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IEEE Std 802.9-1994)

IEEE Standards for Local and Metropolitan Area Networks:

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

Specification of ISLAN16-T

IEEE Computer Society

Sponsored by the
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February 16, 1996

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IEEE Standards for Local and Metropolitan Area Networks:

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

Specification of ISLAN16-T

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

Approved October 16, 1995

IEEE Standards Board

Abstract: The architecture, frame structure, service specifications, Physical (PHY) Layer, management, and signalling of the ISLAN16-T interface are defined. The relationship of the ISLAN16-T network to the ISO/IEC 8802-3 network is also defined.

Keywords: 10BASE-T, carrier sense multiple access with collision detection (CSMA/CD), Data Link Layer, GDMO, hybrid multiplexer (HMUX), integrated services (IS), integrated services local area network (ISLAN), integrated services digital network (ISDN), isochronous services, local area network, managed object, medium access control (MAC), Physical (PHY) Layer, signaling, premise-based network, terminal adapter (TA), unshielded twisted-pair (UTP) wiring, wide area network (WAN)

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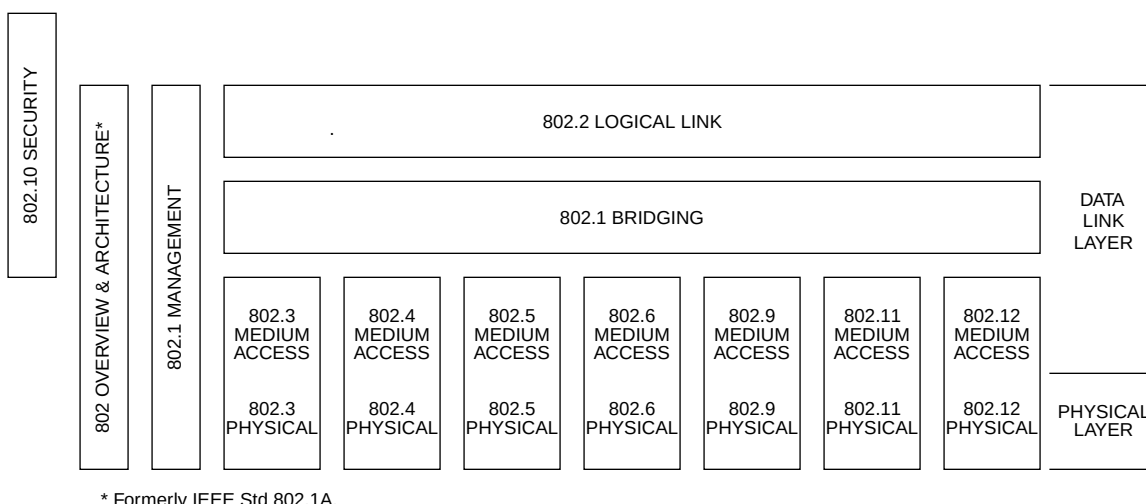
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Introduction

(This introduction is not part of IEEE Std 802.9a-1995, IEEE Standards for Local and Metropolitan Area Networks: Supplement to Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers: Specification of ISLAN16-T.)

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



This family of standards deals with the Physical and Data Link Layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection Basic Reference Model (ISO 7498 : 1984). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation. The IEEE 802.9 ISLAN Interface Standard specifies both isochronous and packet mode services, and provides access to ISDN and other backbone networks for service provisioning.

The standards defining these technologies are as follows:

- IEEE Std 802¹: 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.
- ISO/IEC DIS 15802-2 [IEEE Std 802.1B and 802.1k]: 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 10038 [ANSI/IEEE Std 802.1D]: MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.

¹The 802 Architecture and Overview Specification, originally known as IEEE Std 802.1A, has been renumbered as IEEE Std 802. This has been done to accommodate recognition of the base standard in a family of standards. References to IEEE Std 802.1A should be considered as references to IEEE Std 802.

- ISO/IEC 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 on IEEE 802 LANs.
- ISO/IEC 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 [ANSI/IEEE Std 802.5]: Token Ring Access Method and Physical Layer Specifications
- ISO/IEC 8802-6 [ANSI/IEEE Std 802.6]: Distributed Queue Dual Bus Access Method and Physical Layer Specifications
- IEEE Std 802.9: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers
- IEEE Std 802.10: Interoperable LAN/MAN Security, *Currently approved*: Secure Data Exchange (SDE)
- IEEE Std 802.12: Demand Priority Access Method, Physical Layer and Repeater Specification

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

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

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

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

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.

IEEE Std 802.9a-1995

This standard defines the protocol and compatible interconnection of terminal equipment (TE) to an access unit (AU) utilizing an ISLAN16-T interface. It defines a 16.384 Mbit/s Physical Layer providing isochronous bearer channels, and packet channels used for transporting CSMA/CD MAC frames, over two pairs of category 3 or better unshielded twisted pair wiring.

In the 802.9 family, the following standards have been published:

- IEEE Std 802.9-1994: IEEE Standards for Local Area Networks: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers
- IEEE Std 802.9d-1995: IEEE Standards for Local Area Networks: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers: Protocol Implementation Conformance Statement (PICS) proforma.

In addition, work is currently ongoing in the following areas:

- IEEE P802.9b² Functional specification for AU-to-AU interworking
- IEEE Std 802.9c-1995³ IEEE Standards for Local Area Networks: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers: Managed Object Conformance Statement (MOCS).
- IEEE P802.9e ATM cell bearer mode for IEEE 802.9 integrated services terminal equipment
- IEEE P802.9f Remote terminal line power for IEEE 802.9 integrated services terminal equipment

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²Numbers preceded by P are IEEE authorized standards projects that were not approved by the IEEE Standards Board at the time this publication went to press. For information about obtaining drafts, contact the IEEE.

³As this standard goes to press, IEEE Std 802.9c-1995 is approved but not yet published. The draft standard is, however, available from the IEEE. Anticipated publication date is spring 1996. Contact the IEEE Standards Department at 1 (908) 562-3800 for status information.

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IEEE Standards for Local and Metropolitan Area Networks:

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

Specification of ISLAN16-T

Revisions to IEEE Std 802.9-1994

This supplement to IEEE Std 802.9-1994 defines the architecture, frame structure, service specifications, Physical Layer, management, and signalling of the ISLAN16-T interface. It also defines the relationship of the ISLAN16-T network to the ISO/IEC 8802-3 network.

The contents of this document will be incorporated into IEEE Std 802.9 in a future edition. The clauses of this document are ordered to parallel the order of clauses in the base standard. This supplement is intended to be used in conjunction with IEEE Std 802.9-1994. Editing instructions necessary to incorporate this supplement into IEEE Std 802.9 are provided in ***bold italics***.

1. Overview

Add subclause 1.1.1 as follows:

1.1.1 Scope of the ISLAN16-T interface

Globally networked multimedia applications impose distinct quality of service (QOS) requirements on the local area network (LAN) infrastructure. These applications, which integrate video, audio, and data services, allow for real-time interactive communication between peer entities, requiring the network to provide essential QOS attributes (i.e., guaranteed bandwidth, delay and delay variation, latency, and reliability). Furthermore, to enhance the worker's productivity in the global workplace, the LAN has to provide for interoperability with the wide area network (WAN).

This standard extends the scope and capability of existing unshielded twisted-pair (UTP) wiring by providing an access method that offers integrated services (IS) to the desktop. It allows for interoperability with an ISO/IEC 8802-3 carrier sense multiple access with collision detection (CSMA/CD) network, as well as with integrated services digital network (ISDN) conformant WANs. This is achieved by providing an

ISLAN16-T interface that is capable of carrying ISO/IEC 8802-3 MAC frames at 10 Mbit/s (utilizing the CSMA/CD access method), and also providing 64 kbit/s bearer (B) channels for interfacing with an ISDN. This will enable the integrated services terminal equipment (ISTE) to be attached to an ISLAN16-T IS network, and will allow them to communicate with other ISLAN16-T ISTE's, as well as with other ISO/IEC 8802-3 10BASE-T stations, and premise-based networks offering ISDN services. Furthermore, the use of terminal adapter (TA) devices will permit the direct coupling of native-mode terminal devices such as data-only modules, voice modules, and ISDN terminals.

This standard defines a new ISLAN16-T interface that conforms with the overall IEEE 802.9 architecture. It provides ISO/IEC 8802-3 packet services at 10 Mbit/s, and multiple isochronous digital channels on a common full-duplex interface to the desktop over two pairs of UTP category 3 or better wiring (ISO/IEC 11801). It utilizes the ISO/IEC 8802-3 MAC sublayer for packet mode data transfer at Layer 2. Additionally, it defines the management requirements for such an ISLAN, and provides a definition of signalling for supporting point-to-point and point-to-multipoint calls, and supplementary services, over the isochronous channels.

NOTE—ISLAN4-T specifies the 4.096 Mbit/s PHY of the ISLAN standard. ISLAN16-T specifies the 16.384 Mbit/s PHY of the ISLAN standard. ISLAN20-T specifies the 20.48 Mbit/s PHY of the ISLAN standard.

Add subclause 1.3.5.3 as follows:

1.3.5.3 State diagram representation for the ISLAN16-T interface

In the state diagrams (see 12.6), states are shown as vertical shafts and state transitions are shown as horizontal arrows, with the triggering event or condition above the shaft and any action taken during the transition beneath the shaft. Actions taken within a state are shown at the top of the vertical shaft representing the state. Where necessary, footnotes are used to expand conditions and actions. The transition number is shown on the end of the shaft opposite the arrow. Transition numbers are enclosed in matched pairs of () and consist of two numbers, the first representing the state transitioned from, and the second representing the state transitioned to. A letter is appended to distinguish multiple transitions between the same two states.

It is assumed that time elapses only within discrete states, and that state transitions are logically instantaneous. It follows that actions requiring one or more bit times to complete shall be performed within states; however, when these actions are associated with a specific transition, they may be described as part of that transition. In all such cases the actions occur prior to the associated transition. Actions described as part of a state occur each time the state is entered. Thus, when a triggering event occurs externally to a state machine, the state machine shall perform the following event-processing sequence as a logically atomic operation:

- a) Evaluate all conditions within the current state.
- b) If the conditions for a state transition are satisfied, then
 - 1) Perform the transition actions in the current state.
 - 2) Enter the new state.
 - 3) Perform the entry actions (if any) for the new state.
 - 4) If an immediate transition from the new state is possible, then repeat the sequence beginning with step 1.
- c) If the conditions for in-state actions are satisfied, then the specified actions shall be performed.

State machines are specified both with prose and state diagrams. In the event of any discrepancy between the two, the state diagrams and attached notes shall take precedence over prose; however, the prose may explicitly define optional conditions and actions not shown in the state diagrams.

State transitions shall occur when the conditions are satisfied according to the evaluation rules specified in this subclause, except when explicit exceptions are specified in the prose descriptions.

Symbols used in the conditions, actions, and footnotes for logical operations have the following meanings:

	or—shall indicate a logical “or” function
&&	and—shall indicate a logical “and” function
!	not—shall indicate a logical “not” function

Operators used in the conditions, actions, and footnotes have the following meanings:

IF	shall indicate a conditional test
THEN	shall be true whenever the referenced condition is true
ELSE	shall be true whenever the referenced condition is true and no other conditions are satisfied
BEFORE	shall be true whenever the last item of the referenced field has not been processed
AFTER	shall be true whenever the last item of the referenced field has been processed, and shall be true before the next item.
INC	shall be used to increment a variable.

Optional conditions or actions are delimited by matched pairs of { }, and comments are delimited by matched pairs of « ».

Add subclause 1.3.5.4 as follows:

1.3.5.4 Service specification method and notation for the ISLAN16-T interface

This subclause describes the method of specification of the services required of the Physical 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 1-7 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.

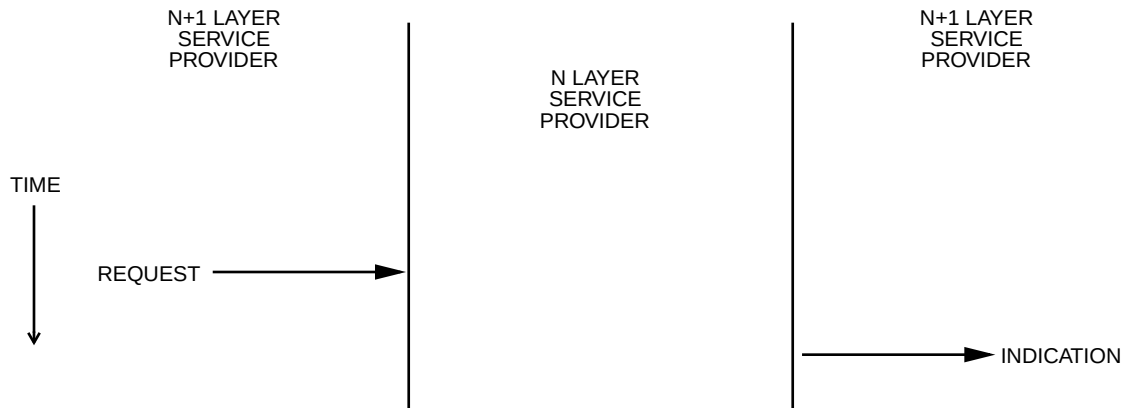


Figure 1-7—Service primitives for the ISLAN16-T interface

Primitives are of two generic types:

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

1.4 Document organization

Add the following text to the end of subclause 1.4:

Clause 12 describes the ISLAN16-T interface and specifies the

- Architecture, protocol sublayers, and layer service boundaries.
- Frame structure for the TDM frame and the Data Link Layer MAC frame.
- Service specifications between the Physical Layer and Layer 2, and the management service specifications for all sublayers.
- Mechanism for the transport of ISO/IEC 8802-3 MAC frames on an ISLAN16-T network segment (in multiservice mode of operation) to maintain synchronization, provide consistent timing, and preserve the same variability values as that of 10BASE-T.
- Detailed description of the HMUX, PS, and PMD sublayers.
- Management procedures and managed objects (MOs) for the ISLAN16-T interface.
- Signalling procedures and protocol requirements.
- Overall network topologies, and the co-existence of ISO/IEC 8802-3 10BASE-T networks utilizing the CSMA/CD access method within the ISLAN16-T network architecture.

Annex J provides a description of the bit encoding for the auto-negotiation link pulse signalling scheme utilized in the ISLAN16-T interface.

Annex K provides a description of the specification and description language (SDL) diagrams for circuit-switched call control procedures for the ISLAN16-T interface.

Annex L provides a description of the guidelines for the development of managed objects (GDMO) and an ASN.1 description of these MOs for the ISLAN16-T interface.

Annex M provides a description of the procedures employed for transporting management information on the D channels, and specifies the segmentation and reassembly procedures for the ISLAN16-T interface.

2. References

EDITORIAL NOTE—Some of the following references have been duplicated from IEEE Std 802.9-1994; duplicate entries are indicated by an asterisk (*). Editorial changes/corrections made to duplicate entries are indicated by a dagger (†).

Add the following text to clause 2:

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

ANSI T1.602-1989, Telecommunications—Integrated Services Digital Network (ISDN)—Data-Link Layer Signalling Specification for Application at the User-Network Interface.¹

ANSI T1.607-1990, Telecommunications—Integrated Services Digital Network (ISDN)—Layer 3 Signalling Specification for Circuit-Switched Bearer Service for Digital Subscriber Signalling System Number 1.

ANSI T1.610-1994, Telecommunications—Generic Procedures for the Control of ISDN Supplementary Services.

IEEE Std 802.3u-1995, IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications: Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation.²

IEEE P802.9b (Draft 4, March 1994), Local and Metropolitan Area Networks—Functional Specification for AU-to-AU Interworking.³

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

*ISO/IEC 8802-2: 1994 [ANSI/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.⁵

†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.⁶

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²IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

³This IEEE standards project was not approved by the IEEE Standards Board at the time this publication went to press. For information about obtaining a draft, contact the IEEE.

⁴ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse or from the IEC Sales Department, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. They 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.

⁵This publication is available from the ISO Central Secretariat. It is also available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁶As this standard goes to press, ISO/IEC 8802-3: 1996 is approved but not yet published. It is anticipated that this standard will be published in 1996. Contact the IEEE Standards Department at 1 (908) 562-3800 for status information.

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

*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.

*ISO/IEC 10022: 1990, Information technology—Open Systems Interconnection—Physical Service Definition.

*ISO/IEC 10038: 1993 [ANSI/IEEE Std 802.1D, 1993 Edition], Information technology—Telecommunications and information exchange between systems—Local area networks—Media access control (MAC) bridges.

*ISO/IEC 10039: 1991, Information technology—Open Systems Interconnection—Local area networks—Medium Access Control (MAC) service definition.

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

*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.

*ISO/IEC 10164-7: 1992, Information technology—Open Systems Interconnection—Systems Management: Security alarm reporting function.

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

ISO/IEC 10164-11: 1994, Information technology—Open Systems Interconnection—Systems Management: Metric objects and attributes.

*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.

ISO/IEC 11572: 1994, Information technology—Telecommunications and information exchange between systems—Private Integrated Services Network—Circuit mode bearer services—Inter-exchange signalling procedures and protocol.

ISO/IEC 11582: 1995, Information technology—Telecommunications and information exchange between systems—Private Integrated Services Network—Generic functional protocol for the support of supplementary services—Inter-exchange signalling procedures and protocol.

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

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

*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 DIS 9314-7...⁷ Information processing systems—Fibre Distributed Data Interface (FDDI)—Part 7: Token Ring Physical Layer Protocol-2 (PHY-2).

+ITU-T Recommendation E.164 (1991), Numbering plan for the ISDN era, Rev. 1 (I.331).⁸

ITU-T Recommendation I.411 (1988), ISDN user-network interfaces—Reference configurations.

+ITU-T Recommendation I.412 (1988), ISDN user-network interfaces—Interface structures and access capabilities.

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

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

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

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

⁷Presently at state of Draft International Standard.

⁸International Telecommunications Union (ITU-T) publications (formerly known as CCITT publications) 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.

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

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

†ITU-T Recommendation Q.940 (1988), ISDN user-network interface protocol for management—General aspects.

ITU-T Recommendation Q.2931 (1995), B-ISDN Subscriber Signalling No. 2 (DSS 2)—User-Network Interface 3 Specification for Basic Call/Connection Control.

†ITU-T Recommendation X.200 (1988), Reference Model of Open Systems Interconnection for ITU-T Applications.

†ITU-T Recommendation Z.100 (1993), Specification and description language (SDL), Rev. 1.

3. Definitions

EDITORIAL NOTE—Some of the following definitions have been duplicated from IEEE Std 802.9-1994; duplicate entries are indicated by an asterisk (*). Editorial changes/corrections made to duplicate entries are indicated by a dagger (†).

Add the following text to clause 3:

3.1 *access unit (AU): The abstraction of the device that provides the IEEE 802.9 functionality, i.e., the integrated set of services, to stations connected across the IEEE 802.9 interface.

3.2 auto-negotiation: A link pulse signalling scheme at the PMD sublayer, whereby devices at each end of a link segment can determine the modes of operation of devices at the other end.

3.3 †bearer service: A telecommunication service that provides the capability for the transmission of signals between user-network interfaces.

3.4 †B channel: A channel that provides 64 kbit/s, full-duplex, isochronous access. B channels support all ISDN bearer services. The information on a B channel may be nonswitched or either circuit or packet switched depending on user request and network capabilities.

3.5 †C channel: A channel that provides an integer multiple of 64 kbit/s, full-duplex, isochronous clear channels. The “C” shall be used to indicate that this is a circuit-switched channel. C_m stands for a channel (m) times 64 kbit/s in size. In general, a C channel has the same characteristics as an ISDN B or H channel, except that it can be any multiple of 64 kbit/s in size, rather than only the ITU-T approved rates. There may be multiple C_m channels of varying sizes ($n \times C_m$).

For ISLAN4-T/ISLAN16-T, the following also applies: The maximum composite bandwidth allocated for the C channel(s) shall be limited by the application requirements for the P channel. That is, the available bandwidth that may be assigned for C channels shall be limited to the difference between the TDM payload field minus the bandwidth required for the P channel. In practice, the C channel size(s) will be effected by the interconnection facility(ies) between the AU and the ISDN wide area network (WAN).

3.6 code symbol: A 4B/5B encoded sequence of five bits representing a unique pattern.

3.7 *convergence protocol: A protocol that provides the convergence service for the provision of enhancements to an underlying service in order to provide for the specific requirements of the convergence service user.

3.8 †coordinating entity: That part of an end system or interworking unit (IWU) responsible for the coordination and synchronization of functions belonging to the data and signalling subentities of the layer entity implementing a PSN access protocol.

3.9 D channel (for the ISLAN16-T): A channel that provides a 64 kbit/s full-duplex packet access. The D channel provides ISDN call control services via the ITU-T Q.93x family of protocols. The use of the D channel may be restricted to conveying signalling information in some applications. The D channel is capable of supporting packet mode information. All information on D channels is packetized.

3.10 †data circuit terminating equipment (DCE): A device that provides the signal conversion and coding between the data terminal equipment (DTE) and the network carrier facility. Note that in the context of an ITU-T X.25 network, for example, the DCE performs functions at the network end of an access line to the network.

3.11 *data terminal equipment (DTE): A device that serves as a data source and/or data sink.

3.12 †H channel: A wideband channel (i.e., a channel that contains multiples of 64 kbit/s). See ITU-T Recommendation I.412 (1988).

3.13 *in-band signalling: Signalling applications in which the signalling information is transmitted in the same information flow as the data. *See also:* **out-of-band signalling**.

3.14 *integrated services terminal equipment (ISTE): A device that serves as an information source and/or information sink for the provision of voice, facsimile, video, data, and other information.

3.15 †interworking unit (IWU): A unit that provides the functions needed to allow interworking between a PSN and another network, e.g., interworking between a PSN and an ITU-T X.25 packet-switched public data network (PSPDN).

3.16 *isochronous: A communication stream transport that is uniform in time. The delivery of the physical stream of information is recurring at regular intervals.

3.17 †layer service: The service that a layer provides to the next higher layer. See ISO 7498-4: 1989 and ITU-T Recommendation X.200 (1988).⁹

3.18 M channel: A 96 kbit/s maintenance channel that is used to convey Physical Layer status and control information to the far end of the link.

3.19 medium attachment unit (MAU): In a local area network (LAN), a device used in a data station to couple the data terminal equipment (DTE) to the transmission medium.

3.20 nibble: A group of four adjacent bits operated on as a unit. (A nibble is encoded as a single code symbol.)

3.21 octet: A data unit composed of eight ordered binary bits. An octet is encoded as a pair of code symbols.

3.22 *out-of-band signalling: Signalling applications in which the signalling information is outside of the user information channel, whether or not transmitted in a different physical or logical channel from the associated user data, e.g., over different physical paths, in different time-slots in a time division multiplex (TDM) stream.

3.23 P channel (for the ISLAN16-T): A 10 Mbit/s packet channel, that provides a Physical Layer service to an ISO/IEC 8802-3 MAC.

3.24 path delay value: The sum of the segment delay values (SDVs) for all the segments along a given path.

3.25 path variability value: A value that is bounded by the sum of the segment variability values (SVVs) for all the segments along a given path.

3.26 point-to-point connection: A connection with only two endpoints.

3.27 point-to-multipoint connection: A connection with multiple endpoints, wherein one endpoint that is designated as the root (originator) is connected by a point-to-point connection with all other endpoints.

3.28 repeater: A device used to extend the length, topology, or interconnectivity of the physical medium beyond that imposed by a single segment, up to the maximum allowable end-to-end trunk transmission line length. Repeaters perform the basic actions of restoring signal amplitude, waveform, and timing applied to the normal data and collision signals.

⁹Information on references can be found in clause 2.

3.29 segment: The medium connection, including connectors, between medium dependent interfaces in a LAN.

3.30 segment delay value (SDV): A number associated with a given segment that represents the delay on that segment (including DTEs—repeaters and end stations, if present).

3.31 segment variability value (SVV): A number associated with a given segment that represents the delay variability on that segment (including a repeater).

3.32 †signalling: The exchange of information specifically concerned with the establishment and control of connections, and the transfer of user-to-user and management information in a circuit-switched network.

3.33 †subnetwork: A set of one or more intermediate open systems that provide relaying and through which end systems may communicate. It is a representation within the OSI model of a real network such as a carrier network, a provider network, or a LAN. It can also be defined as a collection of equipment and physical media that forms an autonomous whole and that can be used to interconnect real systems for the purpose of communication.

3.34 *subnetwork service: The service supported by the subnetwork access protocol.

3.35 10BASE-T: ISO/IEC 8802-3 Physical Layer specification for Ethernet over two pairs of unshielded twisted pair (UTP) media at 10 Mbit/s.

3.36 †terminal adapter (TA): An adapter required to map one specified interface to another. An example is the adapting of the R interface in the ITU-T ISDN to the S/T interface. The TA may be an integral functional entity as part of the terminal or may be a separate physical unit connected between an R interface and the S/T interface [see ITU-T Recommendation I.411 (1988)].

3.37 *virtual circuit: The generic concept of a logical connection. A virtual circuit may be implemented by means of a frame-switched service or a packet-switched service.

3.38 wide band channel (WBC): A 6.144 Mbit/s isochronous channel.

4. Acronyms and abbreviations

EDITORIAL NOTE—Some of the following acronyms and abbreviations have been duplicated from IEEE Std 802.9-1994; duplicate entries are indicated by an asterisk (*). Editorial changes/corrections made to duplicate entries are indicated by a dagger (†).

Add the following text to clause 4:

*ANSI	American National Standards Institute
ASC	accredited standards committee
*ATM	asynchronous transfer mode
*AU	access unit
AUI	attachment unit interface
†B channel	bearer channel
*BER	bit error rate
*B-ISDN	broadband integrated services digital network
*BRI	basic rate interface
BUPS	back up power status
†C channel	circuit-switched channel
†CCITT	Now called ITU-T (International Telecommunication Union—Telecommunication Standardization Sector)
*CMIP	common management information protocol
*CMIPDU	common management information protocol data unit
*CMIS	common management information service
*CMISE	common management information service element
*CO	central office
CPE	customer premises equipment
CRV	call reference value
CSMA/CD	carrier sense multiple access with collision detection
CT	clock time
†D channel	signalling channel
*DCC	data country code
DCRS	D channel receive status
*DLC	data link control
DLCI	Data Link Layer connection identifier
†DSS 1	digital signalling system 1
*DTE	data terminal equipment
*ECMA	European Computer Manufacturers Association
*FCS	frame check sequence

FED	frame error detected
*FDDI	fiber distributed data interface
FMA	frame mastership acknowledge
FMG	frame mastership grant
FRD	fixed receive delay
*FSM	finite state machine
FTD	fixed transmit delay
†GDMO	guidelines for the definition of managed objects (ISO 10165-4)
†H channel	fixed aggregation of isochronous channels
*HDLC	high-level data link control
*HMUX	hybrid multiplexer
*IE	information element
†IEC	International Electrotechnical Commission
*IS	integrated services
*ISDN	integrated services digital network
†ISLAN	integrated services local area network
†ISO	International Organization for Standardization
*ISTE	integrated services terminal equipment
*ITU-T	International Telecommunication Union–Telecommunication Standardization Sector
*IWU	interworking unit
*LAN	local area network
*LAPD	link access procedures for the D channel
LDA	link delay adjustment
†LLB	local loopback
*LLC	logical link control
*LLS	logical link services
*LM	layer management
*LME	layer management entity
LMG	link maintenance grant
*LMI	layer management interface
LMR	link maintenance request
*LPDU	logical link protocol data unit
*LSAP	link layer service access point
*LSb	least significant bit
*LSB	least significant byte
LSNibble	least significant nibble

LSS	link synchronization state
M channel	maintenance channel
*MAC	medium access control
*MAN	metropolitan area network
*MAPDU	management application protocol data unit
MAU	medium attachment unit
*MDI	medium dependent interface
*MIB	management information base
MLD	maximum link delay
*MLME	managed layer management entity
*MO	managed object
MOC	managed object class
*MOCS	managed object conformance statement
*MSb	most significant bit
*MSB	most significant byte
MSNibble	most significant nibble
*MT	management
*MUX	multiplexing
NFSA	network frame synchronization available
NNI	network node interface
NRZ	non return to zero
NRZI	non return to zero, inverted
*OSI	Open Systems Interconnection
†P channel	packet channel
*PBX	private branch exchange
*PCM	pulse code modulation
PDV	path delay value
*Ph-SAP	Physical Layer service access point
*PHY	Physical Layer
*PLME	Physical Layer management entity
*PLS	Physical Layer signalling
*PMA	physical medium attachment
*PMD	physical medium dependent
*PRI	primary rate interface
*PS	physical signalling
PVV	path variability value

†Q.93x	ITU-T Q series protocol (“x” refers to the members of the ITU-T Q.930 family of protocols)
*QOS	quality of service
RD	receive delay
*ROSE	remote operation service element
*SAP	service access point
*SAPI	service access point identifier
†SDL	specification and description language
*SDU	service data unit
SDV	segment delay value
*SMAE	system management application entity
*SMAP	system management application process
*SMASE	system management application service element
*SMI	structure of management information
SMT	station management
*SNMP	simple network management protocol
SVV	segment variability value
*TA	terminal adaptor
TD	transmit delay
*TDM	time division multiplexer
*TE	terminal equipment
*TEI	terminal endpoint identifier
UN	unnumbered information
UNI	user-network interface
UTP	unshielded twisted pair
*WAN	wide area network
WBC	wide band channel
XID	exchange identification

Add clause 12 as follows:

12. ISLAN16-T

12.1 Overview

This clause defines the architecture, frame structure, service specifications, Physical Layer, management, and signalling of the ISLAN16-T interface. It also defines the relationship of the ISLAN16-T network to the ISO/IEC 8802-3 network.

12.2 Architecture

This subclause describes the architecture of the ISLAN16-T interface.

12.2.1 Architectural overview and basic concepts

The ISLAN16-T interface is used for integrated voice/data/video services. It provides ISO/IEC 8802-3 packet services at 10 Mbit/s and isochronous digital channels on a common full-duplex interface to the desktop over two pairs of unshielded twisted pair (UTP) category 3 or better wiring (ISO/IEC 11801: 1995) at a 16.384 Mbit/s aggregate rate.

The integrated services shall be provided to the ISTE across an interface serviced by a functional entity called an access unit (AU). The ISTE's are connected by two pairs of UTP wiring to the AU in a point-to-point configuration, similar to an ISO/IEC 8802-3 10BASE-T configuration. Thus, from the perspective of the ISTE's, their PHY interface is to the AU and services are functionally provided via the AU. There shall be only one interface into which it sends/receives a time division multiplexed (TDM) information stream, independent of the network topology. Figure 12-1 illustrates the physical multiplexing of channels across the UTP media.

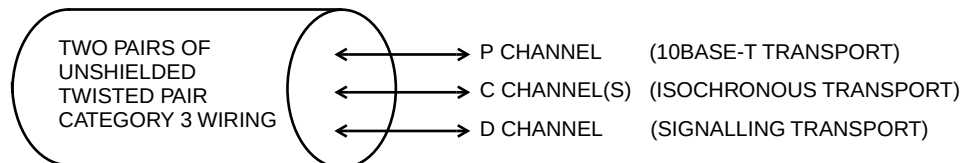


Figure 12-1—ISLAN16-T functionality

This standard shall allow multiple ISLAN16-T ISTE's and ISO/IEC 8802-3 10BASE-T stations to be interconnected with each other, within the same LAN, as shown in figure 12-2. This is possible because the ISLAN16-T interface specifies the use of the ISO/IEC 8802-3 CSMA/CD protocol for transmission of MAC frames over the packet portion of this interface. This shall allow for the transparent existence of an ISO/IEC 8802-3 10BASE-T network within the ISLAN16-T network. Support for such a mixed environment network is enhanced by the presence of a protocol detection mechanism that allows for ISLAN16-T devices to automatically detect the presence of IEEE 802.3u auto-negotiation compliant devices at the other end of the UTP wiring. The auto-negotiation protocol configures devices at both ends of the UTP wiring, causing them to take maximum advantage of their abilities. If, during this process, the ISLAN16-T device detects a 10BASE-T device (DTE, repeater, or bridge) connected to the remote end of the link, the ISLAN16-T device shall configure itself to operate in the 10BASE-T mode. The capability for direct exchange of packet information between ISLAN16-T and ISO/IEC 8802-3 10BASE-T network segments, and the mechanism to operate in the 10BASE-T mode of operation, makes this standard an evolutionary path for 10BASE-T networks to upgrade to an integrated services network.

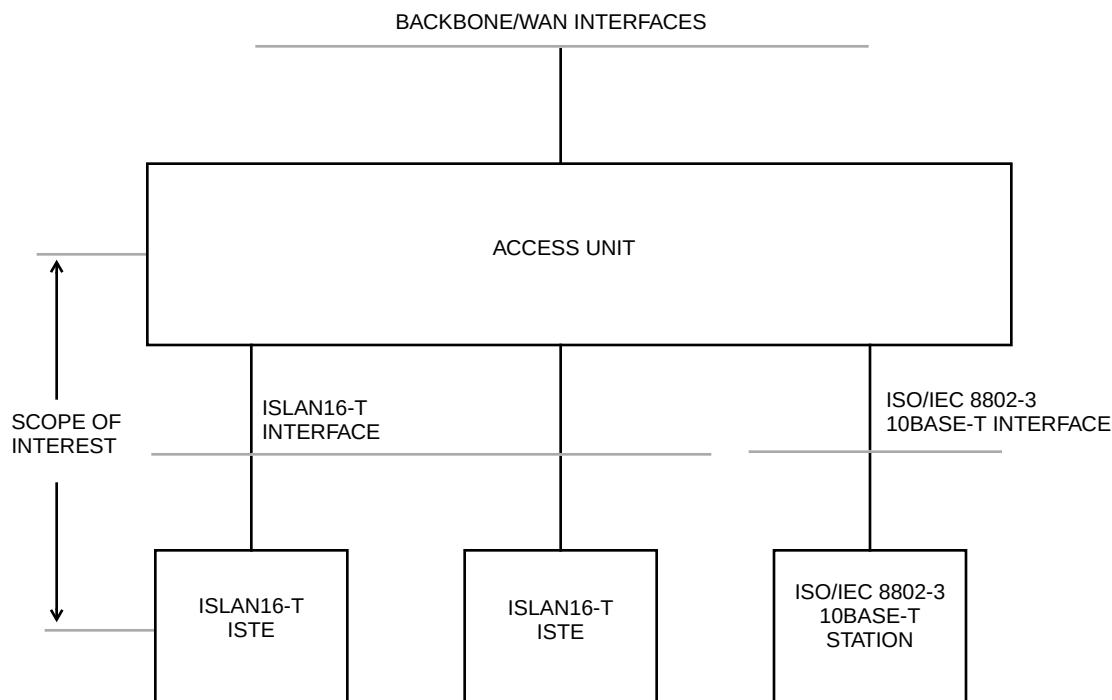


Figure 12-2—Overview of the ISLAN16-T interface

The AU accommodates two fundamentally different application topologies. First, the interface may be to a stand-alone LAN in which the AU actually provides the complete pathway for the required services of the attached ISTE. The second application is the environment wherein the ISLAN16-T interface serves as an access interface that feeds into a private/public backbone/WAN. In this case, the AU becomes an interworking unit (IWU) to the system providing the services. Combinations of the two scenarios are also possible.

The AU shall provide connections to multiple ISLAN16-T ISTE, and ISO/IEC 8802-3 10BASE-T stations, and shall perform a number of different functions. To facilitate the transmission of ISO/IEC 8802-3 MAC frames between the attached TEs/stations, the AU may contain a repeater unit, as defined in clause 9 of ISO/IEC 8802-3: 1996. Alternatively, packet connections may be linked through MAC bridging units, as specified in ISO/IEC 10038: 1993. The AU may also provide a switching function to switch the isochronous digital channels accessed at each AU port. This switching function shall be initiated by out-of-band signalling messages exchanged between the AU and the ISTE. The AU may also provide other channel allocation and management functions. The specific functionality of the AU is implementation dependent. It is recommended that AUs providing an ISLAN16-T interface shall be so labeled.

NOTE—Refer to IEEE P802.9b for a comprehensive description of the AU functionality.

The scope of this standard includes the access link between the ISLAN16-T ISTE and the AU, including the link signalling and service interfaces. Figure 12-2 gives an architectural overview of the ISLAN, and shows a logical view only. The ISLAN, which is star-configured, shall provide a TDM bit stream of packet data, voice wideband data, and other services such as facsimile, image, or video delivered over isochronous channels. The ISTE may contend for access to integrated services from the AU. An example ISLAN network topology is illustrated in figure 12-3.

The ISLAN16-T interface shall be able to support the multiplexing of several channels of information by means of a TDM bearer, which is capable of supporting information transfer at 16.384 Mbit/s, in

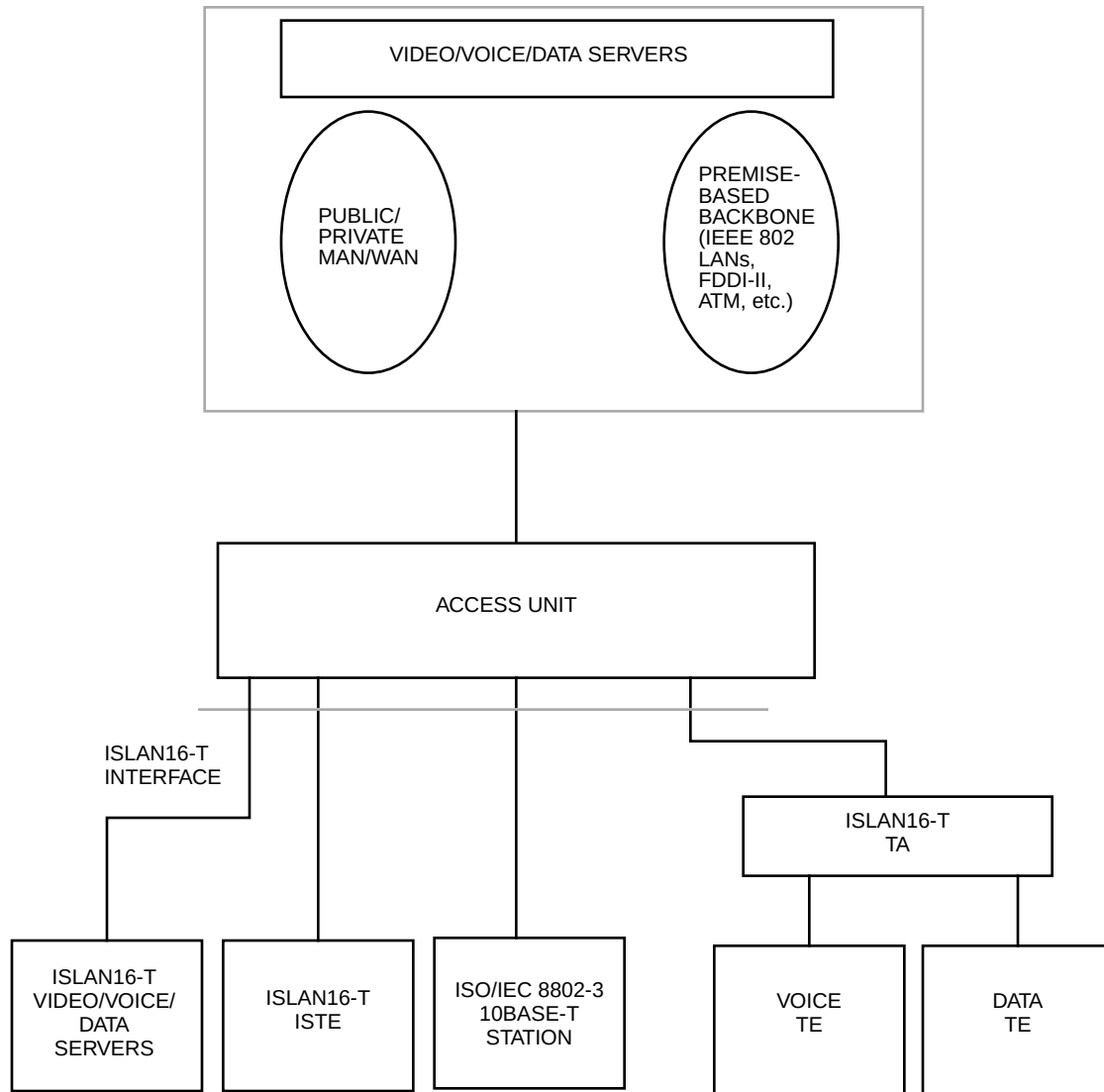


Figure 12-3—An example ISLAN16-T network topology

isochronous frames delivered at 8 kHz. These frames are synchronous with the 8 kHz reference that may be supplied by the AU/backbone/WAN interface, or may be supplied locally by an ISTE. These TDM bearer frames consist of 256 slots (of 64 kbit/s), each comprising one octet.

The multiplexing of the several services carried by octets or multiples thereof within the common TDM bearer is a function of the hybrid multiplexer (HMUX) sublayer of the ISLAN16-T Physical Layer. HMUX sublayer management procedures combined with ITU-T Q.93x based signalling procedures complete the provision of a mechanism that can be used for transparently and dynamically establishing and releasing multiple independent isochronous channels. The ISLAN16-T Physical Layer presents the following bearer channels to Layer 2:

- *D channel.* A 64 kbit/s full-duplex packet channel for the provision of call control procedures via the ITU-T Q.93x family of protocols. The use of the D channel may be restricted to conveying signalling information in some applications. The D channel is also capable of supporting packet mode data transfer.

- *C channel*. A full-duplex isochronous channel whose bandwidth is a multiple of 64 kbit/s. The expression “C” is used to indicate that this is a circuit-switched channel. C_m stands for a channel $m \times 64$ kbit/s in size. Each of the 64 kbit/s channels are coherent with respect to each other, since they are transported within the same TDM bearer. In general, a C channel has the same characteristics as an ISDN B or H channel, except that it can be any multiple of 64 kbit/s in size, rather than only the ITU-T approved rates [refer to ITU-T Recommendation I.431 (1993)]. There may be multiple C_m channels of varying sizes ($n \times C_m$). The maximum composite bandwidth allocated for the C channel shall be limited by the mode of operation of the ISLAN16-T interface. As for ISDN B channels, no upper layer protocols above the Physical Layer’s HMUX sublayer are defined.

Note the following equivalencies:

$$\begin{aligned} C_1 &= B &&= 64 \text{ kbit/s} \\ C_6 &= H_0 &&= 384 \text{ kbit/s} \\ C_{24} &= H_{11} &&= 1.536 \text{ Mbit/s} \\ C_{30} &= H_{12} &&= 1.920 \text{ Mbit/s} \\ C_{96} &= 1 \text{ wideband channel (WBC)} &&= 6.144 \text{ Mbit/s} \end{aligned}$$

- *P channel*. A packet channel that provides an ISO/IEC 8802-3 conformant packet transport service, which utilizes the CSMA/CD MAC protocol. There shall only be one P channel defined per ISLAN interface, which shall always be limited to 10 Mbit/s, in accordance with 14.1 of ISO/IEC 8802-3:1996.

NOTE—Full-duplex P channel operation is a matter for further study.

In addition to these bearer channels, the TDM frames support the transmission of an additional two fields used for providing frame synchronization and maintenance functionality at the Physical Layer, as described below.

- *Frame synchronization*. A full-duplex 64 kbit/s field that is used to carry the frame synchronization pattern, which signifies the start of the TDM frame.
- *Maintenance channel (M channel)*. A full-duplex 96 kbit/s channel that conveys low-level Physical Layer status and control information to the remote end of the link, as described in 12.3.4.5.

12.2.2 Modes of operation

To permit a wide range of capabilities and to allow for interoperability with existing 10BASE-T conformant terminal equipment, this standard allows for the following modes of operation:

- 10BASE-T mode
- Multiservice mode
- All-isochronous mode

A link pulse signalling scheme (auto-negotiation) (see 12.6.4.1) is employed to differentiate between the various modes of operation.

12.2.2.1 10BASE-T mode

In this mode, the Physical Layer behaves as an ISO/IEC 8802-3 (clauses 1 through 7, 9, and 14) conformant Manchester encoder/decoder, and twisted-pair transceiver. This mode provides a packet channel (P channel) of 10 Mbit/s. At the MAC sublayer, CSMA/CD access methods are employed for transmission of 10 Mbit/s ISO/IEC 8802-3 MAC frames. The non return to zero (NRZ) data that is received for an ISO/IEC 8802-3 MAC payload unit is Manchester encoded and transmitted over the physical medium.

This mode is exactly compliant with the ISO/IEC 8802-3 10BASE-T specification, including management, and will not be discussed in this standard. Refer to ISO/IEC 8802-3: 1996 for complete details. There is no TDM bearer support and no isochronous bandwidth available in this mode of operation. Therefore, there is no provision for supporting the C channel or the D channel. This mode permits the interconnection of standard 10 Mbit/s ISO/IEC 8802-3 conformant DTE devices to the ISLAN16-T AU.

12.2.2.2 Multiservice mode

In this mode, the bandwidth is divided into a 10 Mbit/s P channel, a 64 kbit/s D channel, and a 96 kbit/s M channel, with 6.144 Mbit/s available for allocation of C channel(s). The 10 Mbit/s P channel employs the CSMA/CD MAC protocol. The 16.384 Mbit/s of TDM data is encoded using the 4B/5B encoding scheme and is transformed to the non return to zero, inverted (NRZI) format for transmission. The principal negotiation mechanism for providing configuration management of the isochronous channels is through the use of the ITU-T Q.93x family of signalling protocols.

This mode of operation is a combination of the 10BASE-T and all-isochronous modes of operation. Therefore, it shares some elements of bearer service compatibility with each.

12.2.2.3 All-isochronous mode

In this mode, the complete bandwidth delivered to the higher layers is available for C channel services. There is no P channel available. This mode results in a 16.032 Mbit/s aggregate bearer service that supports a 64 kbit/s D channel, a 96 kbit/s M channel, and 248 (64 kbit/s) time slots that may be configured to support one or more instances of C channels. The principal negotiation mechanism for providing configuration management of the isochronous channels is through the use of the ITU-T Q.93x family of signalling protocols.

This mode of operation is compatible with the all-isochronous and multiservice mode devices.

12.2.2.4 Interworking of capabilities

Table 12-1 illustrates an interworking matrix that describes combinations of equipment types and whether there is bearer service interworking across an ISLAN16-T network. The exchange of link pulses between the AU and the ISTE, as specified in 12.6.4.1, establishes which forms of capabilities/services are possible.

Table 12-1—Capabilities interworking between ISTE and AU

AU	ISTE		
	10BASE-T	All-isochronous	Multiservice
10BASE-T	10BASE-T mode	No interworking	10BASE-T services only ^a
All-isochronous	No interworking	All-isochronous mode	Isynchronous services only
Multiservice	10BASE-T services only ^a	Isynchronous services only	Multiservice mode

^aThis capability is achieved by automatically reconfiguring to the 10BASE-T mode of operation using the link pulse signalling (auto-negotiation) scheme.

12.2.3 Layers and layer service boundaries

The ISLAN16-T model and its relationship to the Open System Interconnection (OSI) Reference Model of the International Organization for Standardization (ISO) is illustrated in figure 12-4.

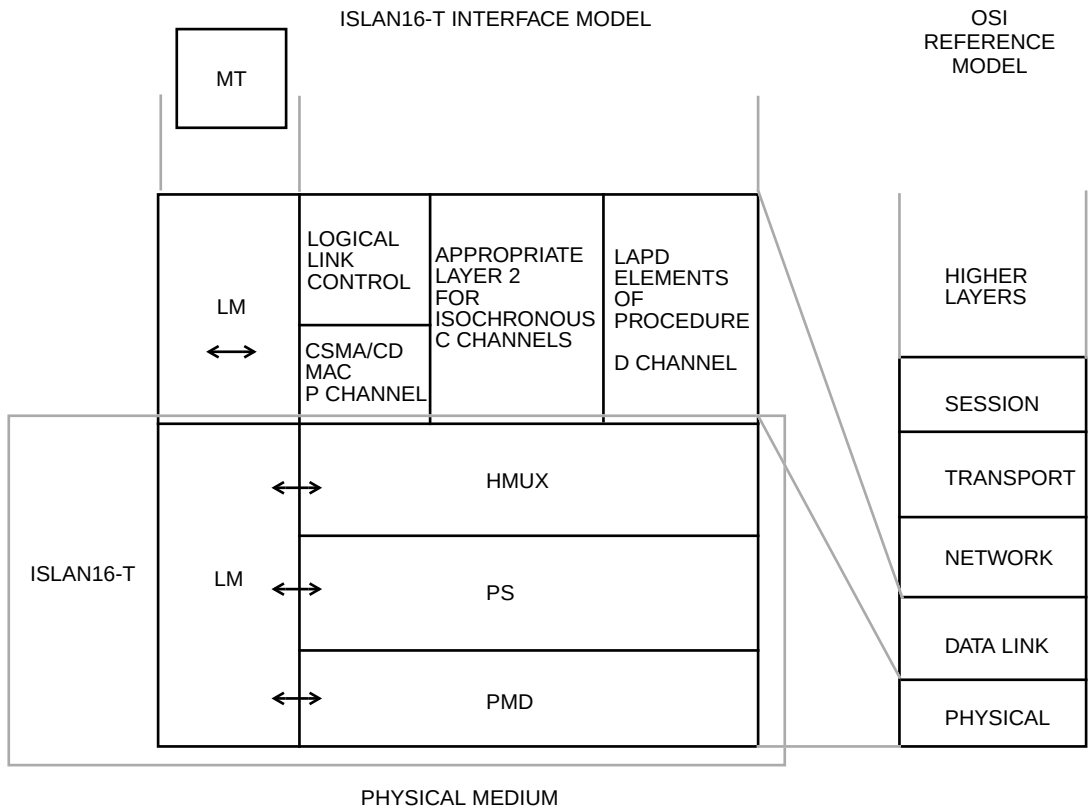


Figure 12-4—Relationship of the ISLAN interface model to the OSI Reference Model

This standard primarily covers the Physical Layer of the OSI Reference Model. It should be noted that the ITU-T Q.93x family of protocols, which are Layer 3 protocols, are used for call control over the D channel. Data Link Layer protocols are employed over the packet channels (i.e., the D channel and the P channel). The Physical Layer considerations defined in this standard apply to all channels.

With respect to the Data Link Layer protocols, there are three types of information channels: the P channel, the D channel, and the C channel. The Data Link Layer for the P channel consists of the ISO/IEC 8802-3 CSMA/CD MAC sublayer together with the ISO/IEC 8802-2 logical link control (LLC) sublayer. The D channel services require the use of the ITU-T LAPD elements of procedure at the Data Link Layer (see 12.6.3.4), when used as a signalling channel. The isochronous channels may use a Layer 2 and higher layer protocol, as appropriate, for the type of service that is being provided over the channel for the given data, voice, or video communication application.

Each of the layers in the OSI Reference Model has an interface to management (MT). From a modelling perspective, each layer (or sublayer) has its individual layer management (LM). The combination of the individual layer management entities (LMEs) interacting with the system management application process (SMAP), is described as the MT entity. The layers interact by way of well-defined interfaces to provide specific services.

12.2.3.1 Physical Layer

The Physical Layer performs functions such as multiplexing the multiple bit streams, adding and removing TDM framing and synchronization information, and providing access to the transmission medium, for the multiservice and all-isochronous modes of operation. In these modes, the Physical Layer is subdivided into

the HMUX, physical signalling (PS), and physical medium dependent (PMD) sublayers, as illustrated in figure 12-4.

For the 10BASE-T mode of operation, the Physical Layer behaves like a 10BASE-T Manchester encoder/decoder and twisted-pair transceiver, as specified in ISO/IEC 8802-3: 1996. The relationship between the OSI Reference Model and the 10BASE-T model is shown in figure 12-5. For detailed specifications of this model, refer to ISO/IEC 8802-3: 1996.

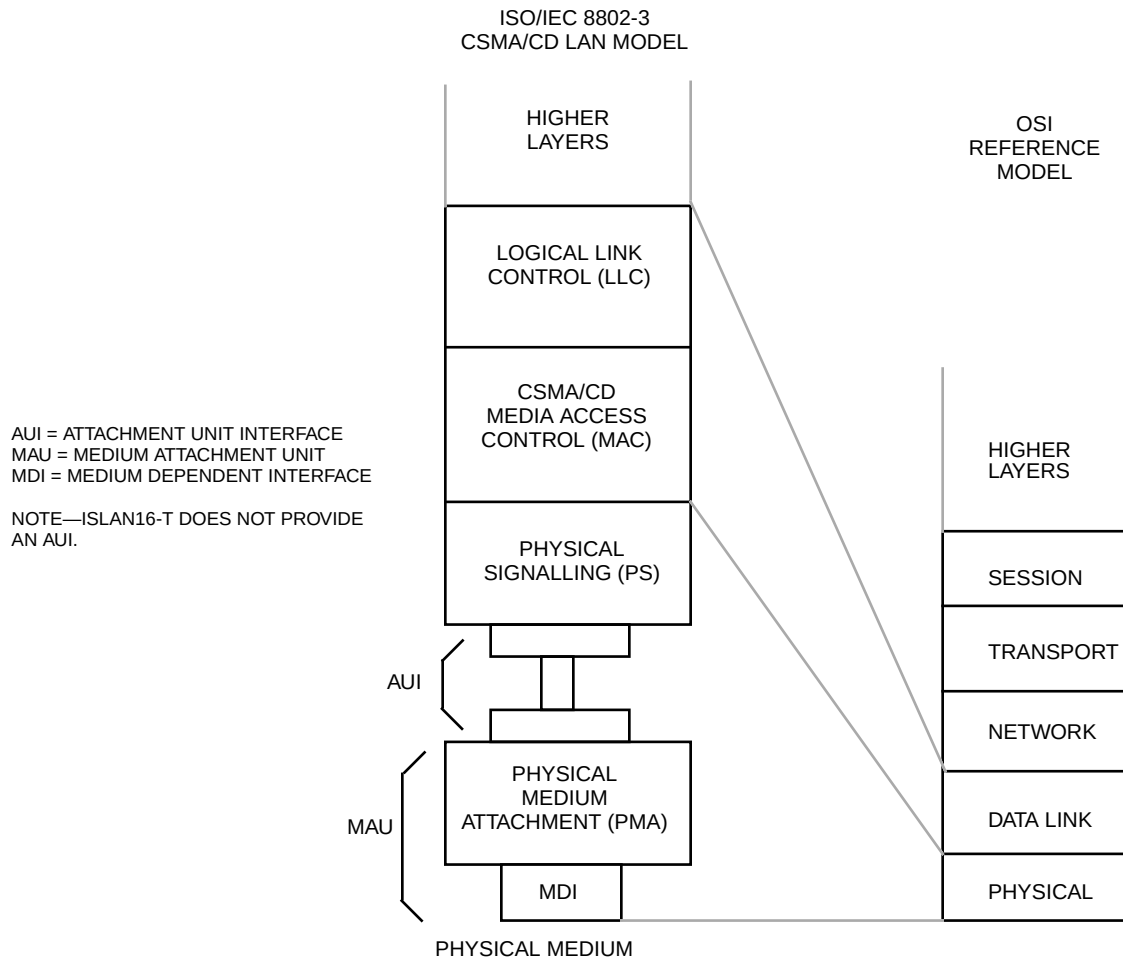


Figure 12-5—Relationship of the 10BASE-T model to the OSI Reference Model

The ISLAN16-T Physical Layer combines the functionality described above, and is illustrated in figure 12-6. The PMD convergence layer does not provide the attachment unit interface (AUI) functionality.

12.2.3.1.1 PHY service convergence

The PHY service convergence sublayer allows Layer 2 entities to utilize the services provided by the PHY Layer in the different modes of operation. In the 10BASE-T mode, the PHY service convergence sublayer provides the P channel with control/timing information for Layer 2. In the multiservice mode of operation, the PHY service convergence sublayer provides the C, D, and P channel information with control/timing to Layer 2. In the all-isochronous mode of operation, the PHY service convergence sublayer provides the C and D channel with control/timing information for Layer 2.

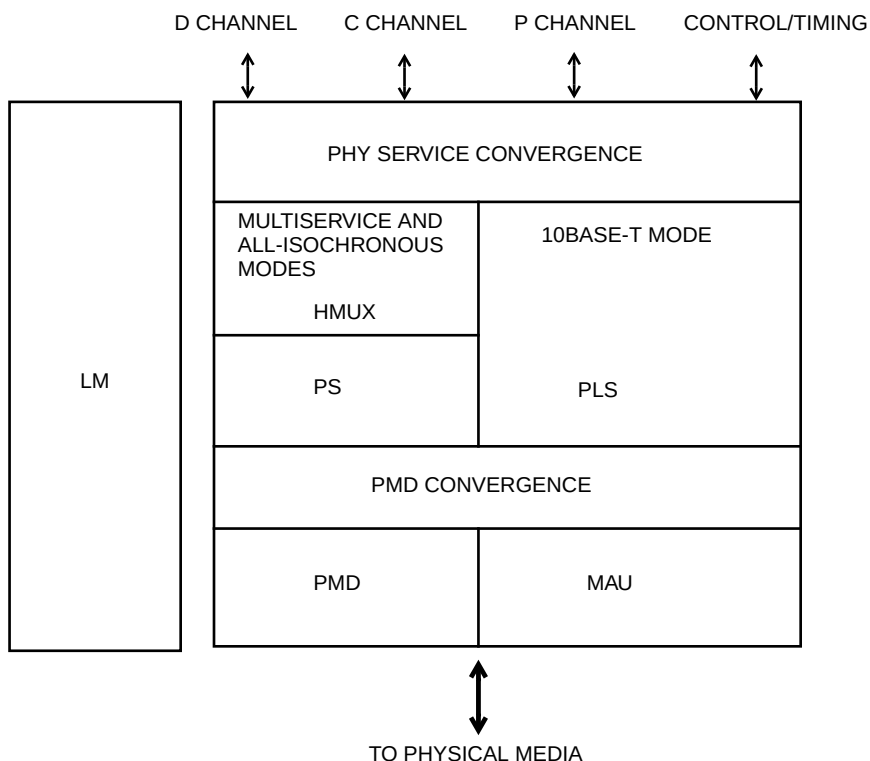


Figure 12-6—Architectural model of the Physical Layer

12.2.3.1.2 Hybrid MUX sublayer

The highest sublayer within the PHY Layer is the HMUX sublayer. This sublayer shall provide an interface to the MAC sublayer for the P and D channels, and shall also provide an interface for isochronous services. An interface for control/timing information is also provided to Layer 2. The transmit functions of the HMUX sublayer are to multiplex streams of information from the higher layers and from the HMUX LM into a single stream of octets for acceptance by the PS sublayer. The HMUX sublayer additionally demultiplexes the stream of octets received by the PS sublayer into a set of channels, each directed to an appropriate higher layer service access point (SAP).

12.2.3.1.2.1 P channel Layer 2/HMUX service boundary

As shown in figure 12-4, the HMUX sublayer, in the transmit direction, receives a 10 Mbit/s ISO/IEC 8802-3 MAC frame from the MAC sublayer to be carried in the P channel payload. The access is governed by the CSMA/CD MAC protocol. The P channel control information also passes across this boundary. In the receive direction, the P channel payload, as well as control information, is passed from the HMUX sublayer to the MAC sublayer (see 12.4.1.1.2).

12.2.3.1.2.2 Isochronous Layer 2/HMUX service boundary

As shown in figure 12-4, the HMUX sublayer transmits and receives C channel(s) information to and from the isochronous Layer 2.

12.2.3.1.2.3 D channel Layer 2/HMUX service boundary

As shown in figure 12-4, the HMUX sublayer transmits and receives D channel information to and from Layer 2. The D channel supports the signalling required to establish, maintain, and release isochronous calls. For signalling applications, LAPD elements of procedure are employed (see 12.6.3.4).

12.2.3.1.2.4 HMUX/LM service boundary

The HMUX sublayer transmits and receives management signals used for dynamic bandwidth allocation of the C channel to and from the HMUX/LM service boundary.

12.2.3.1.2.5 HMUX/PS service boundary

The interface between the HMUX sublayer and the PS sublayer conveys the multiplexed information stream composed of P channel, C channel, D channel, and control and timing information.

12.2.3.1.3 Physical signalling (PS) sublayer

The PS sublayer is responsible for interfacing between the HMUX sublayer and the PMD sublayer. As such, the PS sublayer is responsible for applying required processing to the transmitted and received bit stream before transmitting it to the PMD sublayer and the HMUX sublayer, respectively. The PS sublayer has an interface to LM.

In the transmit direction, the PS sublayer completes the formation of an entire TDM frame by appending M channel information, encoding the bit stream, and appending framing information. In the receive direction, the PS sublayer is responsible for establishing frame synchronization, removing the framing information field, decoding the received bit stream, and passing the M channel information to LM.

12.2.3.1.3.1 PS/LM service boundary

The interface between the PS sublayer and LM is used to transmit/receive M channel information, such as frame synchronization availability, link low power, frame mastership, backup power availability, link synchronization, frame error, D channel status, and local/remote loopback capabilities.

12.2.3.1.3.2 PS/PMD service boundary

The interface between the PS sublayer and the PMD sublayer is defined in terms of the bit stream constituting a complete ISLAN16-T TDM frame. This interface is responsible for transmitting/receiving a valid data bit stream and associated timing information.

12.2.3.1.4 PMD convergence

The PMD convergence sublayer allows for the selection of the PMD/MAU and the mode of operation of the PHY, which is decided using the link pulse signalling (auto-negotiation) scheme.

12.2.3.1.5 Physical medium dependent (PMD) sublayer

The PMD sublayer provides the electrical interface to the physical medium. Included in this sublayer are the functions necessary to connect the interface to the UTP medium. Specifically, the PMD sublayer defines the medium dependent encoding method (NRZI), the transmitter and receiver, physical cable and connectors, and other related issues. The PMD sublayer has an interface to LM.

A description of the pulse mark, transmitter output power spectrum and impedance characteristics, receiver input impedance characteristics, and crosstalk and impulse noise requirements are described in this sublayer. This standard specifies the PMD for a 16.384 Mbit/s aggregate rate at a distance of 100 m.

12.2.3.1.5.1 PMD/LM service boundary

The interface between the PMD sublayer and LM includes the maintenance information, such as local loop-back at the PMD/media interface.

12.3 Frame structure

This subclause describes the frame structures used by the ISLAN16-T interface.

12.3.1 Overview of frame types

This standard shall provide for two types of frames: the Physical Layer's synchronous TDM frame and the ISO/IEC 8802-3 Data Link Layer MAC frame (packet frame). The TDM frame structure shall be used in the multiservice and all-isochronous modes of operation. The MAC frame structure is used in the 10BASE-T mode of operation. In the multiservice mode of operation, the information content of the MAC frame is encoded within the P channel of the TDM frame.

12.3.1.1 TDM frame

The TDM frame structure shall be a set of octets that contains the P, C, and D channels, the frame synchronization, and the M channel. This frame shall be generated synchronously every 125 μ s. Architecturally, this standard provides for the use of a transmission frequency of 20.48 MHz. The information within the TDM frame shall be encoded using 4B/5B code symbol encoding, which results in a TDM frame structure containing 256 octets (± 0.5 octets for cycle length adjustment—see 12.2.4.9) of unencoded data (i.e., 512 ± 1 code symbols), providing an aggregate data rate of 16.384 Mbit/s.

12.3.1.2 MAC frame

The MAC frame shall be delimited from the information carried within the P channel. This frame format shall be employed when operating in the 10BASE-T mode, or the multiservice mode, and is specified in clause 3 of ISO/IEC 8802-3: 1996.

12.3.2 Numbering convention for the TDM frame structure

The bits of the TDM frame structure are grouped into nibbles of unencoded data (or code symbols of encoded data). Adjacent nibbles of unencoded data are grouped together in an ascending manner to form octets. Each code symbol shown in tables 12-2 and 12-4 represents a nibble of information. For example, the first code symbol B1 and the second code symbol B1 in tables 12-2 and 12-4 are grouped together to constitute an octet. In this case, the first code symbol B1 is the least significant nibble (LSNibble) and the second code symbol B1 is the most significant nibble (MSNibble).

The bits of an octet are shown horizontally in figure 12-7, and are numbered from 0 to 7. Multiple octets are shown vertically and are numbered from 0 to 255. Octet 0 corresponds to the frame synchronization pattern (JK) of the TDM frame structure, with the other octets of the TDM frame numbered in an ascending manner (see 12.6.3.6).

Figure 12-8 shows the order of transmission of bits within the encoded 4B/5B code symbols. The nibbles of information are mapped into their respective 4B/5B code symbols. These code symbols are then transmitted with the encoded values of the LSNibble first, followed by the MSNibble. Within each code symbol, the MSb of the encoded value shall be transmitted first.

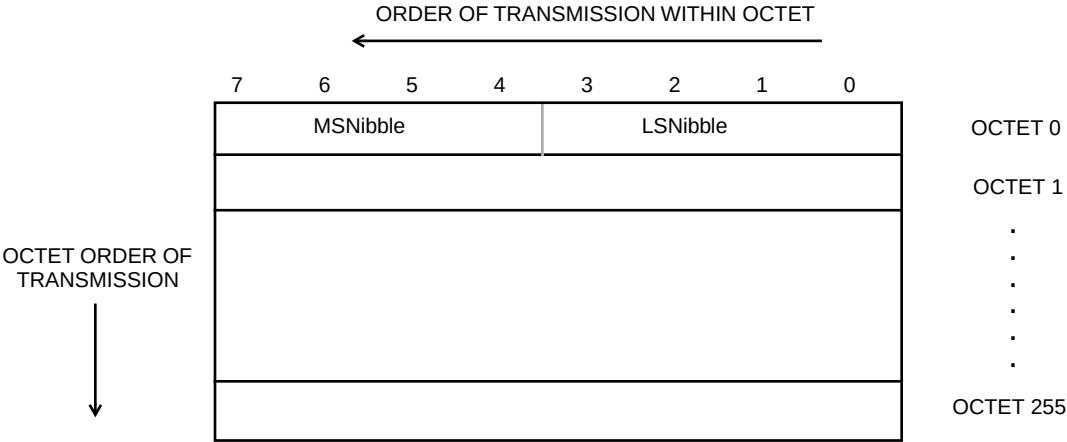


Figure 12-7—TDM frame format convention

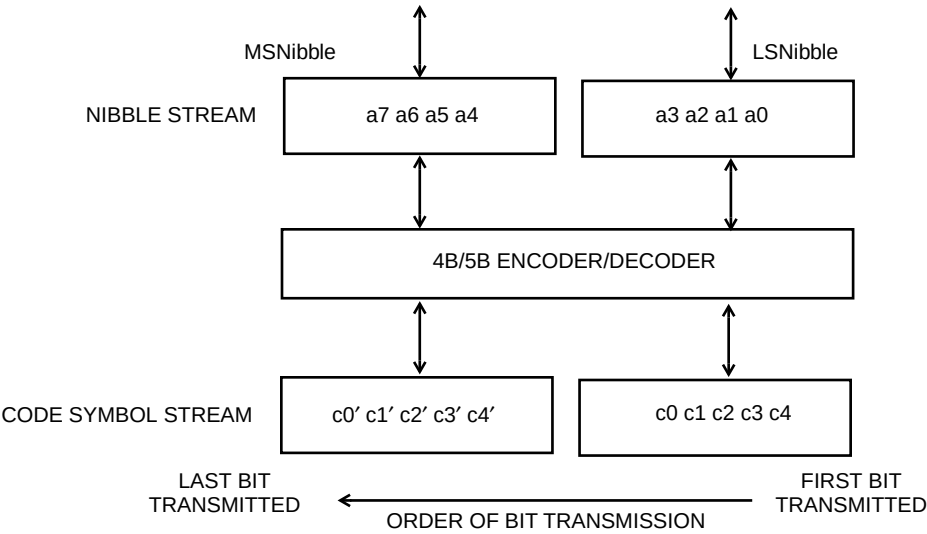


Figure 12-8—Bit transmission scheme

12.3.2.1 Order of bit transmission

Inside an octet of a field, bit 0 shall be the first bit to be transmitted.

12.3.2.2 Order of octet transmission

Octets are transmitted in ascending numerical order. Octet 0 shall be the first octet to be transmitted.

12.3.2.3 Order of transmission for fields that span multiple octets

When a field spans multiple octets, the LSB (octet) is transmitted first, followed by the other octets within the field in an ascending manner. Within each octet, the LSb (bit 0) is the first bit to be transmitted.

12.3.3 Numbering convention for the MAC frame structure

The numbering convention for the MAC frame structure is specified in clause 3 of ISO/IEC 8802-3: 1996.

12.3.4 TDM frame structure

12.3.4.1 Overview

An overview of the frame structure for the TDM frame, which is employed when operating in either the multiservice or all-isochronous mode of operation (see 12.6), is presented in this subclause.

12.3.4.2 TDM frame format for multiservice mode

Table 12-2 illustrates the TDM frame format for multiservice mode.

As shown in table 12-2, the frame template consists of 4 blocks of data, and each block consists of 8 groups. Each group shall be 8 bytes or 16 code symbols in length. Each frame template has 256 bytes of unencoded data (i.e., 512 code symbols) and a 125 μ s cycle period. A new frame template shall be initiated every 125 μ s (8 kHz) and is present on both the transmit and receive lines. This template provides for a 10 Mbit/s CSMA/CD based P channel, with 6.144 Mbit/s available for allocation of C channel(s). The data shall be distributed throughout the frame in units consisting of 5-bit code symbols. These code symbols represent the 4B/5B encoded data.

The bandwidth allocation for the various channels shall be as follows:

- Frame synchronization channel of 64 kbit/s
- M channel of 96 kbit/s
- D channel of 64 kbit/s
- C channel with an aggregate bandwidth of 6.144 Mbit/s
- P channel with an effective bandwidth of 10 Mbit/s

The P channel bandwidth is adjusted in the frame to provide an effective bandwidth of 10 Mbit/s. From the TDM frame template it can be seen that the P channel has 1252 bits per frame or 313 code symbols per frame, giving it a net bandwidth of 10.016 Mbit/s. In every alternate frame the first code symbol of Block 3 (an E code symbol) is not used and instead a “no data” 4B/5B encoded code symbol is transmitted. This will reduce the effective symbols for the P channel in a TDM frame to 312.5 code symbols and the effective bandwidth to 10 Mbit/s, as specified in the ISO/IEC 8802-3 10BASE-T specification.

NOTE—Full-duplex P channel operation is a matter for further study.

The total data rate available is 16.384 Mbit/s at a maximum line transition rate of 10.24 MHz, compared to the standard 10BASE-T data rate of 10 Mbit/s, which has a maximum line transition rate of 10 MHz. The bandwidth allocation in the multiservice mode is shown in table 12-3. The assignment of the octets to the various channels is chosen in such a manner as to minimize the delays and buffer requirements at the AU.

12.3.4.3 TDM frame format for all-isochronous mode

The TDM frame template is shown in table 12-4. The bandwidth allocation for this mode is shown in table 12-5. The frame template shall be similar to the multiservice mode except that the P channel slots are now allocated to the isochronous C channel. In this scheme, 248 B channel slots with a bandwidth of 15.872 Mbit/s are allocated for C channel (isochronous) data. The D, M, and frame synchronization channels are the same as those specified in the multiservice mode. Every block shall be terminated by two code symbols of 4B/5B encoded “idle” data. Also, the beginning of the fourth block has one code symbol of 4B/5B encoded “idle” data resulting in a total of 9 code symbols of “idle” data or 4.5 bytes of “idle” unencoded data (this is equivalent to a bandwidth of 288 kbit/s).

12.3.4.4 Frame synchronization channel

This full-duplex 64 kbit/s channel shall be used for the purpose of establishing synchronization between the ISTE and the AU, with respect to the exchange of the physical TDM frame. Within the TDM frame, the first block of data, which is also the beginning of the frame, shall be indicated by the 4B/5B code symbol frame synchronization pattern 'JK'. The code symbol 'J' shall be the first sequential frame synchronization symbol and 'K' shall be the second sequential frame synchronization symbol. For details of the 4B/5B code symbol encoding scheme, refer to 12.6.3.6.

Table 12-2—Multiservice mode frame template

Block 0:

J	K	E	B1	E	B1	E	B2	E	B2	E	B3	E	B3	E	E	Group 0
E	E	E	B4	E	B4	E	B5	E	B5	E	B6	E	B6	E	E	Group 1
E	E	E	B7	E	B7	E	B8	E	B8	E	B9	E	B9	E	E	Group 2
E	E	E	B10	E	B10	E	B11	E	B11	E	B12	E	B12	E	E	Group 3
E	E	E	B13	E	B13	E	B14	E	B14	E	B15	E	B15	E	E	Group 4
E	E	E	B16	E	B16	E	B17	E	B17	E	B18	E	B18	E	E	Group 5
E	E	E	B19	E	B19	E	B20	E	B20	E	B21	E	B21	E	E	Group 6
E	E	E	B22	E	B22	E	B23	E	B23	E	B24	E	B24	E	E	Group 7

Block 1:

M	M	E	B25	E	B25	E	B26	E	B26	E	B27	E	B27	E	E	Group 8
E	E	E	B28	E	B28	E	B29	E	B29	E	B30	E	B30	E	E	Group 9
E	E	E	B31	E	B31	E	B32	E	B32	E	B33	E	B33	E	E	Group 10
E	E	E	B34	E	B34	E	B35	E	B35	E	B36	E	B36	E	E	Group 11
E	E	E	B37	E	B37	E	B38	E	B38	E	B39	E	B39	E	E	Group 12
E	E	E	B40	E	B40	E	B41	E	B41	E	B42	E	B42	E	E	Group 13
E	E	E	B43	E	B43	E	B44	E	B44	E	B45	E	B45	E	E	Group 14
E	E	E	B46	E	B46	E	B47	E	B47	E	B48	E	B48	E	E	Group 15

Block 2:

D	D	E	B49	E	B49	E	B50	E	B50	E	B51	E	B51	E	E	Group 16
E	E	E	B52	E	B52	E	B53	E	B53	E	B54	E	B54	E	E	Group 17
E	E	E	B55	E	B55	E	B56	E	B56	E	B57	E	B57	E	E	Group 18
E	E	E	B58	E	B58	E	B59	E	B59	E	B60	E	B60	E	E	Group 19
E	E	E	B61	E	B61	E	B62	E	B62	E	B63	E	B63	E	E	Group 20
E	E	E	B64	E	B64	E	B65	E	B65	E	B66	E	B66	E	E	Group 21
E	E	E	B67	E	B67	E	B68	E	B68	E	B69	E	B69	E	E	Group 22
E	E	E	B70	E	B70	E	B71	E	B71	E	B72	E	B72	E	E	Group 23

Block 3:

E*	M	E	B73	E	B73	E	B74	E	B74	E	B75	E	B75	E	E	Group 24
E	E	E	B76	E	B76	E	B77	E	B77	E	B78	E	B78	E	E	Group 25
E	E	E	B79	E	B79	E	B80	E	B80	E	B81	E	B81	E	E	Group 26
E	E	E	B82	E	B82	E	B83	E	B83	E	B84	E	B84	E	E	Group 27
E	E	E	B85	E	B85	E	B86	E	B86	E	B87	E	B87	E	E	Group 28
E	E	E	B88	E	B88	E	B89	E	B89	E	B90	E	B90	E	E	Group 29
E	E	E	B91	E	B91	E	B92	E	B92	E	B93	E	B93	E	E	Group 30
E	E	E	B94	E	B94	E	B95	E	B95	E	B96	E	B96	E	E	Group 31

* The E symbol in every alternate frame shall be transmitted as a “no data” 4B/5B encoded pad symbol to adjust the P channel effective bandwidth (see 12.3.4.2).

NOTE—TDM frame length adjustment may be performed on this frame template by deleting the last E code symbol of the frame or by adding an extra E code symbol to the frame (see 12.3.4.9).

<u>Symbol</u>	<u>Description</u>
J	Frame synchronization channel pattern 1
K	Frame synchronization channel pattern 2
M	M channel (maintenance) information
D	D channel information
B	C channel (isochronous) information
E	P channel (packet) information

Table 12-3—Multiservice mode channel bandwidth allocation

Slot assignment	Bytes/ frame	Symbols/ frame	Bits/ frame	kbit/s (unencoded)	Description
Frame synchronization (JK)	1	2	8	64	Frame synchronization pattern
M	1.5	3	12	96	M channel (maintenance channel)
D	1	2	8	64	D channel (signalling channel)
B	96	192	768	6144	C channel (isochronous bearer channel)
E	156.5	313	1252	10 016 ^a	P channel (packet channel)
Total	256	512	2048	16 384	Total template bandwidth

^aThe P channel effective bandwidth is adjusted to 10 Mbit/s (see 12.3.4.2).

12.3.4.5 M channel

This full-duplex 96 kbit/s M channel shall carry out low-level functions used to maintain the physical link. The purpose of the M channel shall be to provide local Physical Layer status and control information to the far end of the link. In the PS sublayer transmitter, maintenance information is received from the LME and multiplexed into the outgoing bit stream to be transmitted to the far end of the link. In the PS sublayer receiver, this field is demultiplexed out of the incoming bit stream and presented to the LME.

The Physical Layer maintenance bits are transmitted and received using the M slots of the multiservice mode and all-isochronous mode frame templates. These 12 bits per frame contain information for controlling the link (i.e., network frame synchronization control, local and remote loopback capabilities, link low power, frame mastership, backup power, link synchronization, frame error, and D channel status). The M channel bit encoding is shown in figure 12-9.

The M channel bits shall be transmitted LSb first. M channel bits M0–M7 are transmitted within the first M channel octet (composed of the first two M channel nibbles), as shown in tables 12-2 and 12-4, with M0 as the first bit transmitted. In these tables, M channel bits M0–M3 are transmitted within the first M channel nibble of Block 1, with bits M4–M7 transmitted within the second M channel nibble of that block. Maintenance bits M8–M11 are transmitted in the third M channel nibble, as shown in tables 12-2 and 12-4, with M8 as the first bit transmitted. The list of functions for the M channel is given in table 12-6.

- The NFSA bit shall be transmitted by the local end (which is initially a cycle slave to the remote end) to notify the remote end of the link that it can provide an 8 kHz reference signal (which is generally synchronized to a WAN reference).
- The LMR(1:0) bits shall be used to request either the low-power or remote loopback mode of operation.
- The FMG bit shall be transmitted to grant the remote end of the link the capability of using its 8 kHz reference signal to generate the TDM frame template (and can become a cycle master).
- The BUPS bit is reserved for future use with backup power systems, and shall be set to zero.

Table 12-4—All-isochronous mode frame template

Block 0:																
J	K	B1	B1	B2	B2	B3	B3	B4	B4	B5	B5	B6	B6	B7	B7	Group 0
B8	B8	B9	B9	B10	B10	B11	B11	B12	B12	B13	B13	B14	B14	B15	B15	Group 1
B16	B16	B17	B17	B18	B18	B19	B19	B20	B20	B21	B21	B22	B22	B23	B23	Group 2
B24	B24	B25	B25	B26	B26	B27	B27	B28	B28	B29	B29	B30	B30	B31	B31	Group 3
B32	B32	B33	B33	B34	B34	B35	B35	B36	B36	B37	B37	B38	B38	B39	B39	Group 4
B40	B40	B41	B41	B42	B42	B43	B43	B44	B44	B45	B45	B46	B46	B47	B47	Group 5
B48	B48	B49	B49	B50	B50	B51	B51	B52	B52	B53	B53	B54	B54	B55	B55	Group 6
B56	B56	B57	B57	B58	B58	B59	B59	B60	B60	B61	B61	B62	B62	I	I	Group 7
Block 1:																
M	M	B63	B63	B64	B64	B65	B65	B66	B66	B67	B67	B68	B68	B69	B69	Group 8
B70	B70	B71	B71	B72	B72	B73	B73	B74	B74	B75	B75	B76	B76	B77	B77	Group 9
B78	B78	B79	B79	B80	B80	B81	B81	B82	B82	B83	B83	B84	B84	B85	B85	Group 10
B86	B86	B87	B87	B88	B88	B89	B89	B90	B90	B91	B91	B92	B92	B93	B93	Group 11:
B94	B94	B95	B95	B96	B96	B97	B97	B98	B98	B99	B99	B100	B100	B101	B101	Group 12:
B102	B102	B103	B103	B104	B104	B105	B105	B106	B106	B107	B107	B108	B108	B109	B109	Group 13
B110	B110	B111	B111	B112	B112	B113	B113	B114	B114	B115	B115	B116	B116	B117	B117	Group 14
B118	B118	B119	B119	B120	B120	B121	B121	B122	B122	B123	B123	B124	B124	I	I	Group 15
Block 2:																
D	D	B125	B125	B126	B126	B127	B127	B128	B128	B129	B129	B130	B130	B131	B131	Group 16
B132	B132	B133	B133	B134	B134	B135	B135	B136	B136	B137	B137	B138	B138	B139	B139	Group 17
B140	B140	B141	B141	B142	B142	B143	B143	B144	B144	B145	B145	B146	B146	B147	B147	Group 18
B148	B148	B149	B149	B150	B150	B151	B151	B152	B152	B153	B153	B154	B154	B155	B155	Group 19
B156	B156	B157	B157	B158	B158	B159	B159	B160	B160	B161	B161	B162	B162	B163	B163	Group 20
B164	B164	B165	B165	B166	B166	B167	B167	B168	B168	B169	B169	B170	B170	B171	B171	Group 21
B172	B172	B173	B173	B174	B174	B175	B175	B176	B176	B177	B177	B178	B178	B179	B179	Group 22
B180	B180	B181	B181	B182	B182	B183	B183	B184	B184	B185	B185	B186	B186	I	I	Group 23
Block 3:																
I	M	B187	B187	B188	B188	B189	B189	B190	B190	B191	B191	B192	B192	B193	B193	Group 24
B194	B194	B195	B195	B196	B196	B197	B197	B198	B198	B199	B199	B200	B200	B201	B201	Group 25
B202	B202	B203	B203	B204	B204	B205	B205	B206	B206	B207	B207	B208	B208	B209	B209	Group 26
B210	B210	B211	B211	B212	B212	B213	B213	B214	B214	B215	B215	B216	B216	B217	B217	Group 27
B218	B218	B219	B219	B220	B220	B221	B221	B222	B222	B223	B223	B224	B224	B225	B225	Group 28
B226	B226	B227	B227	B228	B228	B229	B229	B230	B230	B231	B231	B232	B232	B233	B233	Group 29
B234	B234	B235	B235	B236	B236	B237	B237	B238	B238	B239	B239	B240	B240	B241	B241	Group 30
B242	B242	B243	B243	B244	B244	B245	B245	B246	B246	B247	B247	B248	B248	I	I	Group 31

NOTE—TDM frame length adjustment may be performed on this frame template by deleting the last I code symbol of the frame or by adding an extra I code symbol to the frame (see 12.3.4.9).

<u>Symbol</u>	<u>Description</u>
J	Frame synchronization channel pattern 1
K	Frame synchronization channel pattern 2
M	M channel (maintenance) information
D	D channel information
B	C channel (isochronous) information
E	P channel (packet) information
I	Idle pattern

Table 12-5—All-isochronous mode channel bandwidth allocation

Slot assignment	Bytes/ frame	Symbols/ frame	Bits/ frame	kbit/s (unencoded)	Description
Frame synchronization (JK)	1	2	8	64	Frame synchronization pattern
M	1.5	3	12	96	M channel (maintenance channel)
D	1	2	8	64	D channel (signalling channel)
B	248	496	1984	15 872	C channel (isochronous bearer channel)
I	4.5	9	36	288	Idle data channel
Total	256	512	2048	16 384	Total template bandwidth

M11	M10	M9	M8
LLB	DCRS	FED	FMA
M7	M6	M5	M4
LSS1	LSS0	LMG	BUPS
M3	M2	M1	M0
FMG	LMR1	LMR0	NFSA

Figure 12-9—M channel encoding

- The LMG bit shall be transmitted to grant to the remote end of the link the capability of activating the low-power or remote loopback mode of operation.
- The LSS(1:0) bits are a status indication of the state of the remote transceiver as it vectors from “No Synchronization” to “information transport state.”

NOTE—The LSS(1:0) = “11” state (link is transparent) shall be set by an entity higher than the PS sublayer.

- The FMA bit shall be transmitted to acknowledge receipt of the FMG bit from the remote end, and that the local end is now using its 8 kHz reference signal to generate the TDM frame template (and has become the cycle master).
- The frame error detected (FED) bit shall be used to notify the remote end that the local end has detected a 4B/5B symbol error on the most recently received TDM frame.
- The D channel receive status (DCRS) bit shall be used as a flow control bit to notify the remote end to activate transmission of data over the D channel.

NOTE—The flow control on the D channel shall be implemented only in the 4B/5B delimited D channel data mode (see 12.6.3.4).

- The LLB bit shall be used to notify the remote end that the local end is operating in local loopback mode.

Table 12-6—M channel functions

Bit(s)	Function	Value
NFSA	Network frame synchronization available	0 = Not available 1 = Available
LMR(1:0)	Link maintenance request	00 = Deactivate request 10 = Activate low-power request 01 = Activate remote loopback 11 = Reserved
FMG	Frame mastership grant	0 = Deactivate grant 1 = Activate grant
BUPS	Backup power status	0 = Not available 1 = Available
LMG	Link maintenance grant	0 = Deactivate grant 1 = Activate grant
LSS (1:0)	Link synchronization state	00 = No synchronization achieved 01 = Bit lock achieved 10 = Frame and bit lock achieved 11 = Link is transparent (information transport state)
FMA	Frame mastership acknowledge	0 = Deactivated 1 = Activated
FED	Frame error detected	0 = No error 1 = Error detected
DCRS	D channel receive status	0 = Cannot receive data 1 = Data can be received
LLB	Local loopback	0 = Deactivated 1 = Activated

A detailed description of the M channel functionality is defined in 12.6.3.2. No M channel support is provided in the 10BASE-T mode of operation.

12.3.4.6 D channel

This channel provides a full-duplex 64 kbit/s ISDN D channel bearer service. At the ISLAN16-T Physical Layer, the D channel interface allows for the delivery of ISDN conformant higher layer (Layer 2 and above) services. The use of the D channel may be restricted to conveying signalling information in some applications. All signalling information in this channel is transmitted as packets, the details of which are specified in 12.8. No D channel support is provided in the 10BASE-T mode of operation.

The D channel bits shall be transmitted within the first two D channel nibbles of Block 2, as illustrated in tables 12-2 and 12-4.

The PS sublayer shall provide flow control for the D channel packets, using the 4B/5B control code symbol. The flow control on the D channel shall be implemented only in the 4B/5B delimited D channel data mode (see 12.6.3.4).