical Medium Attachment (PMA) Specification.....	227
12.5.1 Overview.....	227
12.5.2 PLS-PMA Interface.....	227
12.5.3 Signal Characteristics.....	227
12.6 Medium Dependent Interface (MDI) Specification.....	235
12.6.1 Line Interface Connector.....	235
12.6.2 Connector Contact Assignments.....	235
12.6.3 Labeling.....	235
12.7 Cable Medium Characteristics.....	236
12.7.1 Overview.....	236
12.7.2 Transmission Parameters.....	236
12.7.3 Coupling Parameters.....	236
12.7.4 Noise Environment.....	238
12.8 Special Link Specification.....	238
12.8.1 Overview.....	238
12.8.2 Transmission Characteristics.....	238
12.8.3 Permitted Configurations.....	238
12.9 Timing.....	239
12.9.1 Overview.....	239
12.9.2 DTE Timing.....	239
12.9.3 Medium Timing.....	239
12.9.4 Special Link Timing.....	239
12.9.5 Hub Timing.....	239
12.10 Safety.....	240
12.10.1 Isolation.....	240
12.10.2 Telephony Voltages.....	240
13. System Considerations for Multisegment 10 Mb/s Baseband Networks.....	241
13.1 Overview.....	241
13.2 Definitions.....	241

SECTION	PAGE
13.3 Transmission System Model.....	241
14. Twisted-Pair Medium Attachment Unit (MAU) and Baseband Medium, Type 10BASE-T	245
14.1 Scope	245
14.1.1 Overview	245
14.1.2 Definitions	245
14.1.3 Application Perspective.....	247
14.1.4 Relationship to PLS and AUI	248
14.2 MAU Functional Specifications.....	248
14.2.1 MAU Functions	249
14.2.2 PMA Interface Messages.....	250
14.2.3 MAU State Diagrams	252
14.3 MAU Electrical Specifications.....	256
14.3.1 MAU-to-MDI Interface Characteristics	257
14.3.2 MAU-to-AUI Specification	265
14.4 Characteristics of the Simplex Link Segment.....	266
14.4.1 Overview	266
14.4.2 Transmission Parameters.....	266
14.4.3 Coupling Parameters	267
14.4.4 Noise Environment.....	267
14.5 MDI Specification.....	268
14.5.1 MDI Connectors.....	268
14.5.2 Crossover Function.....	269
14.6 System Considerations	270
14.7 Environmental Specifications	270
14.7.1 General Safety	270
14.7.2 Network Safety.....	270
14.7.3 Environment.....	271
14.8 MAU Labeling	271
14.9 Timing Summary	271

FIGURES

Fig 1-1 LAN Standard Relationship to the ISO Open Systems Interconnection (OSI) Reference Model	32
Fig 1-2 State Diagram Notation Example	33
Fig 1-3 Service Primitive Notation	34
Fig 2-1 Service Specification Relation to the LAN Model.....	37
Fig 3-1 MAC Frame Format	41
Fig 3-2 Address Field Format	42
Fig 4-1 MAC Sublayer Partitioning, Relationship to the ISO Open Systems Interconnection (OSI) Reference Model	46
Fig 4-2 CSMA/CD Media Access Control Functions	48
Fig 4-3 Relationship Among CSMA/CD Procedures	50
Fig 4-4 Control Flow Summary	
(a) TransmitFrame	51
(b) ReceiveFrame	52
Fig 4-5 Control Flow: MAC Sublayer	53
Fig 5-1 Relationship Between the Various Management Entities and Layer Entities According to the ISO Open Systems Interconnection (OSI) Reference Model.....	72
Fig 6-1 Service Specification Relationship to the IEEE 802.3 CSMA/CD LAN Model	83
Fig 7-1 Physical Layer Partitioning, Relationship to the ISO Open Systems Interconnection (OSI) Reference Model	87
Fig 7-2 Generalized MAU Model.....	89
Fig 7-3 PLS Reset and Identify Function	91
Fig 7-4 PLS Mode Function	92
Fig 7-5 PLS Output Function.....	93
Fig 7-6 PLS Input Function.....	97
Fig 7-7 PLS Error Sense Function	98
Fig 7-8 PLS Carrier Sense Function	99

FIGURES

PAGE

Fig 7-9	Interface Function for MAU with Conditioning	100-101
Fig 7-10	Examples of Manchester Waveforms	102
Fig 7-11	Differential Output Voltage, Loaded.....	104
Fig 7-12	Generalized Driver Waveform	105
Fig 7-13	Common-Mode Output Voltage	105
Fig 7-14	Driver Fault Conditions.....	106
Fig 7-15	Common-Mode Input Test	107
Fig 7-16	Receiver Fault Conditions	107
Fig 7-17	Common-Mode Transfer Impedance	109
Fig 7-18	Connector Locking Posts	111
Fig 7-19	Connector Slide Latch.....	112
Fig 7-20	Connector Hardware and AUI Cable Configuration	112
Fig 8-1	Physical Layer Partitioning, Relationship to the ISO Open Systems Interconnection (OSI) Reference Model	115
Fig 8-2	Interface Function: Simple MAU Without Isolate Capability	122
Fig 8-3	Interface Function: Simple MAU with Isolate Capability	123
Fig 8-4	Jabber Function.....	124
Fig 8-5	Recommended Driver Current Signal Levels	125
Fig 8-6	Typical Coaxial Trunk Cable Signal Waveform	125
Fig 8-7	Maximum Coaxial Cable Transfer Impedance	127
Fig 8-8	Coaxial Tap Connector Configuration Concepts	130
Fig 8-9	Typical Coaxial Tap Connection Circuit	131
Fig 8-10	Maximum Transmission Path	132
Fig 8-11	Minimal System Configuration	132
Fig 8-12	Minimal System Configuration Requiring a Repeater Set	132
Fig 8-13	An Example of a Large System with Maximum Transmission Paths	133
Fig 8-14	An Example of a Large Point-to-Point Link System (5140 ns)	133
Fig 9-1	Repeater Set, Coax-to-Coax Configuration.....	137
Fig 9-2	Repeater Unit State Diagram	144
Fig 9-3	Transmit Timer State Diagram for Port X	145
Fig 9-4	Tw2 State Diagram	145
Fig 9-5	MAU Jabber Lockup Protection State Diagram.....	145
Fig 9-6	Partitioning State Diagram for Port X.....	148
Fig 9-7	Schematic of the Vendor-Independent FOIRL and Its Relationship to the Repeater Unit	151
Fig 9-8	FOMAU Transmit, Receive, and Collision Functions State Diagram	157
Fig 9-9	FOMAU Jabber Function State Diagram.....	158
Fig 9-10	Low Light Level Detection Function State Diagram	158
Fig 10-1	Physical Layer Partitioning, Relationship to the ISO Open Systems Interconnection (OSI) Reference Model	165
Fig 10-2	MAU Interface Function	168
Fig 10-3	Jabber Function State Diagram	170
Fig 10-4	Driver Current Signal Levels	173
Fig 10-5	Coaxial Trunk Cable Signal Waveform	173
Fig 10-6	Maximum Coaxial Cable Transfer Impedance	176
Fig 10-7	Examples of Insulated Connector Cover.....	177
Fig 10-8	Maximum Transfer Path	179
Fig 10-9	The Minimum System Configuration.....	179
Fig 10-10	The Minimum System Configuration Requiring a Repeater Set	180
Fig 10-11	An Example of a Large Hybrid System.....	180
Fig 11-1	Physical Layer Partitioning, Relationship to the ISO Open Systems Interconnection (OSI) Reference Model	183
Fig 11-2	Broadband Cable Systems	184
Fig 11-3	Transmit Function Requirements	187
Fig 11-4	MAU State Diagram	192-193
Fig 11-5	MAU Jabber State Diagram	194
Fig 11-6	Packet Format and Timing Diagram (AUI to Coaxial Cable Interface)	196
Fig 11-7	Spectrum Mask for RF Data Signal	197
Fig 11-8	Transmit Out-of-Band Power Attenuation	197
Fig 11-9	Packet Format at Modulator Input.....	200

FIGURES		PAGE
Fig 11-10	Scrambler.....	201
Fig 11-11	Differential Encoder.....	201
Fig 11-12	Descrambler.....	202
Fig 11-13	No Collision Timing Diagram (Coax to AUI).....	203
Fig 11-14	Collision Timing Diagram (RF Data to RF Collision Enforcement).....	204
Fig 11-15	Collision Timing Diagram (Coaxial Cable Interface to AUI Circuit CI).....	204
Fig 11-16	Timing at AUI for Zero-Length Coax.....	205
Fig 12-1	1BASE5 Relationship to the ISO Open Systems Interconnection (OSI) Reference Model and the IEEE 802.3 CSMA/CD LAN Model.....	210
Fig 12-2	Single Hub Network.....	212
Fig 12-3	Network With Two Levels of Hubs.....	212
Fig 12-4	Network With Four Levels of Hubs.....	213
Fig 12-5	Station Physical Signaling, Relationship to the ISO OSI Reference Model and the IEEE 802.3 CSMA/CD LAN Model.....	215
Fig 12-6	DTE PLS Output Function.....	217
Fig 12-7	DTE PLS Input Function.....	218
Fig 12-8	DTE PLS Error Sense Function.....	218
Fig 12-9	DTE PLS Carrier Sense Function.....	219
Fig 12-10	Examples of Manchester Waveforms.....	220
Fig 12-11	Examples of Collision Presence Waveforms.....	220
Fig 12-12	Hub Relationship to the OSI Reference Model and the IEEE 802.3 CSMA/CD LAN Model.....	221
Fig 12-13	Hub PLS Upward Transfer Function.....	224
Fig 12-14	Hub PLS Jabber Function for Port X.....	225
Fig 12-15	Hub PLS Downward Transfer Function.....	226
Fig 12-16	Physical Medium Attachment, Relationship to the OSI Reference Model and the IEEE 802.3 CSMA/CD LAN Model.....	228
Fig 12-17	Simulated Light Load.....	228
Fig 12-18	Simulated Heavy Load.....	229
Fig 12-19	Differential Output Voltage, Nominal Duration BT/2.....	229
Fig 12-20	Differential Output Voltage, Duration BT.....	229
Fig 12-21	Transmitter Waveform for Idle.....	231
Fig 12-22	Start-of-Idle Test Load #1.....	231
Fig 12-23	Start-of-Idle Test Load #2.....	231
Fig 12-24	Transmitter Impedance Balance.....	231
Fig 12-25	Common-Mode Output Voltage.....	232
Fig 12-26	Transmitter Common-Mode Tolerance.....	232
Fig 12-27	Common-Mode Impulse Test.....	233
Fig 12-28	Receiver Signal Envelope.....	233
Fig 12-29	Receiver Common-Mode Rejection.....	234
Fig 12-30	DTE and Hub Connector.....	235
Fig 12-31	Cable Connector.....	235
Fig 12-32	Cable Balance Test.....	237
Fig 13-1	Maximum Transmission Path with Three Coaxial Cable Segments.....	243
Fig 13-2	Example of Maximum Transmission Path Using Coaxial Cable Segments, 10BASE-T Link Segments, and Fiber Optic Link Segments.....	243
Fig 13-3	Example of Maximum Transmission Path with Three Repeater Sets, Four Link Segments (Two are 100 m 10BASE-T and Two are 1 km Fiber).....	244
Fig 14-1	10BASE-T Relationship to the ISO Open Systems Interconnection (OSI) Reference Model and the IEEE 802.3 CSMA/CD LAN Model.....	246
Fig 14-2	Twisted-Pair Link.....	247
Fig 14-3	MAU Transmit, Receive, Loopback, and Collision Presence Functions State Diagram.....	253
Fig 14-4	<i>signal_quality_error</i> Message Test Function State Diagram.....	254
Fig 14-5	Jabber Function State Diagram.....	255
Fig 14-6	Link Integrity Test Function State Diagram.....	256
Fig 14-7	Twisted-Pair Model.....	257
Fig 14-8	Differential Output Voltage Test.....	258
Fig 14-9	Voltage Template.....	258
Fig 14-10	Transmitter Waveform for Start of TP_IDL.....	260

FIGURES	PAGE
Fig 14-11	Start-of-TP_IDL Test Load 260
Fig 14-12	Transmitter Waveform for Link Test Pulse 261
Fig 14-13	Transmitter Impedance Balance and Common-Mode Rejection Test Circuit 262
Fig 14-14	Common-Mode Output Voltage Test Circuit 262
Fig 14-15	Transmitter Fault Tolerance Test Circuit 263
Fig 14-16	Receiver Differential Input Voltage—Narrow Pulse 264
Fig 14-17	Receiver Differential Input Voltage—Wide Pulse 264
Fig 14-18	Receiver Common-Mode Rejection Test Circuit 265
Fig 14-19	Common-Mode Impulse Test Circuit 265
Fig 14-20	MAU MDI Connector 268
Fig 14-21	Twisted-Pair Link Segment Connector 268
Fig 14-22	Crossover Function
	(a) External Crossover Function 269
	(b) MAU-Embedded Crossover Function 269

TABLES		PAGE
Table 8-1	Generation of Collision Presence Signal 119	
Table 9-1	Maximum Allowable Timing Budget Contributions to the FOIRL System Timing Budget 162	
Table 10-1	Generation of Collision Presence Signal 169	
Table 11.2-1	Single-Cable Frequency Allocations (Frequencies in MHz) 198	
Table 11.2-2	Dual-Cable Frequency Allocations (Frequencies in MHz) 199	
Table 11.4-1	Broadband Dual-Cable Systems—Physical Layer Delay Budget 206	
Table 11.5-1	Cable System Electrical Requirements 207	
Table 11.6-1	Frequency Translator Requirements 207	
Table 13-1	Delays for Network Media Segments 241	
Table 14-1	Voltage Template Values for Fig 14-9 259	
Table 14-2	Maximum Timing Parameters 272	

ANNEX

Additional Reference Material.....	273
------------------------------------	-----

APPENDIXES

A. System Guidelines.....	275
A1. Baseband System Guidelines and Concepts.....	275
A1.1 Overall System Objectives.....	275
A1.2 Analog System Components and Parameter Values.....	275
A1.3 Minimum Frame Length Determination.....	276
A1.4 System Jitter Budgets.....	278
A2. System Parameters and Budgets for 1BASE5.....	280
A2.1 Delay Budget.....	280
A2.2 Minimum Frame Length Determination.....	281
A2.3 Jitter Budget.....	282
A3. Example Crosstalk Computation for Multiple Disturbors.....	283
A4. 10BASE-T.....	284
A4.1 System Jitter Budget.....	284
A4.2 Filter Characteristics.....	285
A4.3 Notes for Conformance Testing.....	285
B. State Diagram, MAC Sublayer.....	287
B1. Introduction.....	287
B2. CSMA/CD Media Access Control State Machine Overview.....	287
B2.1 Transmit Component Overview.....	287
B2.2 Transmit Component Event Descriptions.....	287
B2.3 Transmit Component Action Descriptions.....	289
B2.4 Transmit Component State Descriptions.....	289
B3. Receive Component Overview.....	290
B3.1 Receive Component Event Descriptions.....	290

APPENDICES	PAGE
B3.2 Receive Component Action Descriptions	290
B3.3 Receive Component State Descriptions	291
C. Application Context, Selected Medium Specifications.....	292
C1. Introduction.....	292
C2. Type 10BASE5 Applications.....	292
C3. Type 10BASE2 Applications.....	293
C4. Type FOIRL Applications.....	293
D. Receiver Wavelength Design Considerations.....	294
 APPENDIX FIGURES	
Fig A1 Maximal System Configuration Bit Budget Apportionments.....	276
Fig A2 Typical Signal Waveforms	279
Fig A3 Worst-Case Signal Waveform Variations	279
Fig A4 MDNEXT Cumulative Probability Distribution.....	284
Fig B1 Transmit Component State Diagram.....	287
Fig B2 Receive Component State Diagram.....	290
 APPENDIX TABLES	
Table B1 Transmit Component State Transition.....	288
Table B2 Receive Component State Transition.....	290

Information technology—Local and metropolitan area networks—

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

1. Introduction

1.1 Overview

1.1.1 Basic Concepts. The Carrier Sense Multiple Access with Collision Detection (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 sends a few additional bytes 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 sections of this standard.

This is a comprehensive standard for Local Area Networks employing CSMA/CD as the access method. This standard is intended to encompass several media types and techniques for signal rates of from 1 Mb/s to 20 Mb/s. This edition of the standard provides the necessary specifications for 10 Mb/s baseband and broadband systems, a 1 Mb/s baseband system, and a Repeater Unit.

1.1.2 Architectural Perspectives. There are two important ways to view local area network design corresponding to

- (1) *Architecture.* Emphasizing the logical divisions of the system and how they fit together.
- (2) *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 Model for Open Systems Interconnection (see Fig 1-1). See ISO 7498:1984 [10].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 An architectural organization of the standard has two main advantages:

- (1) *Clarity.* A clean overall division of the design along architectural lines makes the standard clearer.
- (2) *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 Local Area Network standards.

¹ The numbers in brackets correspond to those of the references listed in 1.3; when preceded by A, they correspond to those listed in the Annex.