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ISO/IEC 8802-5

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First edition
1992-06-12

Information technology — Local and metropolitan area networks —

Part 5:
Token ring access method and physical layer specifications

Technologies de l'information — Réseaux locaux et urbains —

Partie 5: Méthode d'accès par anneau à jeton et spécifications pour la couche physique

Reference number
ISO/IEC 8802-5 : 1992 (E)
IEEE Std 802.5-1992

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International Standard ISO/IEC 8802-5 : 1992
IEEE Std 802.5-1992
(Revision of ANSI/IEEE Std 802.5-1989)

Information technology—
Local and metropolitan area networks—

Part 5:
Token ring access method and physical layer specifications

Sponsor

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

Approved March 19, 1992

IEEE Standards Board

Abstract: This Local and Metropolitan Area Network standard, ISO/IEC 8802-5 : 1992, is part of a family of local area network (LAN) standards dealing with the physical and data link layers as defined by the ISO Open System Interconnection Reference Model. Its purpose is to provide compatible interconnection of data processing equipment by means of a local area network using the token-passing ring access method. The frame format, including delimiters, addressing, and frame-check sequence, are defined, and medium access control (MAC) frames, timers, and priority stacks are defined. The MAC protocol is defined. The finite-state machine and state tables are supplemented with a prose description of the algorithms. The physical layer (PHY) functions of symbol encoding and decoding, symbol time, and latency buffering are defined. The services provided by the MAC to the station management (SMT) and the services provided by the PHY to SMT and the MAC are described. These services are defined in terms of service primitives and associated parameters. The 4 and 16 Mb/s, shielded twisted pair attachment of the station to the medium, including the medium interface connector (MIC) are also defined. The applications environment for the LAN is intended to be commercial and light industrial. The use of token ring LANs in home and heavy industrial environments, while not precluded, has not been considered in the development of the standard. A Protocol Implementation Conformance Statement (PICS) proforma is provided as an annex to the standard.
Keywords: data processing interconnection, local area network (LAN), medium access control (MAC), token ring

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

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International Standard ISO/IEC 8802-5 : 1992

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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, ANSI/IEEE Std 802.5-1985 was adopted by ISO Technical Committee 97, *Information processing systems,* as draft International Standard ISO/DIS 8802-5. A further revision was subsequently approved by ISO/IEC JTC 1 in the form of this new edition, which is published as International Standard ISO/IEC 8802-5 : 1992.

For the purpose of assigning global addresses, 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 8802-5
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During the preparation of this International Standard, information was gathered on patents upon which application of the standard might depend. Relevant patents were identified as belonging to Willemijn Holding BV. However, ISO cannot give authoritative or comprehensive information about evidence, validity or scope of patent and like rights. The patent-holder has stated that licences will be granted under reasonable terms and conditions and communcations on this subject should be addressed to

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Weena 723
P.O. Box 29193
3001 GD Rotterdam
The Netherlands

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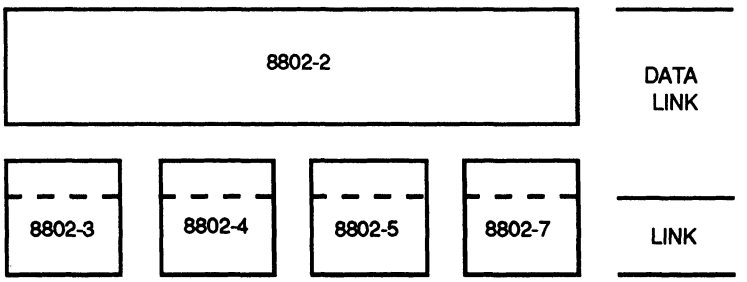
Foreword to International Standard ISO/IEC 8802-5 : 1992

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, 1992 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 [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.

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

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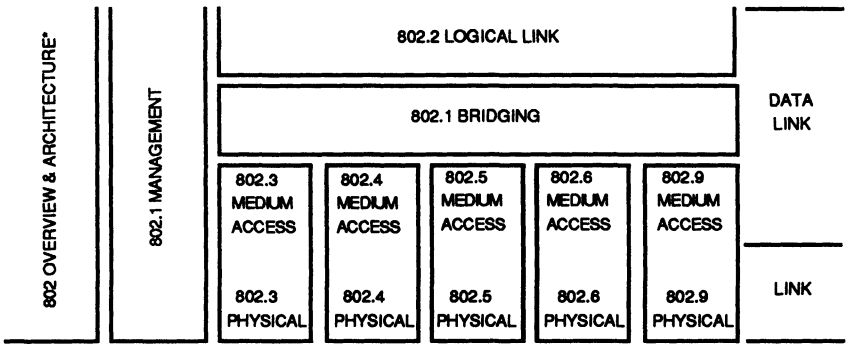
Foreword to IEEE Std 802.5-1992

(This Foreword is not a part of this International Standard or of IEEE 802.5-1992.)

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.)



* Formerly IEEE Std 802.1A.

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 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 802.1D: MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.

[†] 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.

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• 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
• ISO/IEC 8802-4 [ANSI/IEEE Std 802.4]:	Token Bus Access Method and Physical Layer Specifications
• ISO/IEC 8802-5 [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

In addition to the family of standards are technical advisory groups as follows:

• IEEE Std 802.7:	Broadband Technical Advisory and Physical Layer Topics and Recommended Practices
• P802.8:	Fiber Optic Technical Advisory and Physical Layer Topics

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

Conformance Test Methodology

A new 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 11802 to number conformance test standards for 8802 standards.

ISO/IEC 8802-5 : 1992 (IEEE Std 802.5-1992)‡

This standard specifies that each octet of the information field shall be transmitted most significant bit (MSB) first. This convention is reversed from that used in the CSMA/CD and Token Bus standards, which are least significant bit (LSB) first transmission. While the transmission of MSB first is used for token ring, this does not imply that MSB transmission is preferable

‡ This standard contains the following supplements: IEEE Std 802.5d-1992 (Interconnected Token Ring LANs) and IEEE Std 802.5g-1992 (Conformance Testing).

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for any other local are network. Anyone considering interconnecting the token ring with other standard IEEE networks should keep in mind the need to perform bit reordering in the gateway between networks.

The following are now or have been voting members of the Token Ring Access Method Working Group (P802.5). Those individuals who have served as rapporteurs or editors are indicated by an asterisk next to their name:

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Izumi Y. Wilson
Jacalyn Winkler*
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Ivan Reede
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R. O. Westlake
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Kevin White
Barzilai Yoram
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Information technology— Local and metropolitan area networks—

Part 5: Token ring access method and physical layer specifications

1. General

1.1 Scope. For the purpose of compatible interconnection of data processing equipment via a local area network (LAN) using the token ring access method, this standard

(1) Defines the frame format, including delimiters, addressing, routing information, and frame-check sequence (FCS), to allow operation on a single ring or on multiple rings connected by source routing or transparent bridges, and introduces medium access control (MAC) frames, timers, counters, and priority stacks (see Section 3);
(2) Defines the MAC protocol. The finite-state machine and state tables are supplemented with a prose description of the algorithms (see Section 4);
(3) Defines the physical layer (PHY) functions of symbol encoding and decoding, symbol timing, and latency buffering (see Section 5);
(4) Describes the services provided by the MAC to the station management (SMT) and the logical link control sublayer (LLC) and the services provided by the PHY to SMT and the MAC. These services are defined in terms of service primitives and associated parameters (see Section 6);
(5) Defines the 4 and 16 Mb/s, shielded twisted pair attachment of the station to the medium including the definition of the medium interface connector (MIC) (see Section 7);
(6) Includes the PICS proforma in compliance with the relevant requirements, and in accordance with the relevant guidance, given in ISO 9646-2 [7][1] (see Annex C).

The definition of suitable media (twisted pair, coaxial cable, and optical fiber) for connecting stations that meet the attachment standard specified herein is a subject for future consideration. Until such time as these media are specified, the

1 The numbers in the brackets correspond to those of the references in 1.4.

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specifications in Section 7 shall define the performance bounds to which an operating network, including media and trunk coupling unit(s) (TCUs), shall conform.

A particular emphasis of this standard is to specify the homogeneous externally visible characteristics needed for interconnection compatibility, while avoiding unnecessary constraints upon and changes to internal design and implementation of the heterogeneous processing equipment to be interconnected.

The applications environment for the LAN is intended to be commercial and light industrial. The use of token ring LANs in home and heavy industrial environments, while not precluded, has not been considered in the development of this standard.

1.2 Definitions

abort sequence. A sequence that terminates the transmission of a frame prematurely.

accumulated jitter. The jitter measured against the clock of the active monitor. Like alignment jitter, this is not a type of jitter but a way to measure total jitter growth throughout the ring. It is normally used to determine the required size of the elastic buffer.

alignment jitter. The jitter measured against the clock of the upstream adapter. This is not a type of jitter per se; rather, it is a way to measure jitter. When "zero transferred jitter" is specified, the jitter measured is alignment jitter.

broadcast transmission. A transmission addressed to all stations.

channel. The channel is the transmission path from the MIC at the transmitter to the first MIC at the receiver. It may include TCUs and connectors in addition to transmission line.

configuration report server (CRS). A function that controls the configuration of the ring. It receives configuration information from the stations on the ring and either forwards them to the network manager or uses them to maintain a configuration of the ring. It can also, when requested by the network manager, check the status of stations on the ring, change operational parameters of stations on the ring, and remove stations from the ring.

correlated jitter. The portion of the total jitter that is related to the data pattern. Since every adapter receives the same *pattern*, this jitter is *correlated* among all adapters and therefore grows in a *systematic* way along the ring. Correlated jitter is also called *pattern jitter* or *systematic jitter*.

differential Manchester encoding. A signaling method used to encode clock and data bit information into bit symbols. Each bit symbol is split into two halves, where the second half is the inverse symbol of the first half. A 0 bit is represented by a polarity change at the start of the bit time. A 1 bit is represented by no polarity change at the start of the bit time. Differential Manchester encoding is polarity-independent.

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fill. A bit sequence that may be either 0 bits or 1 bits or any combination thereof.

frame. A transmission unit that carries a protocol data unit (PDU) on the ring.

jitter. The time-varying difference between the phase of the recovered clock and the phase of the source clock. Jitter is measured in fractions of a clock cycle, or unit interval (UI).

logical link control (sublayer)(LLC). That part of the data link layer that supports media-independent data link functions, and uses the services of the MAC to provide services to the network layer.

medium. The material on which the data may be represented. Twisted pairs, coaxial cables, and optical fibers are examples of media.

medium access control (sublayer)(MAC). The portion of the data station that controls and mediates the access to the ring.

medium interface connector (MIC). The connector between the station and TCU at which all transmitted and received signals are specified.

monitor. The monitor is that function that recovers from various error situations. It is contained in each ring station; however, only the monitor in one of the stations on a ring is the *active monitor* at any point in time. The monitor function in all other stations on the ring is in standby mode.

multiple frame transmission. A transmission where more than one frame is transmitted when a token is captured.

physical (layer)(PHY). The layer responsible for interfacing with the medium, detecting and generating signals on the medium, and converting and processing signals received from the medium and the MAC.

protocol data unit (PDU). Information delivered as a unit between peer entities that contains control information and, optionally, data.

protocol implementation conformance statement (PICS). A statement of which capabilities and options have been implemented for a given Open Systems Interconnection protocol.

repeat. The action of a station in receiving a bit stream (for example, frame, token, or fill) from the previous station and placing it on the medium to the next station. The station repeating the bit stream may copy it into a buffer or modify control bits as appropriate.

repeater. A device used to extend the length, topology, or interconnectivity of the transmission medium beyond that imposed by a single transmission segment.

ring error monitor (REM). A function that collects ring error data from ring stations. The REM may log the received errors, or analyze this data and record statistics on the errors.

ring latency. In a token ring MAC system, the time (measured in bit times at the data transmission rate) required for a signal to propagate once around the ring.

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The ring latency time includes the signal propagation delay through the ring medium plus the sum of the propagation delays through each station connected to the token ring.

ring parameter server (RPS). That function that is responsible for initializing a set of operational parameters in ring stations on a particular ring.

routing information. A field, carried in a frame, used by source routing transparent bridges that provides source routing operation in a bridged LAN.

service data unit (SDU). Information delivered as a unit between adjacent entities that may also contain a PDU of the upper layer.

source routing. A mechanism to route frames, through a bridged LAN. Within the source routed frame, the station specifies the route that the frame will traverse.

station (or data station). A physical device that may be attached to a shared medium LAN for the purpose of transmitting and receiving information on that shared medium. A data station is identified by a destination address (DA).

static phase offset. The constant difference between the phase of the recovered clock and the optimal sampling position of the received data.

station management (SMT). The conceptual control element of a station that interfaces with all of the layers of the station and is responsible for the setting and resetting of control parameters, obtaining reports of error conditions, and determining if the station should be connected to or disconnected from the medium.

token. The symbol of authority that is passed between stations using a token access method to indicate which station is currently in control of the medium.

transferred jitter. The amount of jitter in the recovered clock of the upstream adapter. Transferred jitter is important because each adapter must both limit the amount of jitter it generates, and track the jitter delivered by the upstream adapter.

transmit. The action of a station generating a frame, token, abort sequence, or fill and placing it on the medium to the next station. In use, this term contrasts with *repeat*.

transparent bridging. A bridging mechanism, in a bridged LAN, that is transparent to the end stations.

trunk cable. The transmission cable that interconnects two TCUs.

trunk coupling unit (TCU). A physical device that enables a station to connect to a trunk cable. The TCU contains the means for inserting the station into the ring or, conversely, bypassing the station.

uncorrelated jitter. The portion of the total jitter that is independent of the data pattern. This jitter is generally caused by noise that is uncorrelated among adapters and therefore grows in a nonsystematic way along the ring. Uncorrelated jitter is also called *noise jitter* or *nonsystematic jitter*.

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unit interval (UI). One half of a bit time. 125 ns for 4 Mb/s transmission and 31.25 ns for 16 Mb/s transmission. UI is used in the specification of jitter.

upstream neighbor's address (UNA). The address of the station functioning upstream from a specific station.

1.3 Abbreviations

A	=	address-recognized bit
AC	=	access control (field)
AD	=	abort delimiter
AMP	=	active monitor present
BCN	=	beacon
BR	=	beacon receive
C	=	frame-copied bit
CL	=	claim
CON	=	conjestion
CNT	=	count
CRS	=	configuration report server
DA	=	destination address
DAT	=	duplicate address test
DC	=	destination class
E	=	error-detected bit
ED	=	ending delimiter
EFS	=	end-of-frame sequence
ETR	=	early token release
FA	=	functional address
FAI	=	functional address indicator
FC	=	frame control (field)
FCS	=	frame-check sequence
FR	=	frame
FS	=	frame status (field)
FSM	=	finite state machine
I	=	intermediate frame bit
INIT	=	initialization
LAN	=	local area network
LLC	=	logical link control (sublayer)
LTH	=	length bits
M	=	monitor bit
MA	=	my (station's) address
MAC	=	medium access control (sublayer)
MIC	=	medium interface connector
MVID	=	major vector identification
NN	=	neighbor notification
P	=	priority (of the AC)
PDU	=	protocol data unit
PHY	=	physical (layer)

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PICS	=	protocol implementation conformance statement
Pm	=	priority of queued PDU
Pr	=	last priority value received
PRG	=	purge
Px	=	the greater value of Pm or Rr
R	=	reservation (of the AC)
RI	=	routing information
RII	=	routing information indicator
REM	=	ring error monitor
RPS	=	ring parameter server
RPT	=	report
RQ	=	request
Rr	=	last reservation value received
RUA	=	received upstream neighbor's address
SA	=	source address
SC	=	source class
SD	=	starting delimiter
SDU	=	service data unit
SFS	=	start-of-frame sequence
SMP	=	standby monitor present
SMT	=	station management
Sr	=	highest stacked received priority
SRT	=	source routing transparent
SV	=	subvector
SVI	=	subvector identifier
SVL	=	subvector length
SUA	=	stored upstream neighbor's address
Sx	=	highest stacked transmitted priority
TA	=	transmit asymmetry
TAM	=	timer, active monitor
TBT	=	timer, BCN transmit
TBR	=	timer, BCN receive
TCU	=	trunk coupling unit
TER	=	timer, error report
THT	=	timer, holding token
TK	=	token
TNT	=	timer, no token
TQP	=	timer, queue PDU
TRR	=	timer, return to repeat
TSM	=	timer, standby monitor
TVX	=	timer, valid transmission
TX	=	transmit
UI	=	unit interval
UNA	=	upstream neighbor's address
VI	=	vector identifier
VL	=	vector length

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1.4 References. The following standards contain provisions which, through reference in this text, constitute provisions of ISO/IEC 8802-5:1992. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on ISO/IEC 8802-5:1992 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of ISO and IEC maintain registers of currently valid International Standards.

[1] CISPR Publication 22:1985, Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment.[2]

[2] IEC Publication 435:1983, Safety of data processing equipment.

[3] IEC Publication 950:1986, Safety of information technology equipment including electrical business equipment.

[4] ISO 7498:1984, Information processing systems—Open Systems Interconnection—Basic Reference Model.[3]

[5] ISO/IEC 7498-4:1989, Information processing systems—Basic Reference Model—Part 4: Management framework.

[6] ISO/IEC 9646-1:1991, Information technology—OSI conformance testing methodology and framework—Part 1: General concepts.

[7] ISO 9646-2:1991, Information technology—OSI conformance testing methodology and framework—Part 2: Abstract test suite specification.

[8] ISO/IEC DIS 10038 DAM 2, MAC Bridging, Source Routing Supplement.[4]

[9] ISO/IEC 10039:1991 Information processing systems—Open Systems Interconnection—Local area networks—MAC service definition.

2 CISPR and IEC publications are available from the International Electrotechnical Commission, 3 rue de Varembé, Case Postal 131, CH-1211, Genève 20, Switzerland/Suisse. These publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036 USA.

3 ISO and IEC publications are available from ISO, Case Postal 56, 1 rue de Varembé, CH-1211 Genève 20, Switzerland/Suisse. These publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036 USA.

4 ISO/IEC 10038:...AMD1:..., to be approved and published.

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1.5 Conformance Requirements The supplier of a protocol implementation which is claimed to conform to this standard shall complete a copy of the PICS proforma in Appendix C and shall provide the information necessary to identify both the supplier and the implementation.

1.5.1 Static Conformance Requirements

1.5.1.1 Medium Access Control Sublayer. An implementation claiming conformance to this standard

(1) Shall implement the token format, the frame format, associated address formats and fields, and MAC frame vectors and subvectors as defined in 3.1, 3.2 and 3.3.
(2) Shall use at least one of the following: 48-bit universally administered addresses, 48-bit locally administered addresses, or a 16-bit locally administered addresses. Note that the implementation may support any or all three address formats.
(3) Shall exhibit external behavior corresponding to the timer values specified in 3.4.
(4) Shall exhibit external behavior corresponding to the flags specified in 3.5. Note that the Early Token Release function is optional (3.5.7).
(5) Shall exhibit external behavior corresponding to the priority registers and stacks specified in 3.6.
(6) May, optionally, implement capabilities corresponding to the counters defined in 3.8. Note that the Frame Count function, 3.8.11, is mandatory if the Early Token Release function is implemented.
(7) Shall recognize the first bit of the source address as the indication of the presence of the routing information field in the frame format. Note that the ability to generate or process frames with source routing information is optional.

1.5.1.2 Physical Layer. An implementation claiming conformance to this standard shall

(1) Add latency as defined in 3.7 and 5.5.1.
(2) Encode and decode symbols as defined in 5.1 and 5.2.
(3) Use a data signaling rate at either 4 or 16 Mb/s as defined in 5.3. Note that the implementation may support both data signaling rates.
(4) Time the symbols with a phase and frequency lock as defined in 5.4.
(5) Compensate for phase jitter with accumulated bit jitter amplitude as defined in 5.5.2.
(6) Couple to the trunk with a ring access control mechanism as defined in 7.3 and 7.4.
(7) Transmit differential Manchester signals with the characteristics defined in 7.5.1 when the channel operates as defined in 7.5.2. Either of the two transmitter signal waveforms may be used.

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(8) Receive differential Manchester signals with the characteristics as defined in 7.5.3 when connected to the channel defined in clause 7.5.2 and a transmitter defined in 7.5.1.
(9) Use a medium interface connector as defined in 7.9.
(10) Provide an output error rate to the station as described in 7.5.4.

1.5.2 Dynamic Conformance Requirements. An implementation claiming conformance to this standard shall perform the following actions as represented in abstract form by the finite-state machine transitions in Figs 4-2 through 4-7. The station shall

(1) Receive frames and perform the actions indicated in Fig 4-2.
(2) Receive and utilize tokens for the transmission of queued PDUs as described in Fig 4-3.
(3) Transmit queued PDUs as frames as described in Fig 4-3.
(4) Strip frames as described in Fig 4-3.
(5) Transmit tokens as described in Fig 4-3 (Note that the implementation of the ETR flag is optional, see 3.5.7).
(6) Perform the priority operation as described in Fig 4-3.
(7) Perform actions indicated in Fig 4-4.
(8) Queue DAT_PDU, SMP_PDU, and RQ_INIT_PDU under the conditions described in Fig 4-4 for transmission by Fig 4-3.
(9) Autonomously transmit CL_TK and FR_BCN frames under the conditions described in Fig 4-5.
(10) Enter BYPASS under the conditions described in Fig 4-5.
(11) Assume ACTIVE MONITOR STATE under the conditions described in Fig 4-5.
(12) Queue the PDUs of Fig 4-6 as indicated for transmission by Fig 4-3.
(13) Autonomously transmit fill and PURGE PDUs as indicated in Fig 4-7.
(14) Queue the PDUs of Fig 4-7 as indicated for transmission by Fig 4-3.
(15) Enter STANDBY MONITOR STATE under the conditions described in Fig 4-7.
(16) Enter BYPASS under the conditions described in Fig 4-7.

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2. General Description

There are two important ways to view local area network design: architectural, which emphasizes the logical divisions of the system and how they fit together, and implementational, which emphasizes the actual components, their packaging, and their interconnection.

This standard presents the architectural view, emphasizing the large-scale separation of the system into two parts: the MAC of the data link layer and the PHY. These layers are intended to correspond closely to the lowest layers of the ISO Basic Reference Model of OSI (ISO 7498 [4]). The LLC and MAC together encompass the functions intended for the data link layer of the OSI model.

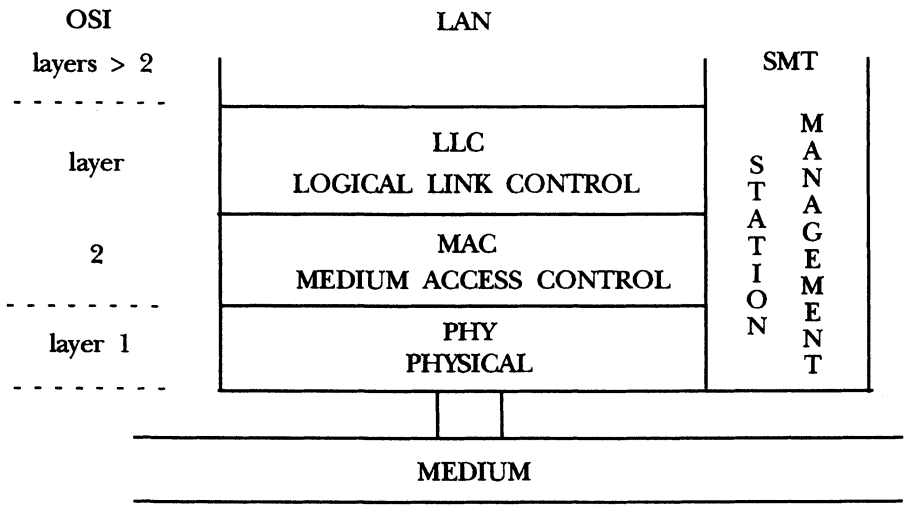

Fig 2-1
Relation of the OSI Reference Model to the LAN Model

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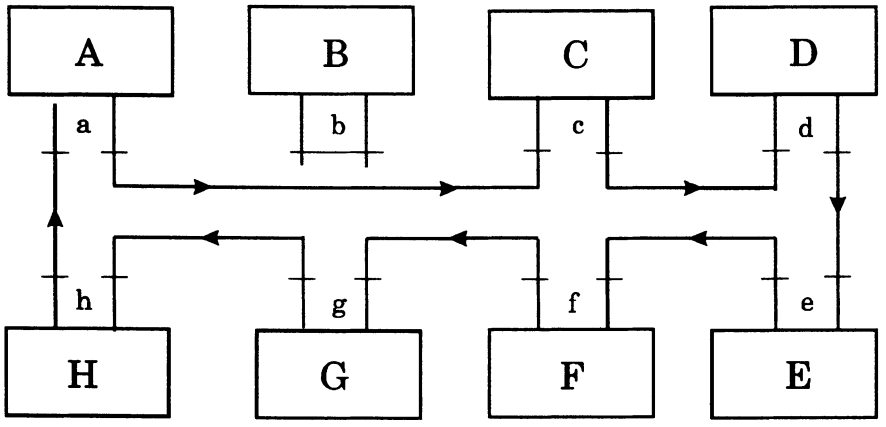
An architectural organization of the standard has the advantages of clarity (a clean overall division of the design along architectural lines makes the standard clearer) and flexibility (segregation of the access-method-dependent aspects of the MAC and PHY allows the LLC to apply to a variety of LAN access methods).

It should be noted that the exact relationship of the layers described in this standard to the layers defined by the OSI Reference Model is for further study.



Physical Medium

A, B, C, D, E, F, G, H — Ring Stations
a, b, c, d, e, f, g — Bypass Function

All stations are active except B (b illustrated in bypass mode)

Fig 2-2
Token Ring Configuration

A token ring consists of a set of stations serially connected by a transmission medium (see Fig 2-2). Information is transferred sequentially, bit by bit, from one active station to the next. Each station generally regenerates and repeats each bit and serves as the means for attaching one or more devices (terminals, work stations) to the ring for the purpose of communicating with other devices on the network. A given station (the one that has access to the medium) transfers information onto the ring, where the information circulates from one station to the next. The addressed destination station(s) *copies* the information as it passes. Finally, the station that transmitted the information effectively removes the information from the ring.

A station gains the right to transmit its information onto the medium when it detects a token passing on the medium. The token is a control signal comprised of a unique signaling sequence that circulates on the medium following each information transfer. Any station, upon detection of an appropriate token, may

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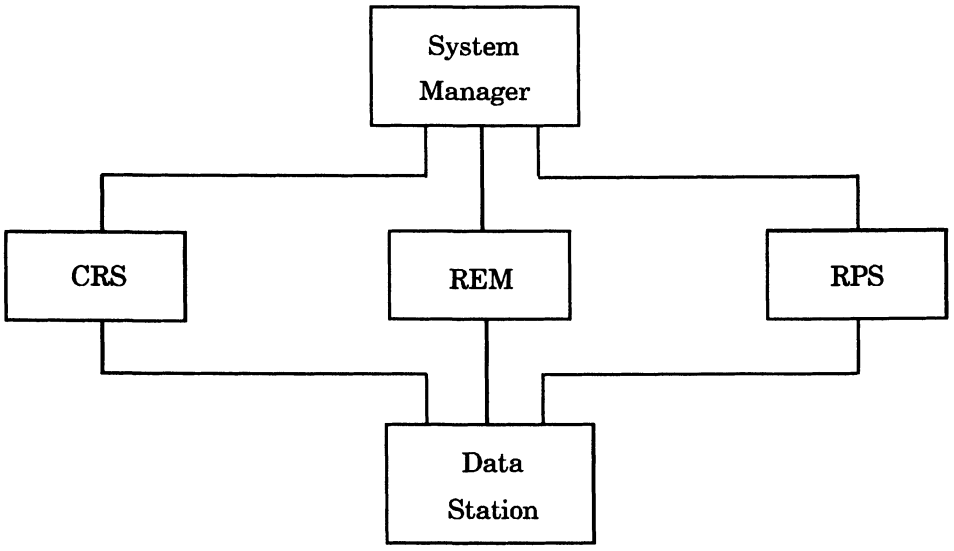
capture the token by modifying it to a SFS and appending appropriate control and status fields, address fields, information field, FCS, and the EFS. At the completion of its information transfer and after appropriate checking for proper operation, the station initiates a new token, which provides other stations the opportunity to gain access to the ring.

A THT controls the maximum period of time a station shall use (occupy) the medium before passing the token.

Multiple levels of priority are available for independent and dynamic assignment depending upon the relative class of service required for any given message, for example, synchronous (real-time voice), asynchronous (interactive), immediate (network recovery). The allocation of priorities shall be by mutual agreement among users of the network.

Error detection and recovery mechanisms are provided to restore network operation in the event that transmission errors or medium transients (for example, those resulting from station insertion or removal) cause the access method to deviate from normal operation. Detection and recovery for these cases utilize a network monitoring function that is performed in a specific station with back-up capability in all other stations that are attached to the ring.



Servers:	CRS	-	Configuration Report Server
	REM	-	Ring Error Monitor
	RPS	-	Ring Parameter Server

Fig 2-3
Relationship of Data Stations, Servers, and System Manager

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Each ring in a token ring network has a set of server stations (*servers*) that are the means through which the systems manager manages the stations in a token ring system. Such arrangement is depicted in Fig 2-3.

Servers are data collection points on each ring where reports from the data stations are gathered. Servers then communicate the necessary information to the systems manager for the purpose of managing a token ring system.

Data stations communicate with the servers by reporting errors that are detected such as lost token, FCS error, or lost frames, requesting operating parameters when inserting into the ring, reporting changes in configuration due to insertion or removal of stations (UNA changes), responding to requests for various status information, and removal from the ring when requested.

The station-to-server message format and content is specified in Section 3; and the protocol for message exchange is specified in Section 4.

The specification of the format and protocol for the information interchange between the servers and the systems manager is not covered by this standard. However, the objects (parameters, events, and actions) specified in 6.3 and 6.4 are the elements of such communication.

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3. Formats and Facilities

3.1 Formats. There are two basic formats used in token rings: tokens and frames. In the following discussion, the figures depict the formats of the fields *in the sequence they are transmitted on the medium,* with the left-most bit or symbol transmitted first.

Processes that require comparison of fields or bits perform that comparison upon those fields or bits *as depicted*, with the left-most bit or symbol compared first and, for the purpose of comparison, considered most significant.

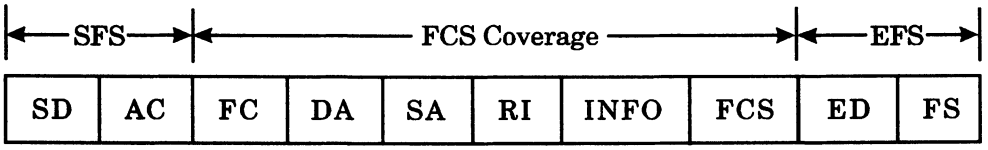
3.1.1 Token Format

SD	AC	ED

SD = Starting Delimiter (1 octet)
AC = Access Control (1 octet)
ED = Ending Delimiter (1 octet)

The token shall be the means by which the right to transmit (as opposed to the normal process of repeating) is passed from one station to another.

3.1.2 Frame Format



SFS = Start-of-Frame Sequence
SD = Starting Delimiter (1 octet)
AC = Access Control (1 octet)
FC = Frame Control (1 octet)
DA = Destination Address (2 or 6 octets)
SA = Source Address (2 or 6 octets)
RI = Routing Information (0 to 30 octets)[5]
INFO = Information (0 or more octets)[6]
FCS = Frame-Check Sequence (4octets)
EFS = End-of-Frame Sequence
ED = Ending Delimiter (1 octet)
FS = Frame Status (1 octet)

5 Note that the RI field is not present in prior IEEE 802.5 standards.

6 See 3.2.6 for limitation of information field length.

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The frame format shall be used for transmitting both MAC and LLC messages to the destination station(s). It may or may not have an information field.

3.1.2.1 Abort Sequence

S D	E D

This sequence shall be used for the purpose of terminating the transmission of a frame prematurely. The abort sequence may occur anywhere in the bit stream; that is, receiving stations shall be able to detect an abort sequence even if it does not occur on octet boundaries.

3.1.3 Fill. When a station is transmitting (as opposed to repeating), it shall transmit fill preceding or following frames, tokens, or abort sequences to avoid what would otherwise be an inactive or indeterminate transmitter state.

Fill may be either 0 or 1 bits or any combination thereof and may be *any number* of bits in length, within the constraints of the THT.

3.2 Field Descriptions. The following is a detailed description of the individual fields in the tokens and frames.

3.2.1 Starting Delimiter (SD)

J	K	0	J	K	0	0	0

J = non-data J
K = non-data K
0 = zero bit

(For a discussion of non-data symbols, see 5.1.)

A frame or token shall be started with these eight symbols. If otherwise, it shall not be considered valid.

3.2.2 Access Control (AC)

P P P	T	M	R R R

PPP = priority bits
T = token bit
M = monitor bit
RRR = reservation bits

3.2.2.1 Priority Bits. The priority bits shall indicate the priority of a token and, therefore, which stations are allowed to use the token. In a multiple-priority system, stations use different priorities depending on the priority of the PDU to be transmitted.

The eight levels of priority increase from the lowest (000) to the highest (111) priority. For purposes of comparing priority values, the priority shall be transmitted most significant bit first; for example, 110 has higher priority than 011 (leftmost bit transmitted first).

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3.2.2.2 Token Bit. The token bit is a 0 in a token and a 1 in a frame. When a station with a PDU to transmit detects a token that has a priority equal to or less than the PDU to be transmitted, it may change the token to a SFS and transmit the PDU.

3.2.2.3 Monitor (M) Bit. The M bit is used to prevent a token that has a priority greater than 0 or any frame from continuously circulating on the ring. If an active monitor detects a frame or a high priority token with the M bit equal to 1, the frame is aborted.

This bit shall be transmitted as 0 in all frames and tokens. The active monitor inspects and modifies this bit. All other stations shall repeat this bit as received.

3.2.2.4 Reservation Bits. The reservation bits allow stations with high priority PDUs to request (in frames or tokens as they are repeated) that the next token be issued at the requested priority. The precise protocol for setting these bits is described in 4.2.2.

The eight levels of reservation increase from 000 to 111. For purposes of comparing reservation values, the reservation shall be transmitted most significant bit first; for example, 110 has higher priority than 011 (left-most bit transmitted first).

3.2.3 Frame Control (FC)

F F	Z Z Z Z Z Z

FF = frame-type bits
ZZZZZZ = control bits

The FC field defines the type of the frame and certain MAC and information frame functions

3.2.3.1 Frame-type Bits. The frame-type bits shall indicate the type of the frame as follows:

00	=	MAC frame (contains a MAC PDU)
01	=	LLC frame (contains an LLC PDU)
1x	=	undefined format (reserved for future use)

MAC Frames. If the frame-type bits indicate a MAC frame, all stations on the ring shall interpret and, based on the finite state of the station, act on the ZZZZZZ control bits.

LLC Frames. If the frame-type bits indicate an LLC frame, the ZZZZZZ bits are designated as rrrYYY. The rrr bits are reserved and shall be transmitted as 0's in all transmitted frames and ignored upon reception. The YYY bits may be used to carry the priority (Pm) of the PDU from the source LLC entity to the target LLC entity or entities. Note that P (the priority in the AC field of a frame) is less than or equal to Pm when the frame is transmitted onto the ring.

Undefined Format. The value "1x" is reserved for frame types that may be defined in the future. However, although currently undefined, any future frame formats shall adhere to the following conditions:

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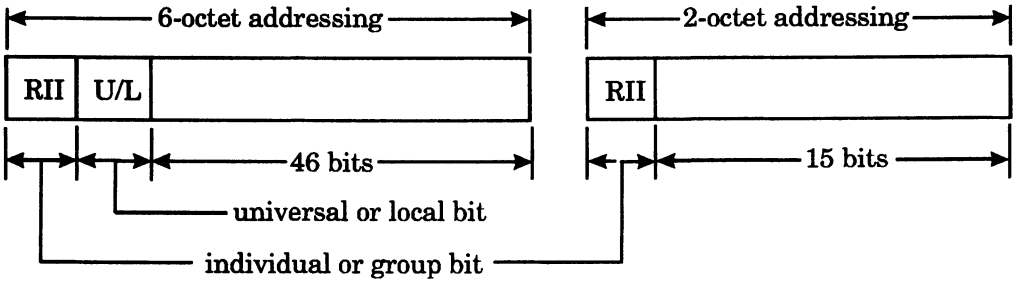
(1) The format shall be delimited by the 2-octet SFS field and the 2-octet EFS field, as defined in this standard. Additional fields may follow the EFS field.
(2) The position of the FC field shall be unchanged.
(3) The SFS and EFS of the format shall be separated by an integral number of octets. This number shall be at least 1 (that is, the FC field) and the maximum length is subject to the constraints of the THT.
(4) All symbols between the SFS and EFS shall be 0 and 1 bits.
(5) All stations on the ring check for data symbols and an integral number of octets between the SFS and EFS fields. The error-detected (E) bit of formats that are repeated shall be set to 1 when a non-data symbol or a non-integral number of octets is detected between the SFS and EFS fields.
(6) All bit errors that occur in the FC field that have a hamming distance of less than four must be detectable by stations using this format and shall not be accepted by any other station conforming to this standard.

3.2.4 Destination and Source Address (DA and SA) Fields. Each frame shall contain two address fields: the destination (station) address and the source (station) address, in that order. Addresses may be either 2 or 6 octets in length; however, all stations of a specific LAN shall have addresses of equal length.

3.2.4.1 Destination Address (DA). The DA identifies the station(s) for which the information field of the frame is intended. Included in the DA is a bit to indicate whether the DA is an individual or group address and, for 6-octet addresses only, the second bit indicates whether it is a universally or locally administered address.



Individual and Group Addresses. The first bit transmitted of the DA distinguishes individual from group addresses:

0 = individual address 1 = group address

Individual addresses identify a particular station on the LAN and shall be distinct from all other individual station addresses on the same LAN (in the case of local administration), or from the individual addresses of other LAN stations on a global basis (in the case of universal administration).

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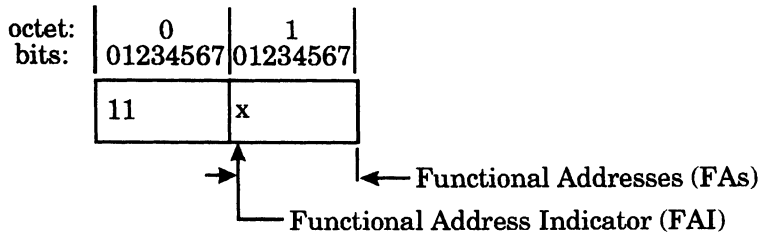
A group address shall be used to address a frame to multiple destination stations. Group addresses may be associated with zero or more stations on a given LAN. In general, a group address is an address associated by convention with a group of logically related stations.

Broadcast Address. The group address consisting of 16 or 48 1's (for 2- or 6-octet addressing, respectively) shall constitute a broadcast address, denoting the set of all stations on a given LAN. Stations using 48-bit addressing must also recognize X'C0 00 FF FF FF FF' as a broadcast address in MAC frames.

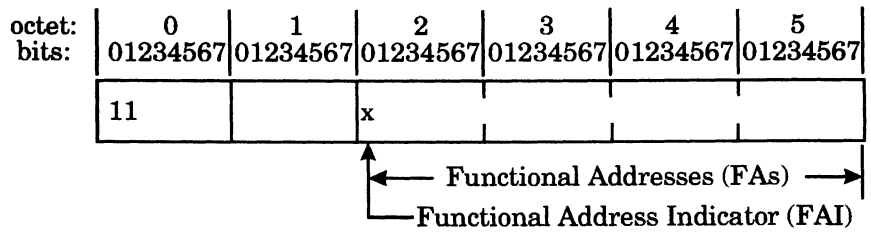
Null Address. An address of 16 or 48 0's (for 2- or 6-octet addressing, respectively) shall be considered a null address. It will mean the frame is not addressed to any particular station.

Functional Addresses (FAs). FAs are a subset of locally administered group addresses. They are bit-significant addresses used to identify well-known functional entities. The Functional Address Indicator (FAI) identifies a FA versus a conventional group MAC address. This indicator is set to a B'1' for conventional group addresses and B'0' for FAs.

2-Octet Addressing



6-Octet Addressing



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