INTERNATIONAL STANDARD

ISO/IEC 8802-9

ANSI/IEEE Std 802.9

First edition
1996-12-15

Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements —

Part 9:

Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Réseaux locaux et métropolitains — Exigences spécifiques —

Partie 9: Interface LAN pour services intégrés (IS) aux couches de contrôle d'accès au support (MAC) et physique (PHY)

Reference number
ISO/IEC 8802-9:1996(E)
ANSI/IEEE
Std 802.9-1996 edition

Abstract: A unified access method that offers integrated services (IS) to the desktop for a variety of publicly and privately administered backbone networks (e.g., ANSI FDDI, IEEE 802.x, and ISDN) is defined. In addition, the interface at the MAC sublayer and the PHY Layer is specified.
Keywords: access unit (AU), data link layer, hybrid multiplexer (HMUX), integrated services digital network (ISDN), integrated services terminal equipment (ISTE), layer management entity, local area network (LAN), logical link control, managed object, management information base (MIB), medium access control (MAC) sublayer, metropolitan area network (MAN), physical (PHY) layer, physical medium dependent, physical signalling, private switching network, protocol data unit (PDU), service access point, time division multiplexer (TDM)

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Information technology—
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Part 9: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers

Sponsor

LAN MAN Standards Committee of the IEEE Computer Society

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International Standard ISO/IEC 8802-9: 1996

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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 1995, ANSI/IEEE Std 802.9-1994 was adopted by ISO/IEC JTC 1, as draft International Standard ISO/IEC DIS 8802-9. 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 8802-9: 1996.

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

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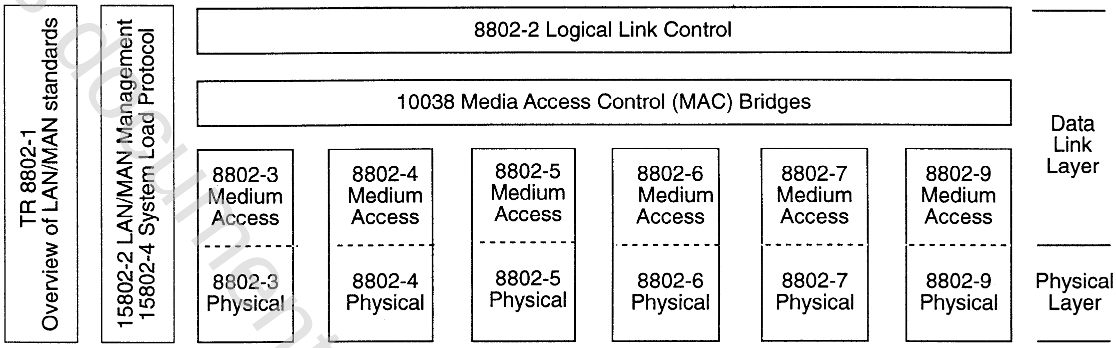
Foreword to International Standard ISO/IEC 8802-9: 1996

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



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

The International Standards defining the access technologies are as follows:

a) ISO/IEC 8802-3 [ANSI/IEEE Std 802.3], a bus utilizing CSMA/CD as the access method.
b) ISO/IEC 8802-4 [ANSI/IEEE Std 802.4], a bus utilizing token passing as the access method.
c) ISO/IEC 8802-5 [ANSI/IEEE Std 802.5], a ring utilizing token passing as the access method.
d) ISO/IEC 8802-6 [ANSI/IEEE Std 802.6], a dual bus utilizing distributed queuing as the access method.
e) ISO 8802-7, a ring utilizing slotted ring as the access method.
f) ISO/IEC 8802-9 [ANSI/IEEE Std 802.9], a unified access method offering global integrated services to the desktop by accessing a variety of networks.

ISO/IEC TR 8802-1 provides an overview of the LAN/MAN standards, along with details of their document numbering.

ISO/IEC 8802-2 [ANSI/IEEE Std 802.2], *Logical Link Control*, is used in conjunction with the medium access standards to provide the data link layer service to network layer protocols.

ISO/IEC 10038 [ANSI/IEEE Std 802.1D], *Media Access Control (MAC) bridges*, specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the level of the logical link control protocol.

ISO/IEC 15802-2 [ANSI/IEEE Std 802.1B], *LAN/MAN Management*, defines an Open Systems Interconnection (OSI) management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.

ISO/IEC 15802-4 [ANSI/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 in ISO/IEC LAN/MAN environments.

The main body of the International Standard serves for both the ISO/IEC 8802-9: 1996 and ANSI/IEEE Std 802.9, 1996 Edition standards. ISO and IEEE each have a unique foreword.

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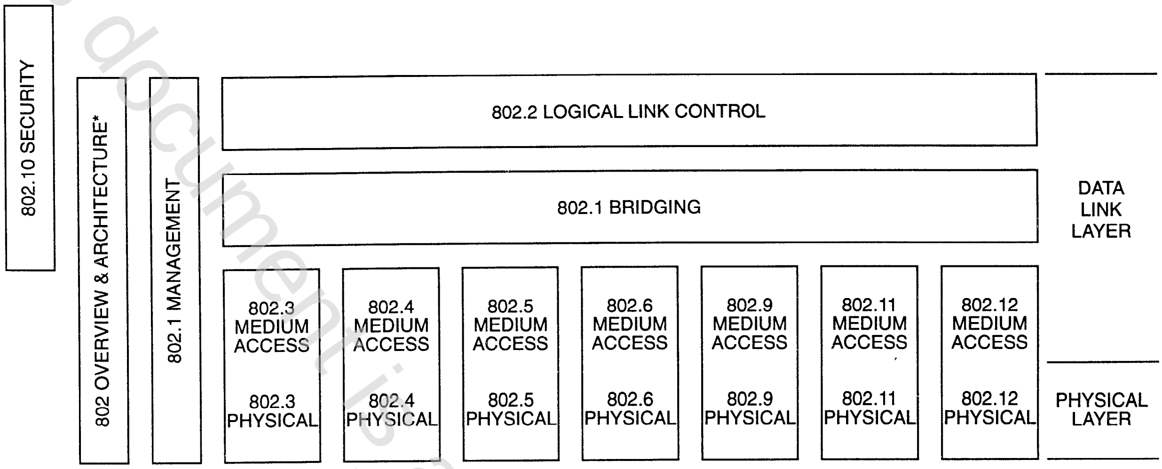
Foreword to ANSI/IEEE Std 802.9, 1996 Edition

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.)



* Formerly IEEE Std 802.1A.

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

The standards defining the access 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.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] — *LAN/MAN Management.* Defines an Open Systems Interconnection (OSI) management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D [ISO/IEC 10038] — *MAC Bridging.* Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/IEEE Std 802.1E [ISO/IEC 15802-4] — *System Load Protocol.* Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2] — *Logical Link Control*
- ANSI/IEEE Std 802.3 [ISO/IEC 8802-3] — *CSMA/CD Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.4 [ISO/IEC 8802-4] — *Token Passing Bus Access Method and Physical Layer Specifications*

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

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

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

The following additional working groups have authorized standards projects under development:

- IEEE 802.11 — *Wireless LAN Medium Access Control (MAC) Sublayer and Physical Layer Specifications*
- IEEE 802.14 — *Standard Protocol for Cable-TV Based Broadband Communication Network*

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

Conformance test methodology

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

ANSI/IEEE Std 802.9, 1996 Edition

The ongoing work of the IEEE 802 committee has resulted in standards for data communications in a local area network (LAN) environment. As office workstations have proliferated, however, the demand for LANs has substantially increased. This has led to the inevitable diversification in market requirements.

Since the typical office worker requires access to both data and voice services, among others, at the desktop, there has been a growing trend toward integrated services (IS), namely voice, data, and video. Due to the increasing need for facsimile, image transfer, and video services, these services are included in the general category of the integration of voice and data services. Such integration offers potential economies to the business customer in terms of reduced components (one port per station instead of two or more), and in simpler management and maintenance (one network instead of two or more).

The provision of voice service is generally effected using unshielded twisted-pair wire. Not only is this medium widespread in typical office environments, but it is also inexpensive and easy to install and maintain. In the vast majority of installations, there is spare capacity, and in these cases, the use of such a medium is essentially free since the need for rewiring is significantly reduced. Moreover, with existing technology, it is possible to provide medium- to high-performance data service over the unshielded twisted-pair wire. This places special emphasis on the use of the unshielded twisted-pair wire to provide IS services. This standard extends the scope and capability of existing twisted-pair wiring and thus reduces the incentive for overlay wiring systems.

With respect to the provision of integrated services, there has been ongoing work in other standards bodies, notably, the International Telecommunication Union–Telecommunication Standardization Sector (ITU-T) on the provision of such services through integrated services digital networks (ISDNs). While the principal focus has been the provision of such services using public networks, efforts are under way [notably, in the European Computer Manufacturers Association (ECMA)] to extend such services to customer premises networks.

This standard defines a unified access method that offers global integrated services to the desktop by accessing a variety of publicly and privately administered backbone networks (e.g., ANSI FDDI, IEEE 802.x[1], and ISDN). This standard will enable integrated services termial adapters (ISTEs) to be attached to IEEE 802.9 LANs and will allow them to communicate with other IS stations as well as data-only stations, voice-only stations, and premises-based networks offering ISDN services. In addition, it specifies the use of unshielded telephone twisted pair as the primary medium of distribution.

The use of terminal adaptor (TA) devices will permit the direct coupling of native mode terminal devices such as data-only modules, voice modules, and ISDN basic rate terminals to the IEEE 802.9 interface. This standard has been designed to accommodate the adaptation of ISDN basic rate station devices and IEEE 802.x station devices to the IEEE 802.9 interface. In summary, this standard represents the integration of IEEE 802 services and ISDN services.

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. Information on the current revision state of this and other IEEE 802 standards may be obtained from

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[1]IEEE 802.x refers to the entire family of IEEE 802 standards.

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This standard was approved by the American National Standards Institute on 15 March 1995.

Note that editorial changes were made to the IEEE standard to accommodate concerns raised during the ISO/IEC JTC 1 balloting process. These are indicated in the text by a change bar (such as shown at the left of this paragraph).

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ANNEX

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Information technology—
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Part 9: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers

1. Overview

1.1 Scope and purpose

The scope of this International Standard is to

— Develop an ISLAN interface at the medium access control (MAC) sublayer and the Physical (PHY) Layer compatible with IEEE 802.x[1] and ISDN standards and architectures

— Develop an ISLAN interface that operates independently from the backbone network

— Focus upon unshielded twisted-pair wiring as the primary distribution medium

— Enable implementation of IS terminal equipment (ISTE) that accesses IEEE 802 LAN and ISDN services through a common interface

The body of this International Standard

— Defines the service provided by the MAC sublayer to the IEEE 802 Logical Link Control (LLC) sublayer and management, and describes the services provided by the PHY Layer to the MAC sublayer and management in terms of service primitives and associated parameters

— Describes the services provided by the Physical Layer (PHY MUX) to support a basic rate interface (BRI) ISDN in terms of service primitives and associated parameters

— Describes the services provided by the PHY MUX to the isochronous channels

— Specifies the MAC functions that allow ISTEs access to one another and to LANs providing IEEE 802 services and/or ISDN services

— Specifies the frame format for the MAC frame

— Defines the MAC protocol

— Specifies the channel structure and frame format of the time division multiplexed (TDM) frame

[1]IEEE 802.x refers to the entire family of IEEE 802 standards.

- Specifies the PHY Layer functions over unshielded telephone twisted-pair (UTTP) cable
- Specifies the characteristics of the UTTP attachment of the station to the access unit (AU) including the specification of the medium interface connector
- Specifies the definition of MAC and PHY managed objects (MOs)
- Describes recommended ISDN signalling and management methods to coordinate the multiple channels operated between ISTEs and the AU

The normative annexes provide

- The Protocol Implementation Conformance Statement (PICS) proforma
- The Managed Object Conformance Statement (MOCS)
- The Guidelines for the Definition of Managed Objects (GDMO) specifications
- Supplemental recommendations on the use of CCITT Q.93x signalling procedures

The informative annexes provide

- Reference models of common configurations as guidelines for implementation
- A sequence and description language (SDL) description of the information flow across protocol layers
- Description of an optional remote secure control (RSC) procedure to invoke secure communication device (SCD) operations
- Recommendations for a common, consistent synthesis of ISDN and IEEE 802 that conforms with the addressing of ISTE devices and services
- Description of a mechanism to support the transport of a broadband ISDN conformant “cell” bearer service

1.2 Notation

1.2.1 Service specification method and notation

This subclause describes the method of specification of the services required of the MAC sublayer by the LLC sublayer as well as of the PHY Layer by the MAC sublayer of the P channel, the Data Link Layer of the D channel, and the services provided on the B and C channels.

In general, the services of a layer (or sublayer) are the capabilities that it offers to a user in the next higher layer (or sublayer). In order to provide its services, a layer builds its functions on the services that it requires from the next lower layer. Figure 1-1 illustrates this notion of service hierarchy and shows the relationship of the two corresponding N Layer users.

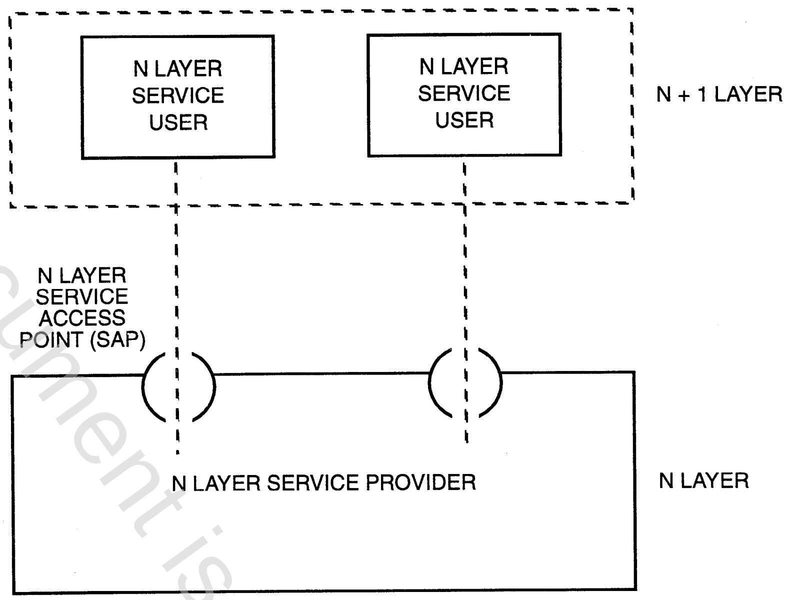


Figure 1-1—Layer service model

This information flow is modeled by discrete, instantaneous events that characterize the provision of a service. Each event consists of passing a service primitive from one layer to the other through an N Layer service access point (SAP) associated with an N+1 Layer service user. These SAPs are shown in figure 1-1. Service primitives convey the information required to provide a particular service. These service primitives are an abstraction in that they specify only the service provided rather than the means by which the service is provided. This definition of layer service is independent of any particular interface implementation, and is not subject to conformance testing requirements.

In order to comply with the service message flow signals described in the CCITT Recommendations on ISDN, it is necessary to consider all four primitive flow types.

a) *Request primitive.* This primitive is passed from the N+1 Layer service user to the N Layer (or sublayer) to request that a service be initiated.

b) *Indication primitive.* This primitive is passed from the N Layer (or sublayer) to the N+1 Layer service user to indicate an internal N Layer event that is significant to the N+1 Layer service user. This may be logically related to a remote service request, or may be caused by an event internal to the N Layer.

c) *Response primitive.* This primitive is passed from the N+1 Layer service user to the N Layer (or sublayer) to complete a procedure previously invoked by an indication primitive.

d) *Confirm primitive.* This primitive is passed from the N Layer (or sublayer) to the N+1 Layer service user to convey the results of one or more associated previous service requests.

Figure 1-2 shows the service primitives and N+1 Layer peer protocol entities associated with the two corresponding N+1 Layer service users. Services are specified by describing the service primitives and parameters that characterize each service. A service may have one or more related primitives that constitute the activity that is related to the particular service. Each service primitive may have zero or more parameters that convey the information required to provide the service.

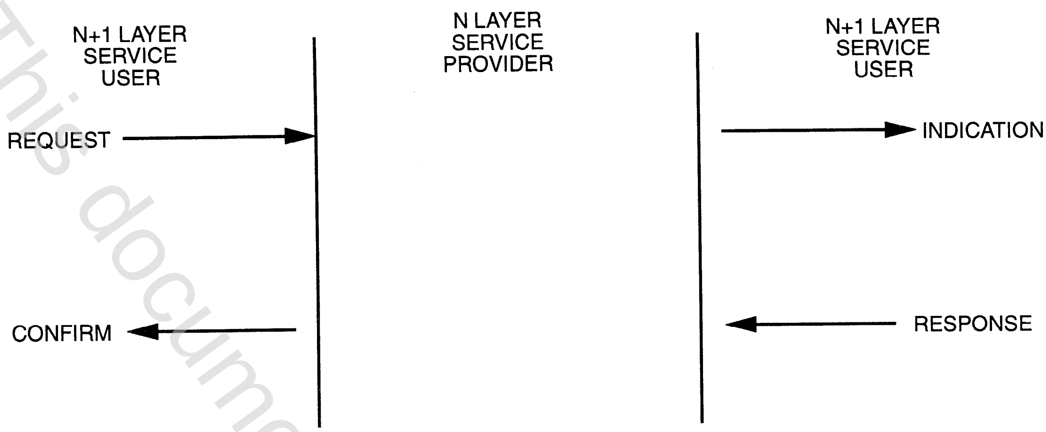


Figure 1-2—Service primitives

Figure 1-3 illustrates the end-to-end relationship of the service primitives and the N Layer peer protocol entities across a communication network.

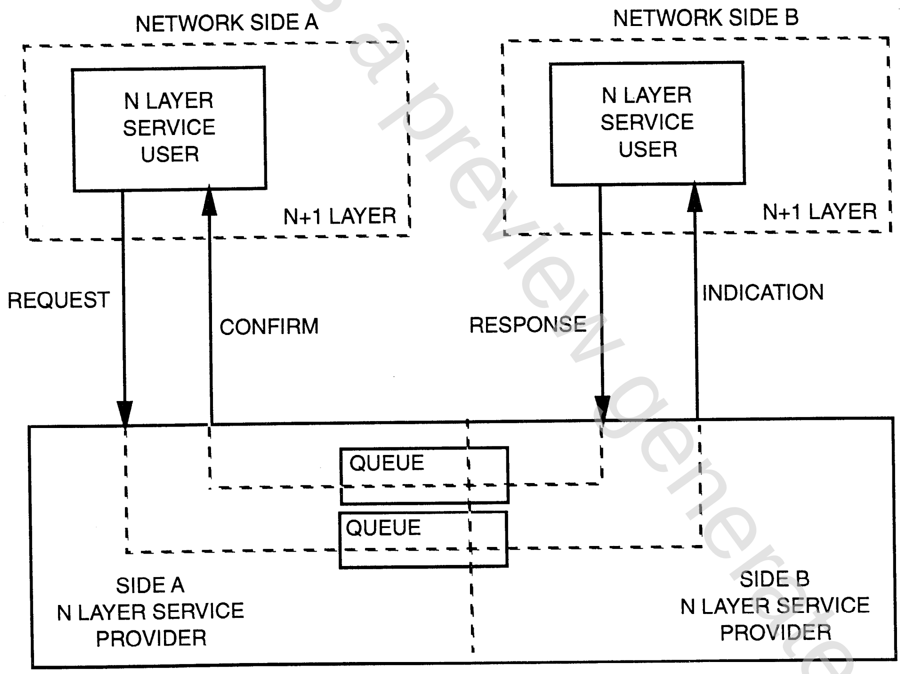
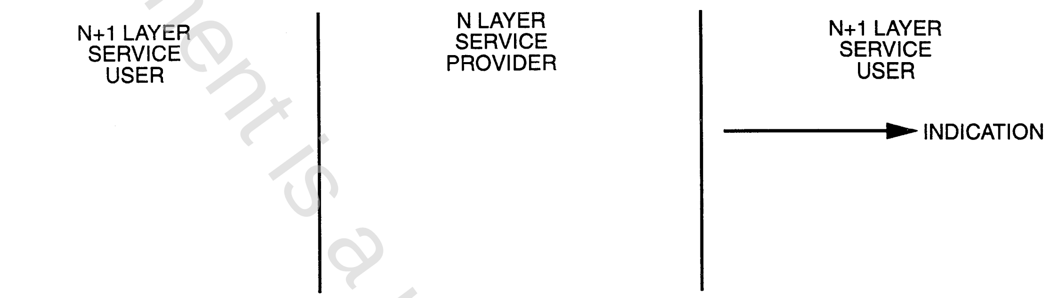


Figure 1-3—End-to-end relationship of service primitives

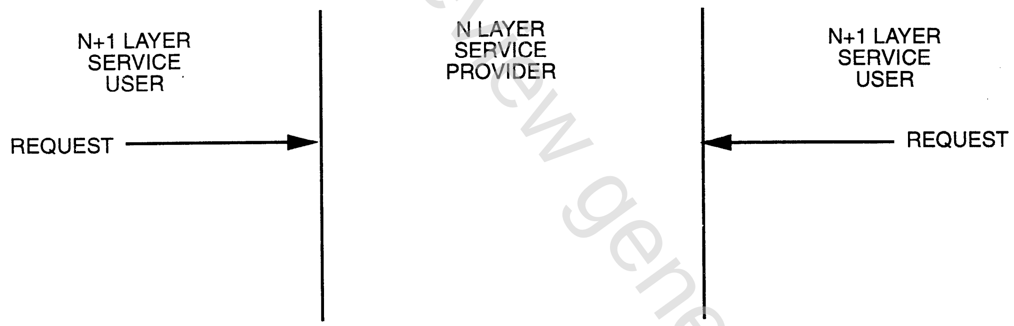
1.2.2 Timing relationship between service primitives

Figure 1-4 a) illustrates the flow from the service user to the service provider for a request. Figure 1-4 b) illustrates the notification to the service user of an event that has occurred in the service provider. Figure 1-4 c) illustrates the event wherein two separate service users are simultaneously making a service request at each end of the peer communication. Figure 1-4 d) illustrates the event wherein both ends of a communication link have the service provider sending up an indication of an event occurrence. Figure 1-4 e) illustrates the common situation wherein a "request" from a service user at one side of a network is sent in the form of a message action across the network to the peer side. The service provider at the other end of the network will report the incoming protocol packet as an "indication." Figure 1-4 f) depicts a communication flow in which all four types of primitives are used as part of a communication between two ends of the network.

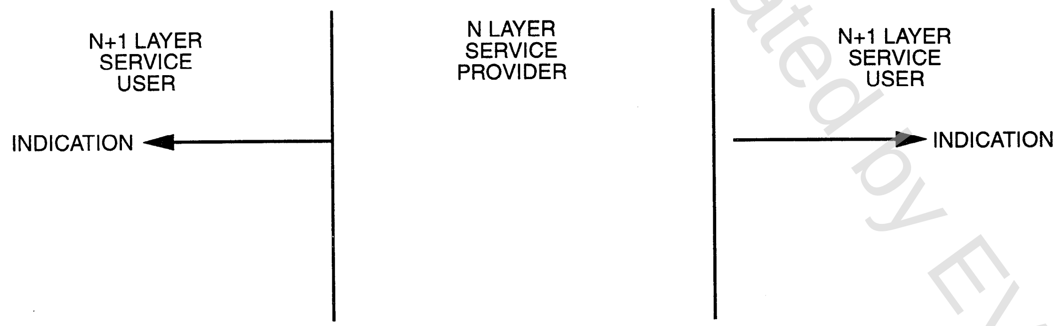
a) Request from user to provider



b) Indication from provider to user

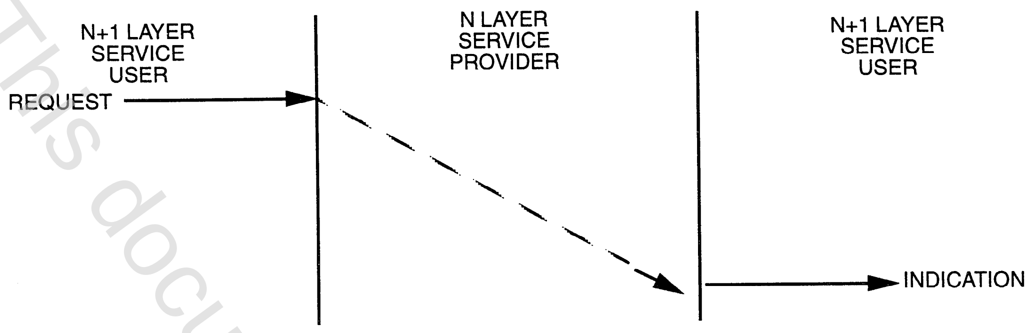


c) Independent simultaneous request at the two ends

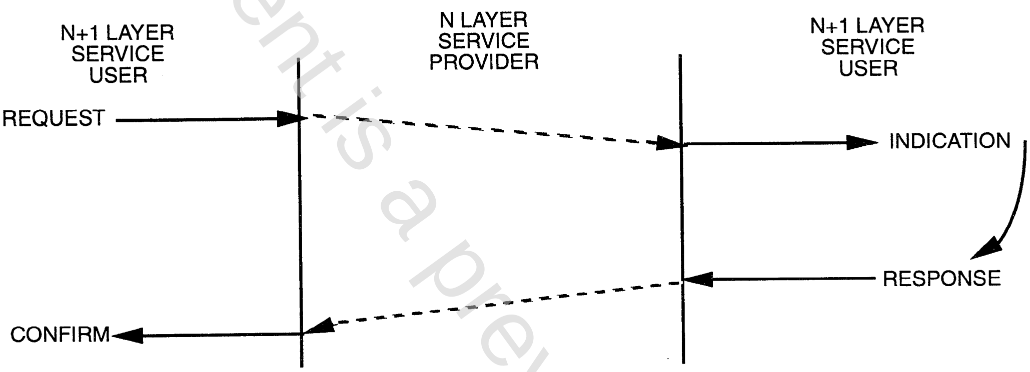


d) Independent simultaneous indications at the two ends

Figure 1-4—Timing relationship between service primitives



e) Request leading to an indication at the peer entity



f) Cycle of interactions between peer entities

Figure 1-4—Timing relationship between service primitives

1.3 Service model

In the general N Layer service model, the N+1 Layer service user communicates with the N Layer service provider via individual request and indication primitives. In theory, this model requires that the transmit and receive processes in the N+1 Layer be synchronized to the N Layer in a serial fashion.

In the OSI model there is a presumption of sending and receiving application layer independence. This is inclusive of asynchronous service operation and hence there shall be at least one queue between communicating peer operations. However, it does not make any particular layer or layer boundary responsible for effecting the required queue.

Furthermore, the OSI model provides no means of describing the conveyance of timing information that is necessarily associated with the data request and indication primitives of an isochronous service.

It is now widely recognized that the description of ISDN "out-of-band" signalling services is best modeled by a coordination function that associates lower level control plane and user plane stacks.

1.3.1 Isochronous services

The ISO/IEC 8802-9 [ANSI/IEEE Std 802.9] ISLAN employs a TDM bearer mechanism within the PHY Layer. This permits the support and delivery of a plurality of transparent separate isochronous service channels, the provision of an octet alignment signal for these channels, and a facility to provide (optionally) and accept precise timing signals.

It is the provision of the timing signal that principally distinguishes the isochronous services from the asynchronous packet services that ISO/IEC 8802-9 provides. In 9.2, the PHY interface service specification includes in addition to received and transmitted data signals, a clock indication (and optionally clock request) as well as framing (TDM) indication and request signals. It is these additional signals that permit the ISO/IEC 8802-9 PHY Layer to support the conveyance of isochronous information.

In delivering an ISDN service, it is essential that the information rate at an ISTE exactly match that of the ISDN network to which the host ISO/IEC 8802-9 AU is attached. Thus, in the case of the AU it is a requirement that the TDM bearer clock rate recovered from the ISDN network can be input to the IEEE PHY for conveyance to a supported ISTE/TA. For this reason an ISO/IEC 8802-9 AU PHY transmit clock is an input signal while at the ISO/IEC 8802-9 ISTE/TA the signal is an output indicating the time at which sequential PHY data request signals will be serviced.

The details of the abstract PHY service specification can be found in 7.1.1.5.

1.3.2 Service queues between layers and layer management

The service channel provided by the ISO/IEC 8802-9 PHY Layer for support of the OSI Data Link Layer functions of the ISO/IEC 8802-9 is not distinct from any other PHY service channel; it too is isochronous. However, it is neither possible nor required that the MAC sublayer should provide an isochronous service to the IEEE 802 LLC sublayer. It is in the ISO/IEC 8802-9 MAC sublayer that the timing information conveyed by the PHY is discarded. In practice, it is conventional to implement within the MAC sublayer a first-in first-out (FIFO) queue both for the send and receive paths. This advantageously allows decoupling of the PHY, MAC, and LLC processes. It is not, however, a requirement.

However, the interface between station management processes and both the ISO/IEC 8802-9 PHY and MAC Layers must be asynchronous since the station management process is an Application Layer entity. It follows, therefore, that there must be a queue between the PHY Layer and its layer management and between the MAC Layer and its layer management.

To allow for the adjoining layers to operate more asynchronously, the N+1 Layer's transmit request may be stored in a transmit work queue wherein the N Layer may choose to serve this request at a later instant in time. Likewise, the N Layer may store its receive messages (in correct time order) in a receive queue. This enables the N+1 Layer to respond to the incoming message at a later instant in time.

Figure 1-5 illustrates this asynchronous linkage between layers. The queues are shown with dashed lines to depict the dynamic length of the given queue. It should be noted that at a given instant in time, the length of the queue may be zero and there may be no measurable delay in the passing of request/indication signals. The general model allows for queues between any two adjoining layers. Since the N Layer management entity may wish to send information to its peer layer management entity via the N Layer, figure 1-5 also shows queues between the N Layer and its associated layer management entity. The management of these queues is the responsibility of layer management. This management/control of the queues is shown with the dotted "control" signals.

The transmit and receive queues that are illustrated between the LME entity and the N Layer are for peer-to-peer LME exchange.

This definition of queues is independent of any particular interface implementation, and is not subject to conformance testing requirements.

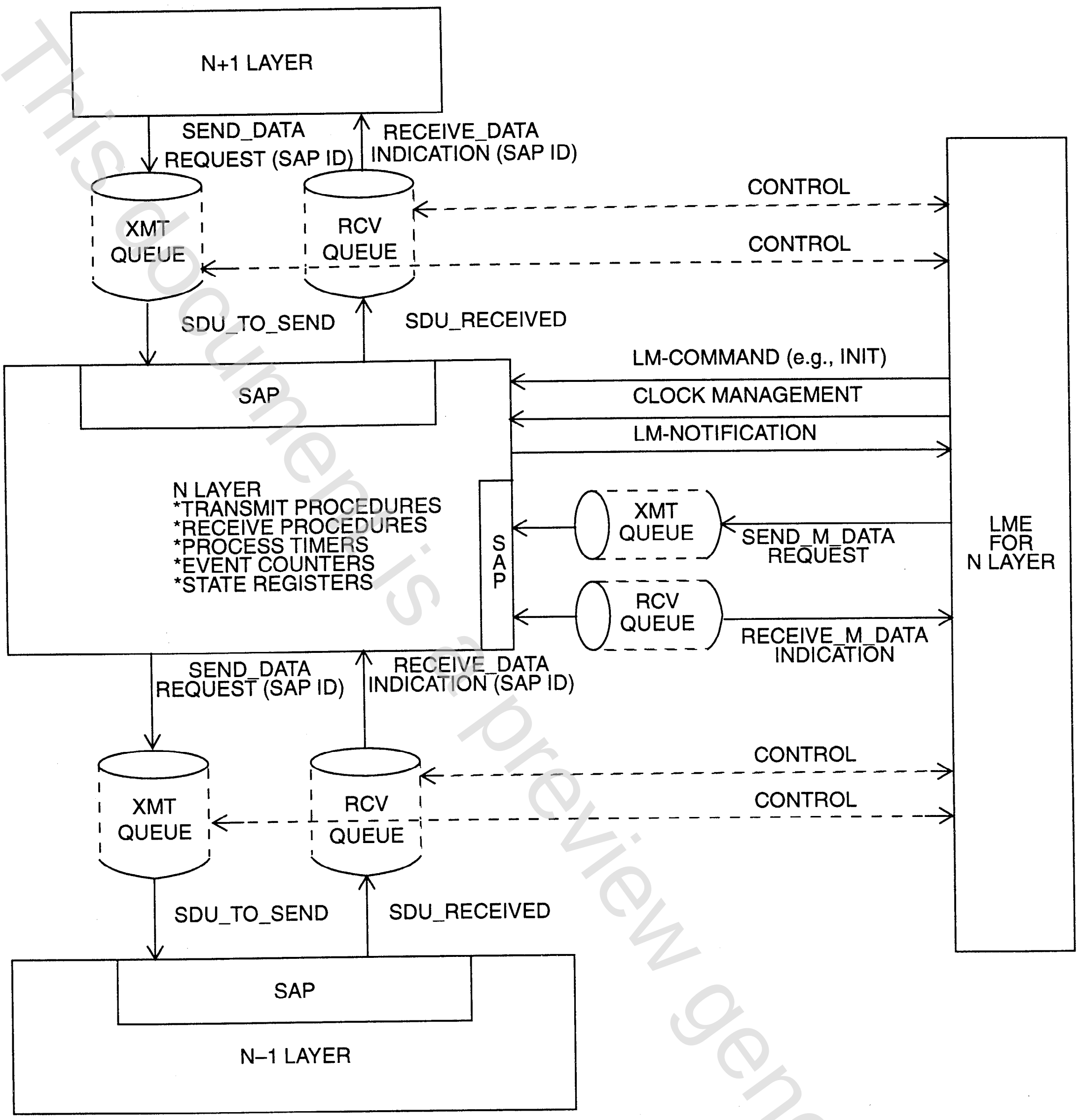


Figure 1-5—Service queues between adjacent layers

1.3.3 Coordination function

The ISDN out-of-band signalling operations may be seen as being implemented by a "control" plane OSI stack that is associated with a user plane in which end-to-end user information may be conveyed. In the case of on-demand services (e.g., a dialed telephone service) a sequential process of call establishment, followed by an information interchange phase (in the user plane), and finally a call release phase, is required. To ensure that provision of the end-to-end user service is fully established and functional, a coordination function is required. In providing the dynamic bandwidth allocation functions provided in the ISO/IEC 8802-9 PHY Layer's HMUX sublayer, there is a need for additional higher (OSI) level coordination functions. The details of these functional requirements can be found in Chapter 8.

1.3.4 State machine notation

The operation of a protocol can be described by subdividing the protocol into a number of interrelated functions. The operation of a function can be described by state machines. Each machine represents the domain of a function and consists of a group of connected, mutually exclusive states. The specification of the state machine determines the order of the transition. Only one state of a function is active at any given time.

Signals and flags refer to the form by which one functional block communicates with another. Both terms arise from the use of the state machines as a descriptive method in this International Standard. Signals are transient communications (in theory, they are of infinitesimal width) that occur during a change of state. Flags are steady, nontransient indications that remain constant until explicitly changed.

Each state that the function can assume is represented by a box or a circle. All permissible transitions between states of a function are represented by arrows from one state to the next state. The condition that causes a change from one state to another is shown next to the transition arrow.

1.3.5 General introduction of finite state machine (FSM) diagrams and tables

The procedures employed in the receive and transmit functions that operate to convey the request/grant protocol are specified in terms of a finite state machine (FSM). The principles of FSM are as follows:

a) A process is evaluated as one finite step during an instant in time.

b) Each "state" represents an information level consisting of:

   1) *Output operand directives (commands).* These output commands specify the work output from the FSM.

   2) *Input operand directives (test events/signals).* These input events are utilized by the FSM process to determine what state transition should be performed. These input events may be subdivided into external events (signals) and internal events (signals).

c) A description of a process may be expressed via a combination of states, control flags/state variables, input events (test conditions), and output actions.

d) This FSM definition technique is very implementation styled since it defines things in such fine detail.

e) The FSM documentation consists of two forms of graphic documentation:

   1) FSM state diagrams

   2) FSM state tables

1.3.5.1 FSM diagrams

The FSM diagrams are intended to illustrate a "minimum" set of processing states that comprise the functional operation of the process. Figure 1-6 illustrates the manner in which the FSM diagrams are used in this International Standard.

In figure 1-6, the FSM has two states: A and B. The occurrence of External Signal 1 equals "true" will cause a transition from State A to State B. Once the FSM is operational in State B, the occurrence of Internal Signal 2 equals "false" will cause the FSM to transition back to State A. Note that for the purpose of documentation, the value "0" will be equivalent to the condition "false" and the value "1" will be equivalent to the condition "true."

As can be seen from this example, the FSM diagram technique overviews the essential operational states and identifies the key signal events that cause a transition from one state to another. In order to illustrate the precise details of input signal processing, output signal generation, and the treatment of error counters/timers/control variables, there is a companion description called state transition tables.

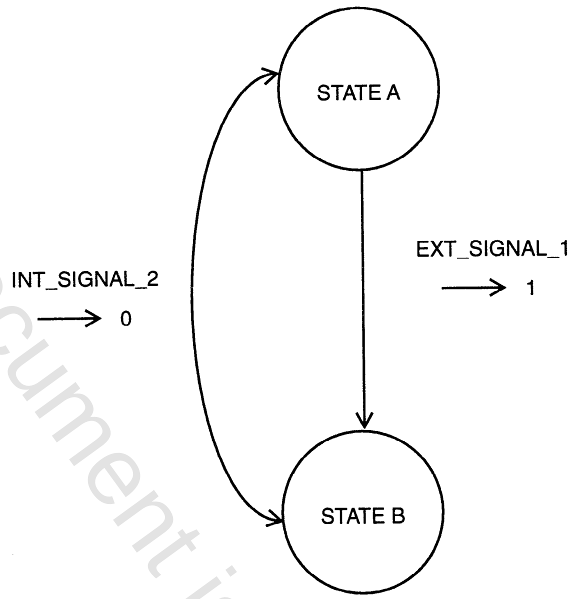


Figure 1-6—Example FSM diagram

1.3.5.2 FSM state transition tables

FSM state transition tables are a companion description to the FSM state diagrams. These tables illustrate a finite set of actions that occur while the FSM is operational within a given state. Table 1-1 illustrates an example of a portion of a state transition table that would accompany the state diagram in figure 1-6.

Table 1-1—Example state transition table

Current state	Event	Action(s)	Next state
STATE_A	EXT_SIGNAL_1→1	SEND_MESSAGE_2 SET_FLAG_3:=1 START_TIMER_1	STATE_B
STATE_B	INT_SIGNAL_2→0	SEND_MESSAGE_4 SET_FLAG_3:=0 STOP_TIMER_1	STATE_A

In this example, a horizontal row represents a finite FSM processing step. While the FSM is in State A, it will regularly test or sample for the presence of external signal EXT_SIGNAL_1. When this EXT_SIGNAL_1 transitions to a "1," this will cause the FSM to vector to State B. In addition, the output actions will be to

— Send MESSAGE_2
— Set internal flag FLAG_3 to value "1"
— Start timer TIMER_1

While the FSM is in State B, it will regularly test for the presence of internal signal INT_SIGNAL_2. When this signal transitions to a "0," this will cause the FSM to vector back to State A. In addition, the output actions will be to

— Send MESSAGE_4
— Clear internal flag FLAG_3 to value “0”
— Stop timer TIMER_1

1.4 Document organization

This International Standard is organized as follows:

Chapters 1 through 4 contain the overview, references, definitions, and abbreviations, respectively.

Chapter 5 presents the overall architecture of the ISO/IEC 8802-9 ISLAN. The protocol sublayers and the layer service boundaries are introduced.

Chapter 6 presents the specification of the structure for the TDM and MAC frames. The individual fields are defined.

Chapter 7 presents the service specifications for the LLC/MAC and the MAC/PHY for the P channel. The isochronous service specifications from PHY to Layer 2 are presented. The management service specifications for all sublayers are presented.

Chapter 8 presents a detailed description of the procedures for the various functional modules that operate within the MAC. The descriptions contain detailed FSM models to describe the functional operations.

Chapter 9 provides a detailed description of the three sublayers of the PHY Layer: the HMUX sublayer, the PS sublayer, and the physical medium dependent (PMD) sublayer. The ISO/IEC 8802-9 interface supports two PMD sublayers: a 4.096 Mb/s line rate interface and a 20.480 Mb/s line rate interface. Complete descriptions for both are contained in this chapter.

Chapter 10 presents the ISLAN layer management. A complete description of the managed objects (MOs) contained in the management information base (MIB) for the ISO/IEC 8802-9 interface is presented.

Chapter 11 presents ISDN signalling and management, followed by a complete description of the information flow of ISDN management information. A set of enhancements to the ISDN standard repertoire is presented to complete the signalling message set.

Annex A contains the Protocol Implementation Conformance Statement (PICS) proforma. The detailed specification of the PICS is a matter for further study.

Annex B contains the Managed Object Conformance Statement (MOCS). The detailed specification of the MOCS is a matter for further study.

Annex C contains GDMO specifications of information elements required for the full definition of ISLAN systems and layer management.

Annex D describes the CCITT Q.93x message set used during local bandwidth management between the AU and the ISTE. The relationship of the HMC control field exchange between the AU and the ISTE and their respective layer management entities are defined.

Annex E provides reference models for the AU and guidelines for implementation.

Annex F contains the SDL description of the information flow across layers.

Annex G describes the optional procedures for secure control involved with the RSC procedures used to gate on/off an SCD that resides at the network side of the AU.

Annex H describes how address structures may be applied for a topology involving addressing techniques to access a wide area network (WAN) destination.

Annex I describes the optional procedures involved with the support of a cell bearer service across an ISO/IEC 8802-9 subnetwork. This service results in a restructure of the MAC frame so that the cell-based payload units may be transported.

2. References[2]

The ISO/IEC 8802-9 ISLAN standard's architecture is required to interwork with the standard data-only and integrated services local area network (LAN) and metropolitan area network (MAN) backbone networks, as well as with ISDN networks. As such, the following specifications are important references:

ANSI/TIA/EIA-568-A-1995, Commercial Building Telecommunications Cabling Standard.[3]

ANSI X3.139-1987 (Reaff 1992), Information Systems—Fiber Distributed Data Interface (FDDI)—Token Ring Media Access Control (MAC).[4]

ANSI X3.186-1992, Fiber Distributed Data Interface (FDDI) Hybrid Ring Control (HRC).

CCITT Recommendation E.164 (1991), Numbering plan for the ISDN era, Rev. 1 (I.331).[5]

CCITT Recommendation F.69 (1993), Plan for telex destination codes, Rev. 1.

CCITT Recommendation I.112 (1993), Vocabulary of terms for ISDNs, Rev. 1.

CCITT Recommendation I.210 (1993), Principles of telecommunication services supported by ISDN and the means to describe them, Rev. 1.

CCITT Recommendation I.320 (1988), ISDN protocol reference model. In vol. III.8 of the *CCITT Blue Books*—Integrated Services Digital Network (ISDN)—Overall network aspects and function, user-network interface.

CCITT Recommendation I.412 (1988), ISDN user-network interfaces—Interface structures and access capabilities. In vol. III.8 of the *CCITT Blue Books*—Integrated Services Digital Network (ISDN)—Overall network aspects and function, user-network interface.

CCITT Recommendation I.430 (1993), Basic user-network interface—Layer 1 specification, Rev. 1.

CCITT Recommendation I.431 (1993), Primary rate user-network interface—Layer 1 specification, Rev. 1.

CCITT Recommendation I.440 (Q.920 protocol) (1993), ISDN user-network interface data link layer—General aspects, Rev. 1.

CCITT Recommendation I.441 (Q.921 protocol) (1993), ISDN user-network interface—Data link layer specification, Rev. 1.

CCITT Recommendation I.450 (Q.930 protocol) (1993), ISDN user-network interface layer 3—General aspects, Rev. 1.

[2]Wherever a draft standard was cited in the original issue of this standard (IEEE Std 802.9-1994), it has been updated to reflect the approved edition now available. These changes are not indicated by a change bar. New issues of International Standards are noted by a change bar.

[3]EIA publications are available from Global Engineering, 1990 M Street NW, Suite 400, Washington, DC, 20036, USA.

[4]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

[5]All CCITT publications are now being labeled as International Telecommunications Union (ITU-T) publications. They are available from the International Telecommunications Union, Sales Section, Place des Nations, CH-1211, Genève 20, Switzerland/Suisse. They are also available in the United States from the U.S. Department of Commerce, Technology Administration, National Technical Information Service (NTIS), Springfield, VA 22161, USA.

CCITT Recommendation I.451 (Q.931 protocol) (1993), ISDN user-network interface layer 3 specification for basic call control, Rev. 1.

CCITT Recommendation I.452 (Q.932 protocol) (1993), Generic procedures for the control of ISDN supplementary services, Rev. 1.

CCITT Recommendation Q.933 (1993), Layer 3 signalling specification for frame mode bearer service.

CCITT Recommendation Q.940 (1988), ISDN user-network interface protocol for management—General aspects. In vol. VI.11 of the *CCITT Blue Books*—Digital access signalling system, network layer, user—network management.

CCITT Recommendation X.3 (1993), Packet assembly disassembly facility (PAD) in a public data network, Rev. 1.

CCITT Recommendation X.25 (1993), Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit, Rev. 1.

CCITT Recommendation X.28 (1993), DTE/DCE interface for a start-stop mode data terminal equipment accessing the packet assembly/disassembly facility (PAD) in a public data network situated in the same country, Rev. 1.

CCITT Recommendation X.29 (1993), Procedures for the exchange of control information and user data between a packet assembly/disassembly (PAD) facility and a packet mode DTE or another PAD, Rev. 1.

CCITT Recommendation X.121 (1992), International numbering plan for public data networks, Rev. 1.

CCITT Recommendation X.200 (1988), Reference Model of Open Systems Interconnection for CCITT Applications. In vol. VIII.4 of the *CCITT Blue Books*—Open Systems Interconnection (OSI)—model and notation, service definition.

CCITT Recommendation X.212 (1988), Data link service definition for open systems interconnection for CCITT applications. In vol. VIII.4 of the *CCITT Blue Books*—Open Systems Interconnection (OSI)—model and notation, service definition.

CCITT Recommendation Z.100 (1993), Specification and description language (SDL), Rev. 1.

ECMA TR 44: 1989, An Architectural Framework for Private Networks.[6]

ECMA TR 51: 1990, Requirements for Access to Integrated Voice and Data Local and Metropolitan Area Networks.

IEC 60-1: 1989, High-voltage test techniques—Part 1: General definitions and test requirements.[7]

IEC 60-3: 1976, High-voltage test techniques—Part 3: Measuring devices.

IEC 60-4: 1977, High-voltage test techniques—Part 4: Application guide for measuring devices.

[6]ECMA publications are available from Global Engineering, 1990 M Street NW, Suite 400, Washington, DC, 20036, USA.

[7]IEC publications are available from IEC Sales Department, Case Postale 131, 3 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse. IEC 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.

IEC 955: 1989, Process data highway, Type C (PROWAY C), for distributed process control systems.

IEC 1156-1: 1994, Multicore and symmetrical pair/quad cables for digital communications—Part 1: Generic specification.

IEEE Std 802-1990, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture (ANSI).[8]

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

ISO 3166: 1993, Codes for the representation of names of countries.[9]

ISO 6523: 1984, Data interchange—Structures for the identification of organizations.

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

ISO 8648: 1988, Information processing systems—Open Systems Interconnection—Internal organization of the Network Layer.

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

ISO/IEC 8208: 1990, Information technology—Data communications—X.25 Packet Layer Protocol for Data Terminal Equipment.

ISO/IEC 8348: 1993, Information technology—Open Systems Interconnection—Network Service Definition.

ISO/IEC 8802-2: 1994 [IEEE Std 802.2, 1994 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 2: Logical link control.

ISO/IEC 8802-3: 1996 [ANSI/IEEE Std 802.3, 1996 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

ISO/IEC 8802-4: 1990 [ANSI/IEEE Std 802.4-1990], Information processing systems—Local area networks—Part 4: Token-passing bus access method and physical layer specifications.

ISO/IEC 8802-5: 1995 [ANSI/IEEE Std 802.5-1995], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 5: Token ring access method and physical layer specifications.

[8]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

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

ISO/IEC 8802-6: 1994 [ANSI/IEEE Std 802.6, 1994 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 6: Distributed Queue Dual Bus (DQDB) access method and physical layer specifications.

ISO/IEC 8877: 1992, Information technology—Telecommunications and information exchange between systems—Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T.

ISO/IEC 8886: 1992, Information technology—Telecommunications and information exchange between systems—Data link service definition for Open Systems Interconnection.

ISO/IEC 9506: 1991, Industrial automation systems—Manufacturing message specification.

ISO/IEC 9595: 1991, Information technology—Open Systems Interconnection—Common management information service definition.

ISO/IEC 9596-1: 1991, Information technology—Open Systems Interconnection—Common management information protocol—Part 1: Specification.

ISO/IEC 9596-2: 1993, Information technology—Open Systems Interconnection—Common management information protocol: Protocol Implementation Conformance Statement (PICS) proforma.

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

ISO/IEC 10164-2: 1993, Information technology—Open Systems Interconnection—Systems Management: State Management Function.

ISO/IEC 10164-3: 1993, Information technology—Open Systems Interconnection—Systems Management: Attributes for representing relationships.

ISO/IEC 10164-4: 1992, Information technology—Open Systems Interconnection—Systems Management: Alarm reporting function.

ISO/IEC 10164-5: 1993, Information technology—Open Systems Interconnection—Systems Management: Event Report Management Function.

ISO/IEC 10164-6: 1993, Information technology—Open Systems Interconnection—Systems Management: Log control function.

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ISO/IEC 10164-8: 1993, Information technology—Open Systems Interconnection—Systems Management—Security audit trail function.

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

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

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

ISO/IEC 10165-5: 1994, Information technology—Open Systems Interconnection—Structure of management information—Generic management information.[10]

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

ISO/IEC 15802-2: 1995 [ANSI/IEEE Std 802.1B-1992 and 802.1k-1993], Information technology—Telecommunications and information exchange between systems— Local and metropolitan area networks—Common specifications—Part 2: LAN/MAN management.[11]

ISO/IEC 15802-4: 1994 [ANSI/IEEE Std 802.1E, 1994 Edition], Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Common specifications—Part 4: System load protocol.

ISO/IEC TR 9577: 1993, Information technology—Telecommunications and information exchange between systems—Protocol identification in the network layer.

ISO/IEC TR 10178: 1992, Information technology—Telecommunications and information exchange between systems—The structure and coding of Logical Link Control addresses in Local Area Networks.

[10]This International Standard was a draft International Standard (DIS) in the IEEE edition of this standard (IEEE Std 802.9-1994).

[11]See footnote 10.