

Abstract: This standard is part of a family of standards for local area networks (LANs) and metropolitan area networks (MANs) that deals with the physical and data link layers as defined by the ISO Open Systems Interconnection Basic Reference Model. The functions, features, protocol, and services of the Logical Link Control (LLC) sublayer, which constitutes the top sublayer in the data link layer of the ISO/IEC 8802 LAN protocol, are described. The services required of, or by, the LLC sublayer at the logical interfaces with the network layer, the medium access control (MAC) sublayer, and the LLC sublayer management function are specified. The protocol data unit (PDU) structure for data communication systems is defined using bit-oriented procedures, as are three types of operation for data communication between service access points. In the first type of operation, PDUs are exchanged between LLCs without the need for the establishment of a data link connection. In the second type of operation, a data link connection is established between two LLCs prior to any exchange of information-bearing PDUs. In the third type of operation, PDUs are exchanged between LLCs without the need for the establishment of a data link connection, but stations are permitted to both send data and request the return of data simultaneously.

Keywords: local area networks, protocols; logical link control

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International Standard ISO/IEC 8802-2:1998
ANSI/IEEE Std 802.2, 1998 edition
(Incorporating ANSI/IEEE Stds 802.2c-1997,
802.2f-1997, and 802.2h-1997)

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

Part 2: Logical Link Control

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International Standard ISO/IEC 8802-2 : 1998

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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.

International Standard ISO/IEC 8802-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

This third edition cancels and replaces the second edition (ISO/IEC 8802-2: 1994), which has been technically revised. It also incorporates Amendment 3: 1995.

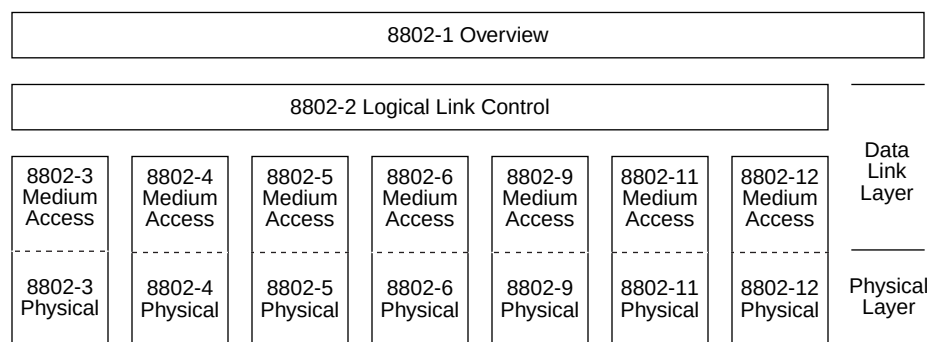
ISO/IEC 8802 consists of the following parts, under the general title *Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements*:

- *Part 1: Overview of Local Area Network Standards*
- *Part 2: Logical link control*
- *Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*
- *Part 4: Token-passing bus access method and physical layer specifications*
- *Part 5: Token ring access method and physical layer specifications*
- *Part 6: Distributed Queue Dual Bus (DQDB) access method and physical layer specifications*
- *Part 9: Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers*
- *Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications (Draft International Standard)*
- *Part 12: Demand-priority access method, physical layer and repeater specifications*

Annexes A and E form an integral part of this part of ISO/IEC 8802. Annexes B to D are for information only.

Foreword to International Standard ISO/IEC 8802-2 : 1998

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/IEC Standard numbers.)



This family of International Standards deals with the Physical and Data Link layers as defined by the ISO/IEC Open Systems Interconnection (OSI) Basic Reference Model (ISO/IEC 7498-1 : 1994). The access standards define seven 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:

- ISO/IEC 8802-3, utilizing carrier sense multiple access with collision detection (CSMA/CD) as the access method.
- ISO/IEC 8802-4, utilizing token passing bus as the access method.
- ISO/IEC 8802-5, utilizing token passing ring as the access method.
- ISO/IEC 8802-6, utilizing distributed queuing dual bus as the access method.
- ISO/IEC 8802-9, a unified access method offering integrated services for backbone networks.
- ISO/IEC DIS 8802-11, a wireless LAN utilizing carrier sense multiple access with collision avoidance (CSMA/CA) as the access method.
- ISO/IEC DIS 8802-12, utilizing Demand Priority as the access method.

ISO/IEC TR 8802-1, *Overview of Local Area Network Standards*, provides an overview of the series of ISO/IEC 8802 standards.

ISO/IEC 8802-2, *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 15802-1, *Medium Access Control (MAC) service definition*, specifies the characteristics of the common MAC Service provided by all IEEE 802 LAN MACs. The service is defined in terms of primitives that can be passed between peer service users, their parameters, their interrelationship and valid sequences, and the associated events of the service.

ISO/IEC 15802-2, *LAN/MAN Management*, defines an OSI management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.

ISO/IEC 10038, *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 (to be renumbered 15802-3).

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.

ISO/IEC 15802-5, *Remote Media Access Control (MAC) bridging*, specifies extensions for the interconnection, using non-LAN communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.

ANSI/IEEE Std 802.2, 1998 Edition

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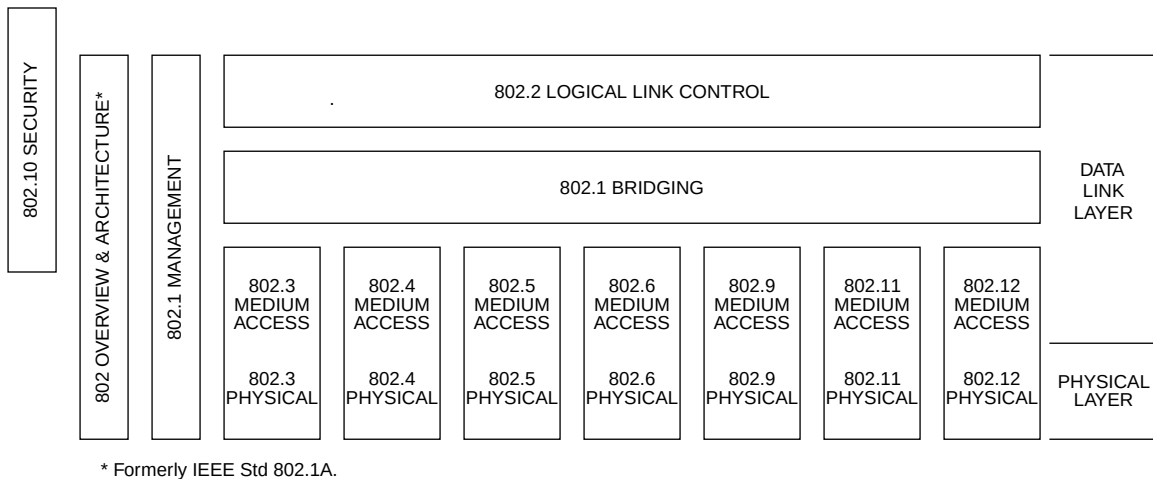
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Introduction to ANSI/IEEE Std 802.2, 1998 Edition

(This introduction is not a part of ANSI/IEEE Std 802.2, 1998 Edition or of ISO/IEC 8802-2 : 1998.)

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



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

The standards defining the technologies noted above are as follows:

- IEEE Std 802 *Overview and Architecture.* This standard provides an overview to the family of IEEE 802 Standards.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] *LAN/MAN Management.* Defines an 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] *Media Access Control (MAC) Bridges.* 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 802.1G [ISO/IEC 15802-5] *Remote Media Access Control (MAC) Bridging.* Specifies extensions for the interconnection, using non-LAN communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.
- 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*
- IEEE Std 802.11 [ISO/IEC DIS 8802-11] *Wireless LAN Medium Access Control (MAC) and Physical Layer Specifications*
- ANSI/IEEE Std 802.12 [ISO/IEC DIS 8802-12] *Demand Priority Access Method, Physical Layer and Repeater Specifications*

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

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

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

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

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.

ANSI/IEEE Std 802.2, 1998 Edition [ISO/IEC 8802-2 : 1998]

This edition of the standard incorporates three supplements: 802.2c-1997, *Conformance Requirements* (ISO/IEC Amendment 3); 802.2f-1997, *Managed Objects Definition for Logical Link Control (LLC)* (ISO/IEC Amendment 6) along with Technical Corrigendum 001; and 802.2h-1997, *Optional Toleration of Duplicate Information Transfer Format Protocol Data Units* (ISO/IEC Amendment 7). In the previous edition, the following supplements were incorporated: 802.2a-1993, *Standard for Flow Control Techniques for Bridged Local Area Networks* (ISO/IEC Amendment 1); 802.2b-1993, *Standard for Acknowledged Connectionless-Mode Service and Protocol (Type 3 Operation)* (ISO/IEC Amendment 2); 802.2d-1993, *Editorial Changes and Technical Corrections* (ISO/IEC Amendment 4); 802.2e-1993, *Bit Delivery Referencing* (ISO/IEC Defect Report 001); and 802.5p-1993, *Standard for Route Determination Entity* (ISO/IEC Amendment 5). The base standard with supplements incorporated into the 1994 edition was reaffirmed by IEEE on 16 September 1997.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are possible 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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Contents

1.	Overview.....	1
1.1	Scope and purpose	1
1.2	Standards compatibility.....	3
1.3	Normative references	3
1.4	Acronyms and definitions	5
1.5	Conformance.....	11
2.	LLC sublayer service specifications	12
2.1	General	12
2.2	Network layer/LLC sublayer interface service specification.....	14
2.3	LLC sublayer/MAC sublayer interface service specification	35
2.4	LLC sublayer/LLC sublayer management function interface service specification.....	38
3.	LLC PDU structure	39
3.1	General	39
3.2	LLC PDU format	39
3.3	Elements of the LLC PDU	39
4.	LLC types and classes of procedures.....	42
4.1	General	42
4.2	Classes of LLC (conformance clause)	43
4.3	Support of route determination entity (RDE) (conformance clause).....	45
5.	LLC elements of procedure	46
5.1	General	46
5.2	Control field formats.....	46
5.3	Control field parameters.....	47
5.4	Commands and responses	50
6.	LLC description of the Type 1 procedures	62
6.1	Mode of operation	62
6.2	Procedure for addressing.....	62
6.3	Procedure for the use of the P/F bit.....	62
6.4	Procedures for logical data link setup and disconnection	62
6.5	Procedures for information transfer	62
6.6	Uses of the XID command PDU and response PDU	63
6.7	Uses of the TEST command PDU and response PDU.....	63
6.8	List of logical data link parameters.....	64
6.9	Precise description of the Type 1 procedures	64
7.	LLC description of the Type 2 procedures	73
7.1	Modes.....	73
7.2	Procedure for addressing.....	74
7.3	Procedures for the use of the P/F bit	74

7.4	Procedures for data link setup and disconnection	74
7.5	Procedures for information transfer	76
7.6	Procedures for resetting	80
7.7	FRMR exception conditions	81
7.8	List of data link connection parameters	82
7.9	Precise description the Type 2 procedures.....	83
8.	LLC description of the Type 3 procedures	115
8.1	Modes of operation	115
8.2	Procedure for addressing.....	115
8.3	Procedure for the use of the P/F bit.....	115
8.4	Procedures for link setup and disconnection.....	115
8.5	Procedures for information transfer	116
8.6	List of logical link parameters	119
8.7	Precise description of Type 3 procedures	121
9.	LLC RDE procedures	130
9.1	Overview of RDE.....	130
9.2	Support of the LLC service	130
9.3	Principles of operation	135
9.4	Encoding of RDE PDUs	139
9.5	Encoding of the routing information field (RIF).....	140
9.6	RDE route control process	140
9.7	The route determination component (RDC)	147
10.	LLC sublayer managed objects.....	154
10.1	LLCStation managed object.....	155
10.2	ILCSAP managed object.....	162
10.3	LLCConnectionless managed object	163
10.4	LLCConnection2 managed object	167
10.5	LLCConnection2IVMO managed object.....	180
10.6	LLCConnectionlessAck managed object.....	181
10.7	LLCConnectionlessAckIVMO managed object	188
10.8	RDE setup managed object	189
10.9	1RDE pair managed object	191
10.10	Resource Type ID managed object	193
10.11	Conformance.....	194
10.12	ASN.1 LLCDefinitions	194

ANNEX

Annex A	(normative) Protocol Implementation Conformance Statement (PICS) proforma	199
Annex B	(informative) Relationship between LLC Type 3 and PROWAY (IEC 60955 : 1989).....	223
Annex C	(informative) LLC flow control techniques for bridged LANs	228
Annex D	(informative) Subnetwork access protocol support	230
Annex E	(normative) Allocation of object identifier values.....	231

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

Part 2: Logical Link Control

1. Overview

1.1 Scope and purpose

This International Standard is one of a set of international standards produced to facilitate the interconnection of computers and terminals on a Local Area Network (LAN). It is related to the other international standards by the Reference Model for Open Systems Interconnection (OSI).

NOTE—The exact relationship of the layers described in this International Standard to the layers defined by the OSI Reference Model is under study.

This International Standard describes the functions, features, protocol, and services of the Logical Link Control (LLC) sublayer in the ISO/IEC 8802 LAN Protocol. The LLC sublayer constitutes the top sublayer in the data link layer (see figure 1) and is common to the various medium access methods that are defined and supported by the ISO/IEC 8802 activity. Separate International Standards describe each medium access method individually and indicate the additional features and functions that are provided by the Medium Access Control (MAC) sublayer in each case to complete the functionality of the data link layer as defined in the LAN architectural reference model.

This International Standard describes the LLC sublayer service specifications to the network layer (Layer 3), to the MAC sublayer, and to the LLC sublayer management function. The service specification to the network layer provides a description of the various services that the LLC sublayer, plus underlying layers and sublayers, offer to the network layer, as viewed from the network layer. The service specification to the MAC sublayer provides a description of the services that the LLC sublayer requires of the MAC sublayer. These services are defined so as to be independent of the form of the medium access methodology, and of the nature of the medium itself. The service specification to the LLC sublayer management function provides a description of the management services that are provided to the LLC sublayer. All of the above service specifications are given in the form of primitives that represent in an abstract way the logical exchange

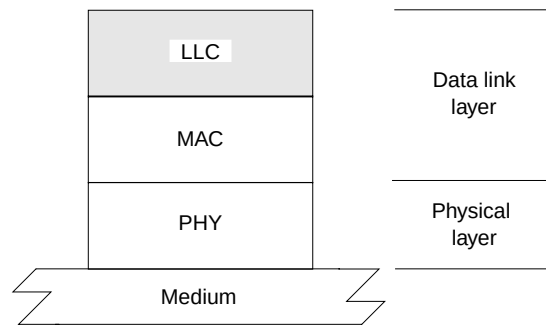


Figure 1—Relationship to LAN reference model

of information and control between the LLC sublayer and the identified service function (network layer, MAC sublayer, or LLC sublayer management function). They do not specify or constrain the implementation of entities or interfaces.

This International Standard provides a description of the peer-to-peer protocol procedures that are defined for the transfer of information and control between any pair of data link layer service access points on a LAN. The LLC procedures are independent of the type of medium access method used in the particular LAN.

To satisfy a broad range of potential applications, three types of data link control operation are included (see clause 4). The first type of operation (see clause 6) provides a data-link-connectionless-mode service across a data link with minimum protocol complexity. This type of operation may be useful when higher layers provide any essential recovery and sequencing services so that these do not need replicating in the data link layer. In addition, this type of operation may prove useful in applications where it is not essential to guarantee the delivery of every data link layer data unit. This type of service is described in this International Standard in terms of “logical data links.” The second type of operation (see clause 7) provides a data-link-connection-mode service across a data link comparable to existing data link control procedures provided in International Standards such as HDLC (see ISO/IEC 13239 : 1997¹). This service includes support of sequenced delivery of data link layer data units, and a comprehensive set of data link layer error recovery techniques. This second type of service is described in this International Standard in terms of “data link connections.” The third type of operation (see clause 8) provides an acknowledged-connectionless-mode data unit exchange service, which permits a station to both send data and request the return of data at the same time. Although the exchange service is connectionless, in-sequence delivery is guaranteed for data sent by the initiating station.

This International Standard identifies four distinct “classes” of LLC operation. Class I provides data-link-connectionless-mode service only. Class II provides data-link-connection-mode service plus data-link-connectionless-mode service. Class III provides acknowledged-connectionless-mode service plus data-link-connectionless-mode service. Class IV provides acknowledged-connectionless-mode service plus data-link-connection-mode service plus data-link-connectionless-mode service. Any one of these classes of operation may be supported.

The basic protocols described herein are peer protocols for use in multistation, multiaccess environments. Because of the multistation, multiaccess environment, it shall be possible for a station to be involved in a multiplicity of peer protocol data exchanges with a multiplicity of different stations over a multiplicity of different logical data links and/or data link connections that are carried by a single physical layer (PHY) over a single physical medium. Each unique to-from pairing at the data link layer shall define a separate logical

¹Information about references can be found in 1.3.

data link or data link connection with separate logical parameters and variables. Except where noted, the procedures described shall relate to each data link layer logical data link or data link connection separately and independently from any other logical data link or data link connection that might exist at the stations involved.

ISO/IEC 10038 : 1993, annex C, provides additional services to allow the MAC service user the ability to determine and use multiple routes through a bridged LAN. This International Standard specifies the provision for an optional Route Determination Entity (RDE) within the LLC sublayer. This entity provides for the discovery and selection of a path (bridged route) for each required data link through the bridged LAN. It does not preclude the LLC service user from providing its own method of discovery and selection of routes.

To evaluate conformance of a particular implementation, it is necessary to have a statement of which capabilities and options have been implemented. Such a statement is called a Protocol Implementation Conformance Statement (PICS), as defined in ISO/IEC 9646-1 : 1994. This International Standard provides such a PICS proforma (Annex A) in compliance with the relevant requirements, and in accordance with the relevant guidance given in ISO/IEC 9646-2 : 1994.

1.2 Standards compatibility

The peer protocol procedures defined in clause 5 utilize some of the concepts and principles, as well as commands and responses, of the balanced data link control procedures known as Asynchronous Balanced Mode (ABM), as defined in ISO/IEC 13239 : 1997. (The ABM procedures provided the basis upon which the ITU-T Recommendation X.25 Level 2 LAPB procedures were defined.) The frame structure defined for the data link layers procedures as a whole is defined in part in clause 3 of this International Standard and in part in those International Standards that define the various MAC procedures. The combination of a MAC sublayer address and an LLC sublayer address is unique to each data link layer service access point in the LAN.

NOTE—This division of data link layer addressing space into separate MAC and LLC address fields is not presently a part of any present ISO data link layer International Standard.

The RDE procedures defined in clause 9 utilize some of the concepts and principles as defined in ISO/IEC 10038 : 1993, annex C.

1.3 Normative references

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

IEC 60955 : 1989, Process data highway, Type C (PROWAY C), for distributed process control systems.²

ISO/IEC 7498-1 : 1994, Information technology—Open Systems Interconnection—Basic Reference Model—The Basic Model.³

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

²IEC publications are available from IEC Sales Department, Case Postale 131, 3 rue de Varembe, 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.

³ISO and ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. ISO and ISO/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.

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

ISO/IEC 8886 : 1996, Information technology—Open Systems Interconnection—Data link service definition.

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 9646-1 : 1994, Information technology—Open Systems Interconnection—Conformance testing methodology and framework—Part 1: General concepts.

ISO/IEC 9646-2 : 1994, Information technology—Open Systems Interconnection—Conformance testing methodology and framework—Part 2: Abstract Test Suite specification.

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.⁴

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 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.

⁴This 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.

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

ISO/IEC TR 10171 : 1994, Information technology—Telecommunications and information exchange between systems—List of standard data link layer protocols that utilize high-level data link control (HDLC) classes of procedures and list of standardized XID format identifiers and private parameter set identification values.

ISO/IEC 10742 : 1994, Information technology—Telecommunications and information exchange between systems—Elements of management information related to OSI Data Link Layer standards.

ISO/IEC 11575 : 1995, Information technology—Telecommunications and information exchange between systems—Protocol mappings for the OSI Data Link service.

ISO/IEC 13239 : 1997, Information technology—Telecommunications and information exchange between systems—High-level data link control (HDLC) procedures.

ITU-T Recommendation X.25, 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.⁵

ITU-T Recommendation X.200, Reference model on open systems interconnection for CCITT applications.

1.4 Acronyms and definitions

1.4.1 Acronyms and abbreviations

ABM	Asynchronous Balanced Mode
ACK	ACKnowledge
ADM	Asynchronous Disconnected Mode
ARE	All Routes Explorer
C	Command
C/R	Command/Response
DA	Destination Address
DCE	Data Circuit-terminating Equipment
DISC	DISConnect
DL	Data Link
DLE	Data Link Entity
DM	Disconnected Mode
DSAP	Destination Service Access Point
DTE	Data Terminal Equipment
F	Final
FCS	Frame Check Sequence
FRMR	FRaMe Reject
HDLC	High-level Data Link Control
I	Information
I	Information transfer format
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization

⁵All ITU-T 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	International Telecommunications Union—Telecommunications
LAN	Local Area Network
LAPB	Link Access Procedure, Balanced
LLC	Logical Link Control
LSAP	Link Service Access Point
LSB	Least Significant Bit
LSDU	Link layer Service Data Unit
M	Modifier function bit
MAC	Medium Access Control
MO	Managed Object
N(R)	Receive sequence Number
N(S)	Send sequence Number
NSR	Non Source Routed
OSI	Open Systems Interconnection
P	Poll
PDU	Protocol Data Unit
P/F	Poll/Final
PHY	PHYsical
R	Response
RCC	Route Control Component
RDC	Route Determination Component
RDE	Route Determination Entity
REJ	Reject
RIF	Routing Information Field
RII	Routing Information Indicator
RNR	Receive Not Ready
RQ	Route Query
RQC	Route Query Command
RQR	Route Query Response
RR	Receive Ready
RS	Route Selected
RSC	Route Selected Command
S	Supervisory format
S	Supervisory function bit
SA	Source Address
SABME	Set Asynchronous Balanced Mode Extended
SAP	Service Access Point
SRF	Specifically Routed Frame
SRT	Source Routing Transparent (bridge)
SSAP	Source Service Access Point
STE	Spanning Tree Explorer
STR	Spanning Tree Route
TEST	Test
TRR	Timer, Route Response
TRS	Timer, Route Select
U	Unnumbered format
UA	Unnumbered Acknowledgment
UI	Unnumbered Information
V(R)	Receive state Variable
V(S)	Send state Variable
XID	eXchange IDentification

Within the Managed Object definitions and GDMO templates, the following abbreviations are used in the standard-name element of a document identifier when making references to other documents.

DMI	CCITT Rec.X.721 (1992) ISO/IEC 10165-2 : 1992
GMI	CCITT Rec.X.723 (1992) ISO/IEC 10165-5 : 1994
DML	ISO/IEC 10742 : 1994

1.4.2 Definitions

For the purpose of this International Standard, the following definitions shall apply:

1.4.2.1 accept: The condition assumed by an LLC upon accepting a correctly received PDU for processing.

1.4.2.2 address fields (DSAP and SSAP): The ordered pair of service access point (SAP) addresses at the beginning of an LLC PDU that identifies the LLC(s) designated to receive the protocol data unit (PDU) and LLC sending the PDU. Each address field is one octet in length.

1.4.2.3 all routes explorer (ARE): A frame that traverses every path and combination of paths through a bridged network.

1.4.2.4 basic status: The capability of an LLC to send or receive a PDU containing an information field.

1.4.2.5 command: In data communications, an instruction represented in the control field of a PDU and sent by an LLC. It causes the addressed LLC(s) to execute a specific data link control function.

1.4.2.6 command PDU: All PDUs sent by an LLC in which the C/R bit in the SSAP address field is equal to “0”.

1.4.2.7 control field (C): The field immediately following the DSAP and SSAP address fields of a PDU. The content of the control field is interpreted by the receiving destination LLC(s) designated by the DSAP address field:

- 1) As a command, from the source LLC designated by the SSAP address field, instructing the performance of some specific function; or
- 2) As a response, from the source LLC designated by the SSAP address field.

1.4.2.8 data link: An assembly of two or more terminal installations and the interconnecting communications channel operating according to a particular method that permits information to be exchanged; in this context the term *terminal installation* does not include the data source and the data sink.

1.4.2.9 data link layer: The conceptual layer of control or processing logic existing in the hierarchical structure of a station that is responsible for maintaining control of the data link. The data link layer functions provide an interface between the station higher layer logic and the data link. These functions include address/control field interpretation, channel access and command PDU/response PDU generation, sending, and interpretation.

1.4.2.10 descriptor: The portion of the routing information field that indicates the individual segment and bridge of the network path. A series of descriptors therefore describe a path through the network.

1.4.2.11 exception condition: The condition assumed by an LLC upon receipt of a command PDU that it cannot execute due to either a transmission error or an internal processing malfunction.

1.4.2.12 global (broadcast) DSAP address: The predefined LLC DSAP address (all ones) used as a broadcast (all parties) address. It can never be the address of a single LLC on the data link.

1.4.2.13 group (multicast) DSAP address: A destination address assigned to a collection of LLCs to facilitate their being addressed collectively. The least significant bit shall be set equal to “1”.

1.4.2.14 higher layer: The conceptual layer of control or processing logic existing in the hierarchical structure of a station that is above the data link layer and upon which the performance of data link layer functions are dependent; for example, device control, buffer allocation, LLC station management, etc.

1.4.2.15 information field: The sequence of octets occurring between the control field and the end of the LLC PDU. The information field contents of I, TEST, and UI PDUs are not interpreted at the LLC sublayer.

1.4.2.16 invalid frame: A PDU that either

- 1) Does not contain an integral number of octets,
- 2) Does not contain at least two address octets and a control octet, or
- 3) Is identified by the physical layer or MAC sublayer as containing data bit errors.

1.4.2.17 LLC: That part of a data station that supports the logical link control functions of one or more logical links. The LLC generates command PDUs and response PDUs for sending and interprets received command PDUs and response PDUs. Specific responsibilities assigned to an LLC include

- 1) Initiation of control signal interchange,
- 2) Organization of data flow,
- 3) Interpretation of received command PDUs and generation of appropriate response PDUs, and
- 4) Actions regarding error control and error recovery functions in the LLC sublayer.

1.4.2.18 MAC: That part of a data station that supports the medium access control functions that reside just below the LLC sublayer. The MAC procedures include framing/deframing data units, performing error checking, and acquiring the right to use the underlying physical medium.

1.4.2.19 N-layer: A subdivision of the architecture, constituted by subsystems of the same rank (N).

1.4.2.20 N-user: An N+1 entity that uses the services of the N-layer, and below, to communicate with another N+1 entity.

1.4.2.21 non-source routed (NSR): Indicates that the frame does not make use of a routing information field (i.e., the RIF is null and the RII is not set).

1.4.2.22 octet: A bit-oriented element that consists of eight contiguous binary bits.

1.4.2.23 path: A bridged route between a source and a destination.

1.4.2.24 peer protocol: The sequence of message exchanges between two entities in the same layer that utilize the services of the underlying layers to effect the successful transfer of data and/or control information from one location to another location.

1.4.2.25 priority (use in primitives): A parameter used to convey the priority required or desired.

1.4.2.26 protocol data unit (PDU): The sequence of contiguous octets delivered as a unit to the MAC sublayer or received as a unit from the MAC sublayer. A valid LLC PDU is at least 3 octets in length, and contains two address fields and a control field. A PDU may or may not include an information field in addition.

1.4.2.27 protocol type (PTYPE): A field in the RDE PDU information field that describes the protocol function of the PDU.

1.4.2.28 remote MAC (RMAC): The MAC component at the remote end of the data link as specified by its unique 48-bit address.

1.4.2.29 remote SAP (RSAP): The SAP at the remote end of a data link as specified by its LLC address.

1.4.2.30 response: In data communications, a reply represented in the control field of a response PDU. It advises the addressed destination LLC of the action taken by the source LLC to one or more command PDUs.

1.4.2.31 response PDU: All PDUs sent by a LLC in which the C/R bit in the SSAP address field is equal to “1”.

1.4.2.32 route: Denotes the information employed to generate routing information. It becomes a routing_information parameter when placed in the MAC primitive. The route explicitly describes the path a frame takes through a bridged network.

1.4.2.33 route query (RQ): An RDE PDU used to explore possible paths between two stations developing a data link. The route query consists of a command PDU (RQC) and a response PDU (RQR).

1.4.2.34 route selected (RS): An RDE PDU used to announce the selection of a path between two stations developing a data link.

1.4.2.35 routing information: The data that explicitly describes the route a frame takes through a bridged network. The routing_information parameter is included in the MA_UNITDATA request and MA_UNITDATA indication MAC primitives.

1.4.2.36 routing information field (RIF): Denotes the routing information field of the source-routed frame format.

1.4.2.37 routing information indicator (RII): An indication that the frame format contains a routing information field (RIF).

1.4.2.38 service: The capabilities and features provided by an N-layer to an N-user.

1.4.2.39 service class (use in primitives): A parameter used to convey the class of service required or desired.

1.4.2.40 source routing: The capability for a source to specify the path that a frame will use to traverse the bridged network.

1.4.2.41 Source Routing Transparent (SRT): The bridging technology defined by ISO/IEC 10038 : 1993, annex C, as an extension to the transparent bridging rules allowing the source station to specify the path through the bridged network (source routing).

1.4.2.42 spanning tree explorer (STE): A type of source-routed frame that will traverse the network following the spanning tree path created by the transparent bridging rules.

1.4.2.43 spanning tree route (STR): A term used to denote the configuration of transparent bridges such that every segment is connected to the root of the network through exactly one path. A frame sent without routing information (NSR) traverses the network on the spanning tree path according to the rules for transparent bridging. A frame sent with a routing type of STE is forwarded through the network on the spanning tree path, but is forwarded by the rules for SRT bridges (note that a bridge that does not support source routing will not forward STE frames).

1.4.2.44 specifically routed frame (SRF): A frame sent with a routing information field that describes the exact path that the frame will take through the bridged network.

This International Standard uses the following term as defined in ISO/IEC 9646-1 : 1994:

- Protocol implementation conformance statement (PICS) proforma

1.4.3 Basic reference model

This part of ISO/IEC 8802 makes use of the following terms defined in ISO/IEC 7498-1 : 1994:

- Data Link layer
- Open system
- (N)-entity
- (N)-protocol
- (N)-service access point

1.4.4 Management framework

This part of ISO/IEC 8802 makes use of the following term defined in ISO/IEC 7498-4 : 1989:

- Managed object

1.4.5 Systems management overview

This part of ISO/IEC 8802 makes use of the following terms defined in ISO/IEC 10040 : 1992:

- Managed object class
- Notification

1.4.6 Common management information service definition

This part of ISO/IEC 8802 makes use of the following term defined in ISO/IEC 9595 : 1991:

- Attribute

1.4.7 Information model

This part of ISO/IEC 8802 makes use of the following terms defined in ISO/IEC 10165-1 : 1993:

- Attribute type
- Behaviour
- Containment
- Distinguished name
- Inheritance
- Name binding
- Package
- Parameter
- Relative distinguished name
- Subclass
- Superclass

1.4.8 Guidelines for the definition of managed objects

This part of ISO/IEC 8802 makes use of the following terms defined in ISO/IEC 10165-4 : 1992:

- Managed object class definition
- Template
- Parameter

1.5 Conformance

1.5.1 Static conformance

1.5.1.1 General requirements

An implementation that claims conformance to this International Standard shall implement the following:

- a) LLC Type 1 operation as specified in 6.9.

1.5.1.2 Optional requirements

An implementation that claims conformance to this International Standard may implement any of the following options:

- a) LLC Type 2 operation, or LLC Type 3 operation, or LLC Type 2 operation and LLC Type 3 operation. LLC Type 2 operation is specified in 7.9, and LLC Type 3 operation is specified in 8.7, or
- b) The flow control technique as specified in annex B, or
- c) Initiation of the Duplicate Address Check procedure as specified in 6.9, or
- d) Initiation of the TEST function as specified in 6.7, or
- e) The RDE as specified in clause 9.

1.5.2 Dynamic conformance

For each function that the PICS states to be supported, the implementation shall exhibit behavior consistent with the implementation of the following:

- a) The corresponding data link layer procedures, and
- b) The encoding of any transmitted frames

as specified in the clauses to which the PICS proforma entry for the function refers.

1.5.3 PICS proforma

The supplier of a protocol implementation that is claimed to conform to this International Standard shall complete a copy of the PICS proforma in annex A, including the information necessary to identify fully both the supplier and the implementation.

2. LLC sublayer service specifications

2.1 General

This clause covers the services required of, or by, the LLC sublayer at the logical interfaces with the network layer, the MAC sublayer, and the LLC sublayer management function.

In general, the services of a layer (or sublayer) are the capabilities it offers to a user in the next higher layer (or sublayer). In order to provide its service, a layer (or sublayer) builds its functions on the services it requires from the next lower layer (or sublayer). Figure 2 illustrates this notion of service hierarchy and shows the relationship of the two correspondent N-users and their associated N-layer (or sublayer) peer protocol entities.

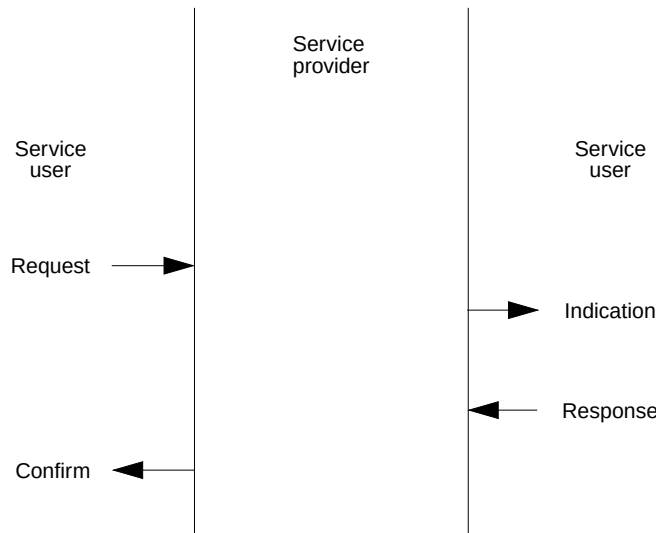


Figure 2—Service primitives

Services are specified by describing the information flow between the N-user and the N-layer (or sublayer). This information flow is modeled by discrete, instantaneous events, which characterize the provision of a service. Each event consists of passing a service primitive from one layer (or sublayer) to the other through an N-layer (or sublayer) service access point associated with an N-user. Service primitives convey the information required in providing 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 service is independent of any particular interface implementation.

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.

Primitives are of four generic types:

- 1) **REQUEST:** The request primitive is passed from the N-user to the N-layer (or sublayer) to request that a service be initiated.
- 2) **INDICATION:** The indication primitive is passed from the N-layer (or sublayer) to the N-user to indicate an internal N-layer (or sublayer) event that is significant to the N-user. This event may be logically related to a remote service request, or may be caused by an event internal to the N-layer (or sublayer).

- 3) **RESPONSE:** The response primitive is passed from the N-user to the N-layer (or sublayer) to complete a procedure previously invoked by an indication primitive.
- 4) **CONFIRM:** The confirm primitive is passed from the N-layer (or sublayer) to the N-user to convey the results of one or more associated previous service request(s).

Possible relationships among primitive types are illustrated by the time-sequence diagrams shown in figure 3. The figure also indicates the logical relationship of the primitive types. Primitive types that occur earlier in time and are connected by dotted lines in the diagrams are the logical antecedents of subsequent primitive types.

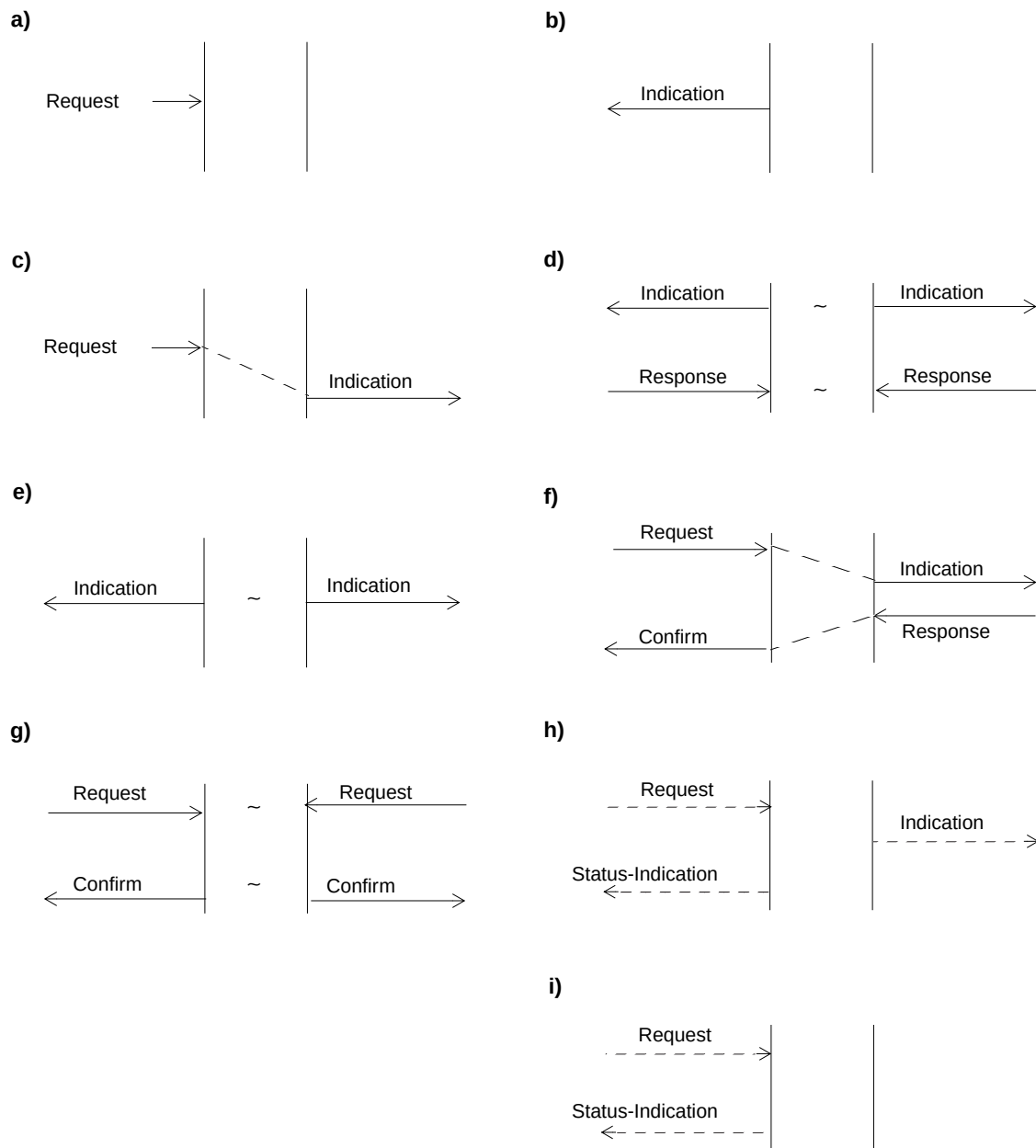


Figure 3—Time-sequence diagrams

2.2 Network layer/LLC sublayer interface service specification

This subclause specifies the services required of the LLC sublayer by the network layer, as viewed from the network layer, to allow a local network layer entity to exchange packets with remote peer network layer entities. The services are described in an abstract way and do not imply any particular implementation or any exposed interface.

Three forms of service are provided: *unacknowledged connectionless-mode*, *connection-mode*, and *acknowledged connectionless-mode*.

- 1) **Unacknowledged connectionless-mode services:** This set of data transfer services provides the means by which network entities can exchange link service data units (LSDUs) without the establishment of a data link level connection. The data transfer can be point-to-point, multicast, or broadcast.
- 2) **Connection-mode services:** This set of services provides the means for establishing, using, resetting, and terminating data link layer connections. These connections are point-to-point connections between LSAPs.
 - a) The *connection establishment service* provides the means by which a network entity can request, or be notified of, the establishment of data link layer connections.
 - b) The *connection-oriented data transfer service* provides the means by which a network entity can send or receive LSDUs over a data link layer connection. This service also provides data link layer sequencing, flow control, and error recovery.
 - c) The *connection reset service* provides the means by which established connections can be returned to the initial state.
 - d) The *connection termination service* provides the means by which a network entity can request, or be notified of, the termination of data link layer connections.
 - e) The *connection flow control service* provides the means to control the flow of data associated with a specified connection, across the network layer/data link layer interface.
- 3) **Acknowledged connectionless-mode services:** The acknowledged connectionless-mode data unit exchange services provide the means by which network layer entities can exchange link service data units (LSDUs) that are acknowledged at the LLC sublayer, without the establishment of a data link connection. The services provide a means by which a network layer entity at one station can send a data unit to another station, request a previously prepared data unit from another station, or exchange data units with another station. The data unit transfer is point-to-point.

2.2.1 Overview of interactions

2.2.1.1 Unacknowledged connectionless-mode services

2.2.1.1.1 Unacknowledged connectionless-mode data transfer

The primitives associated with unacknowledged connectionless-mode data transfer are as follows:

- DL-UNITDATA request
- DL-UNITDATA indication

The DL-UNITDATA request primitive is passed to the LLC sublayer to request that an LSDU be sent using unacknowledged connectionless-mode procedures. The DL-UNITDATA indication primitive is passed from the LLC sublayer to indicate the arrival of an LSDU.

2.2.1.2 Connection-mode services

2.2.1.2.1 Connection establishment

The primitives associated with connection establishment are as follows:

- DL-CONNECT request
- DL-CONNECT indication
- DL-CONNECT response
- DL-CONNECT confirm

The DL-CONNECT request primitive is passed to the LLC sublayer to request that a data link connection be established between a local LSAP and a remote LSAP. The DL-CONNECT indication primitive is passed from the LLC sublayer to indicate the request by a remote entity to establish a connection to a local LSAP. The DL-CONNECT response primitive is passed to the LLC sublayer to signal acceptance of a connection. The DL-CONNECT confirm primitive is passed from the LLC sublayer to convey the results of the previous associated DL-CONNECT request primitive.

2.2.1.2.2 Connection-mode data transfer

The primitive associated with connection-mode data transfer are as follows:

- DL-DATA request
- DL-DATA indication

The DL-DATA request primitive is passed to the LLC sublayer to request that an LSDU be sent using connection-mode procedures. The DL-DATA indication primitive is passed from the LLC sublayer to indicate the arrival of an LSDU.

2.2.1.2.3 Connection termination

The primitives associated with connection termination are as follows:

- DL-DISCONNECT request
- DL-DISCONNECT indication

The DL-DISCONNECT request primitive is passed to the LLC sublayer to request the immediate termination of a data link connection. The DL-DISCONNECT indication primitive is passed from the LLC sublayer to indicate to the network that a connection has been terminated.

2.2.1.2.4 Connection reset

The primitives associated with connection resetting are as follows:

- DL-RESET request
- DL-RESET indication
- DL-RESET response
- DL-RESET confirm

The DL-RESET request primitive is passed to the LLC sublayer to request that a connection be immediately reset to the initial state. The DL-RESET indication primitive is passed from the LLC sublayer to indicate a connection reset attempt by either a remote entity or the local LLC sublayer. The DL-RESET response primitive is passed to the LLC sublayer to signal acceptance of the reset condition. The DL-RESET confirm

primitive is passed from the LLC sublayer to convey the results of the previous associated DL-RESET request primitive.

2.2.1.2.5 Connection flow control

The primitives associated with connection flow control are as follows:

- DL-CONNECTION-FLOWCONTROL request
- DL-CONNECTION-FLOWCONTROL indication

The DL-CONNECTION-FLOWCONTROL request primitive is passed to the LLC sublayer to control the flow from the LLC sublayer of DL-DATA indication primitives related to a connection. The DL-CONNECTION-FLOWCONTROL indication primitive is passed from the LLC sublayer to control the flow from the network layer of DL-DATA request primitives related to a connection.

2.2.1.3 Acknowledged connectionless-mode services

2.2.1.3.1 Acknowledged connectionless-mode data unit transmission service

The primitives associated with the acknowledged connectionless-mode data unit transmission service are as follows:

- DL-DATA-ACK request
- DL-DATA-ACK indication
- DL-DATA-ACK-STATUS indication

The DL-DATA-ACK request primitive is passed to the LLC sublayer to request that an LSDU be sent to a remote LLC using acknowledged connectionless-mode data unit transmission procedures. The DL-DATA-ACK indication primitive is passed from the LLC sublayer to indicate the arrival of a command PDU except in the case where this PDU is used only for resynchronization. The DL-DATA-ACK-STATUS indication primitive is passed from the LLC sublayer to convey the results of the previous associated DL-DATA-ACK request primitive.

2.2.1.3.2 Acknowledged connectionless-mode data unit exchange service

The primitives associated with the acknowledged connectionless-mode data unit exchange service are as follows:

- DL-REPLY request
- DL-REPLY indication
- DL-REPLY-STATUS indication

The DL-REPLY request primitive is passed to the LLC sublayer to request that an LSDU be returned from a remote station or that LSDUs be exchanged between stations using acknowledged connectionless-mode data unit exchange procedures. The DL-REPLY indication primitive is passed from the LLC sublayer to indicate the arrival of a command PDU. The DL-REPLY-STATUS indication primitive is passed from the LLC sublayer to convey the results of the previous associated DL-REPLY request primitive.

2.2.1.3.3 Reply data unit preparation

The primitives associated with reply data unit preparation are as follows:

- DL-REPLY-UPDATE request
- DL-REPLY-UPDATE-STATUS indication

The DL-REPLY-UPDATE request primitive is passed to the LLC sublayer with an LSDU to be held by LLC and sent out at a later time when requested to do so by some other station. The DL-REPLY-UPDATE-STATUS indication primitive is passed from the LLC sublayer to convey the results of the previous associated DL-REPLY request primitive.

2.2.2 Detailed service specifications

This subclause describes in detail the primitives and parameters associated with the identified services. Note that the parameters are specified in an abstract sense. The parameters specify the information that must be available to the receiving entity. A specific implementation is not constrained in the method of making this information available.

The “source_address” and “destination_address” parameters provide at a minimum the logical concatenation of the MAC address field (SA and/or DA) and the LLC address field (SSAP and/or DSAP). An implementation of connection-mode services may make use of a locally significant connection identifier to imply source and destination address parameters. The “data” parameter may be provided by actually passing the link service data unit, by passing a pointer, or by other means. The “priority” parameter provides the priority associated with the data unit transfer. The “priority” parameter is passed transparently to the underlying MAC sublayer via the appropriate LLC/MAC primitives; see 2.3. The “reason” parameter provides an explanation of the disconnection, including a request by the remote entity, or an error internal to the LLC sublayer. The “amount” parameter provides information regarding the amount of data that the LLC entity is allowed to pass. The “service_class” parameter indicates whether or not an acknowledge capability in MAC sublayer is to be used for the data unit transfer. The “status” parameter indicates the success or failure of the previous associated data unit transfer request.

2.2.2.1 DL-UNITDATA request

2.2.2.1.1 Function

This primitive is the service request primitive for the unacknowledged connectionless-mode data transfer service.

2.2.2.1.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-UNITDATA request (
    source_address,
    destination_address,
    data,
    priority
)
```

The source_address and destination_address parameters specify the local and remote LSAPs involved in the data unit transfer. The destination_address may specify either an individual or group address. The data parameter specifies the link service data unit to be transferred by the data link layer entity. The priority parameter specifies the priority desired for the data unit transfer.

2.2.2.1.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request that an LSDU be sent to one or more remote LSAP(s) using unacknowledged connectionless-mode procedures.

2.2.2.1.4 Effect on receipt

Receipt of this primitive causes the LLC sublayer to attempt to send the LSDU using unacknowledged connectionless-mode procedures.

2.2.2.1.5 Additional comments

This primitive is independent of any connection with the remote LSAP. A possible logical sequence of primitive associated with successful unacknowledged connectionless-mode data unit transfer is illustrated in figure 3, item (c).

2.2.2.2 DL-UNITDATA indication

2.2.2.2.1 Function

This primitive is the service indication primitive for the unacknowledged connectionless-mode data unit transfer service.

2.2.2.2.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-UNITDATA indication (
    source_address,
    destination_address,
    data,
    priority
)
```

The `source_address` and `destination_address` parameters specify, respectively, the remote and local LSAPs involved in the data unit transfer. The destination address may be the address of a local LSAP, or may be a group address specifying multiple LSAPs, including a local LSAP. The data parameter specifies the link service data unit that has been received by the LLC sublayer entity. The priority parameter specifies the priority desired for the data unit transfer.

2.2.2.2.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate the arrival of an LSDU from the specified remote entity.

2.2.2.2.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.2.5 Additional comments

This primitive is independent of any connection within the remote LSAP. In the absence of errors, the contents of the data parameter are logically complete and unchanged relative to the data parameter in the associated DL-UNITDATA request primitive.

2.2.2.3 DL-CONNECT request

2.2.2.3.1 Function

This primitive is the service request primitive for the connection establishment service.

2.2.2.3.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-CONNECT request (
    source_address,
    destination_address,
    priority
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs that are to be connected. The `priority` parameter specifies the priority desired for the connection.

2.2.2.3.3 When generated

This primitive is passed from the network layer to the LLC sublayer when the network layer entity wishes to establish a logical link connection, of a given priority, to a remote LSAP.

2.2.2.3.4 Effect on receipt

The receipt of this primitive by the LLC sublayer causes the local LLC entity to initiate the establishment of a logical link connection with the remote LLC entity.

2.2.2.3.5 Additional comments

A possible logical sequence of primitives associated with successful connection establishment is illustrated in figure 3, item (f).

2.2.2.4 DL-CONNECT indication

2.2.2.4.1 Function

This primitive is the service indication primitive for the connection establishment service.

2.2.2.4.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-CONNECT indication (
    source_address,
    destination_address,
    priority
)
```

The `source_address` and `destination_address` parameters specify the remote and local LSAPs that are to be connected. The `priority` parameter indicates the priority desired for the connection.

2.2.2.4.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate that a connection of a certain priority is being requested.

2.2.2.4.4 Effect on receipt

The network layer entity shall issue either a DL-CONNECT response primitive to accept the connection, or a DL-DISCONNECT request primitive to refuse the connection.

2.2.2.4.5 Additional comments

None.

2.2.2.5 DL-CONNECT response

2.2.2.5.1 Function

This primitive is the service response primitive for the connection establishment service.

2.2.2.5.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-CONNECT response (
    source_address,
    destination_address,
    priority
)
```

The source_address and destination_address parameters specify the local and remote LSAPs that are to be connected. The priority parameter indicates the priority provided for the connection.

2.2.2.5.3 When generated

This primitive is passed from the network layer to the LLC sublayer to indicate acceptance of the requested connection.

2.2.2.5.4 Effect on receipt

The receipt of this primitive by the LLC sublayer causes the local LLC entity to accept a logical link connection with the remote LLC entity.

2.2.2.5.5 Additional comments

The network layer entity can return the same priority as given in the DL-CONNECT indication primitive or it may select a lower priority. After returning a DL-CONNECT response primitive, the network layer entity assumes that the connection is established.

2.2.2.6 DL-CONNECT confirm

2.2.2.6.1 Function

This primitive is the service confirm primitive for the connection establishment service.

2.2.2.6.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-CONNECT confirm (
    source_address,
    destination_address,
    priority
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs that are to be connected. The `priority` parameter indicates the priority provided for the connection.

2.2.2.6.3 When generated

This primitive is passed by the LLC sublayer to the network layer to convey the results of the previous associated DL-CONNECT request primitive. The results indicate that the connection attempt was successful, and specify the priority obtained.

2.2.2.6.4 Effect on receipt

The network layer entity may use this connection for data unit transfer.

2.2.2.6.5 Additional comments

This primitive indicates that the remote network layer entity received and accepted the connection attempt.

2.2.2.7 DL-DATA request

2.2.2.7.1 Function

This primitive is the service request primitive for the connection-mode data unit transfer service.

2.2.2.7.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-DATA request (
    source_address,
    destination_address,
    data
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection. The `data` parameter specifies the link service data unit to be transferred by the LLC sublayer entity.

2.2.2.7.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request that an LSDU be transferred to a remote LSAP over an existing connection.

2.2.2.7.4 Effect on receipt

The receipt of this primitive by the LLC sublayer causes the LLC sublayer to transfer the LSDU over the specified logical link connection using connection-mode procedures.

2.2.2.7.5 Additional comments

The DL-DATA request primitive does not contain a priority parameter because priority must be uniform for all DL-DATA request primitive in a particular connection.

A possible logical sequence of primitives associated with successful connection-mode data unit transfer is illustrated in figure 3, item (c).

2.2.2.8 DL-DATA indication

2.2.2.8.1 Function

This primitive is the service indication primitive for the connection-mode data unit transfer service.

2.2.2.8.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-DATA indication  (
                    source_address,
                    destination_address,
                    data
                    )
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection. The `data` parameter specifies the link service data unit that has been received by the LLC sublayer entity.

2.2.2.8.3 When generated

This primitive is passed by the LLC sublayer to the network layer to indicate the arrival of an LSDU from the specified remote network layer entity over a particular connection.

2.2.2.8.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.8.5 Additional comments

In the absence of errors, the contents of the `data` parameter are logically complete and unchanged relative to the `data` parameter in the associated DL-DATA request primitive.

2.2.2.9 DL-DISCONNECT request

2.2.2.9.1 Function

This primitive is the service request primitive for the connection termination service.

2.2.2.9.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-DISCONNECT request (
    source_address,
    destination_address
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection to be terminated.

2.2.2.9.3 When generated

This primitive is passed from the network layer to the LLC sublayer when the network layer entity wishes to terminate a connection.

2.2.2.9.4 Effect on receipt

Receipt of this primitive causes the LLC sublayer to immediately terminate the connection.

2.2.2.9.5 Additional comments

All unacknowledged LSDUs are discarded. The connection termination service is an abortive service. That is, no guarantee of delivery can be assumed about data that is not yet acknowledged at a higher layer. Thus, graceful disconnection (i.e., without loss of data) is the responsibility of a higher layer protocol.

A possible logical sequence of primitives associated with successful connection termination is illustrated in figure 3, item (c).

2.2.2.10 DL-DISCONNECT indication

2.2.2.10.1 Function

This primitive is the service indication primitive for the connection termination service.

2.2.2.10.2 Semantics of the service primitive

This primitive shall provide parameters as follows:

```
DL-DISCONNECT indication (
    source_address,
    destination_address,
    reason
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the terminated connection. The `reason` parameter specifies the reason for the disconnection. The reasons for disconnection may include a request by the remote entity, or an error internal to the LLC sublayer.

2.2.2.10.3 When generated

This primitive is passed from the LLC sublayer to the network layer to inform the network layer that a connection has been terminated.

2.2.2.10.4 Effect on receipt

The network entity may no longer use this connection for data unit transfer.

2.2.2.10.5 Additional comments

All unacknowledged LSDUs are discarded. The connection termination service is an abortive service. That is, no guarantee of delivery can be assumed about data that is not yet acknowledged at a higher layer. Thus, graceful disconnection (i.e., without loss of data) is the responsibility of a higher layer protocol.

2.2.2.11 DL-RESET request

2.2.2.11.1 Function

This primitive is the service request primitive for the connection reset service.

2.2.2.11.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-RESET request  (
                    source_address,
                    destination_address
                    )
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection to be reset.

2.2.2.11.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request that a connection be reset to the initial state.

2.2.2.11.4 Effect on receipt

Receipt of this primitive causes immediate resetting of the connection.

2.2.2.11.5 Additional comments

All unacknowledged LSDUs are discarded. The connection reset service is an abortive service. That is, no guarantee of delivery can be assumed about data that is not yet acknowledged at a higher layer. Thus, graceful reset (i.e., without loss of data) is the responsibility of a higher layer protocol.

A possible logical sequence of primitives associated with successful connection reset is illustrated in figure 3, item (f).

2.2.2.12 DL-RESET indication

2.2.2.12.1 Function

This primitive is the service indication primitive for the connection reset service.

2.2.2.12.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-RESET indication  (
                        source_address,
                        destination_address,
                        reason
                      )
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection that is affected. The `reason` parameter specifies the cause for the reset indication primitive. One of the reason codes indicates that a reset was requested by a remote network layer entity or a remote LLC sublayer peer [as shown in figure 3, items (f) and (d), respectively]. All other codes indicate that the local LLC sublayer has detected the need for a connection reset [as shown in figure 3, item (b)].

2.2.2.12.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate either that a connection reset has been requested by the remote network layer entity or remote LLC sublayer peer, or that the local LLC sublayer has determined that the data link connection is in need of reinitialization [as shown in figure 3, item (d)].

2.2.2.12.4 Effect on receipt

For remote reset request, the network layer entity shall issue either a DL-RESET response primitive to signal acceptance of the connection reset, or a DL-DISCONNECT request primitive to terminate the connection. For local reset condition indication, the network layer entity shall issue either a DL-RESET request primitive to reinitialize the connection, or a DL-DISCONNECT request primitive to terminate the connection.

2.2.2.12.5 Additional comments

The reasons for the reset may include a request by the remote entity, or an error condition detected by the local LLC sublayer. All unacknowledged LSDUs are discarded. The connection reset service is an abortive service. That is, no guarantee of delivery can be assumed about data that is not yet acknowledged at a higher layer. Thus, graceful reset (i.e., without loss of data) is the responsibility of a higher layer protocol.

2.2.2.13 DL-RESET response

2.2.2.13.1 Function

This primitive is the service response primitive for the connection reset service.

2.2.2.13.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-RESET response  (
                    source_address,
                    destination_address
                  )
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection that is affected.

2.2.2.13.3 When generated

This primitive is passed by the network layer to the LLC sublayer to indicate acceptance of the connection reset.

2.2.2.13.4 Effect on receipt

The receipt of this primitive by the LLC sublayer causes the local LLC sublayer entity to complete the connection reset.

2.2.2.13.5 Additional comments

All unacknowledged LSDUs are discarded. The connection reset service is an abortive service. That is, no guarantee of delivery can be assumed about data that is not yet acknowledged at a higher layer. Thus, graceful reset (i.e., without loss of data) is the responsibility of a higher layer protocol.

2.2.2.14 DL-RESET confirm

2.2.2.14.1 Function

This primitive is the service confirm primitive for the connection reset service.

2.2.2.14.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-RESET confirm (
    source_address,
    destination_address
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection that is affected.

2.2.2.14.3 When generated

This primitive is passed from the LLC sublayer to the network layer to inform the network layer that a connection reset has been completed.

2.2.2.14.4 Effect on receipt

The network layer entity may use this connection for data unit transfer.

2.2.2.14.5 Additional comments

This primitive indicates that the remote LLC sublayer entity has acknowledged the reset.

2.2.2.15 DL-CONNECTION-FLOWCONTROL request

2.2.2.15.1 Function

This primitive is the service request primitive for the connection flow control service.

2.2.2.15.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-CONNECTION-FLOWCONTROL request (
    source_address,
    destination_address,
    amount
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection to be flow controlled. The `amount` parameter specifies the amount of data the LLC sublayer entity is permitted to pass.

2.2.2.15.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request control of the flow of DL-DATA indication primitives associated with a connection from the LLC sublayer.

2.2.2.15.4 Effect on receipt

Receipt of this primitive causes the LLC sublayer to adjust the amount of data that may be passed to the network layer.

2.2.2.15.5 Additional comments

Control of the flow of data on a connection is independent of control of the flow on other connections. The amount of data permitted to be passed is dynamically updated by each request. If `amount` is specified as zero, then the associated flow is stopped. Specific implementations may allow `amount` to be specified in implementation-specific units, and may allow `amount` to be specified as “infinite.”

A possible logical sequence of primitives associated with a DL-CONNECTION-FLOWCONTROL request is illustrated in figure 3, item (a).

2.2.2.16 DL-CONNECTION-FLOWCONTROL indication

2.2.2.16.1 Function

This primitive is the service indication primitive for the connection flow control service.

2.2.2.16.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-CONNECTION-FLOWCONTROL indication (
    source_address,
    destination_address,
    amount
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs of the connection to be flow controlled. The `amount` parameter specifies the amount of data that the network layer entity is permitted to pass to avoid data loss.

2.2.2.16.3 When generated

This primitive is passed from the LLC sublayer to the network layer to request control of the flow of DL-DATA request primitive associated with a connection from the network layer.

2.2.2.16.4 Effect on receipt

Receipt of the primitive causes the network layer to adjust the amount of data that it is allowed to pass without data loss.

2.2.2.16.5 Additional comments

Control of the flow of data on a connection is independent of control of the flow on other connections. The amount of data permitted to be passed is dynamically updated by each indication. If amount is specified as zero, then the associated flow is stopped. Specific implementations may allow amount to be specified in implementation-specific units, and may allow amount to be specified as “infinite.”

A possible logical sequence of primitive associated with a DL-CONNECTION-FLOWCONTROL indication is illustrated in figure 3, item (b).

2.2.2.17 DL-DATA-ACK request

2.2.2.17.1 Function

This primitive is the service request primitive for the acknowledged connectionless-mode data unit transfer service. This primitive is used to send a data unit with acknowledgment to another station.

2.2.2.17.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-DATA-ACK request (
    source_address,
    destination_address,
    data,
    priority,
    service_class
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs involved in the data unit transfer. The `data` parameter specifies the link service data unit to be transferred by the LLC sublayer entity. The `priority` parameter specifies the priority desired for the data unit transfer. The `service_class` parameter specifies whether or not an acknowledge capability in the medium access control sublayer is to be used for the data unit transfer.

2.2.2.17.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request that an LSDU be sent to a remote LSAP using acknowledged connectionless-mode data unit transfer procedures.

2.2.2.17.4 Effect on receipt

Receipt of this primitive causes the LLC sublayer to attempt to send the LSDU using acknowledged connectionless-mode procedures.

2.2.2.17.5 Additional comments

This primitive can be passed with a null (having zero length) data parameter for the purpose of resynchronizing the remote LLC. This primitive is independent of any connection with the remote LSAP. A possible sequence of DL-DATA-ACK primitives associated with a successful acknowledged connectionless-mode data unit transfer is illustrated in figure 3, item (h).

2.2.2.18 DL-DATA-ACK indication

2.2.2.18.1 Function

This primitive is the service indication primitive for the acknowledged connectionless-mode data unit transfer service.

2.2.2.18.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-DATA-ACK indication (
    source_address,
    destination_address,
    data,
    priority,
    service_class
)
```

The source_address and destination_address parameters specify the local and remote LSAPs involved in the data unit transfer. The data parameter specifies the link service data unit that has been received by the LLC sublayer entity. The priority parameter specifies the priority provided for the data unit transfer. The service_class parameter specifies whether or not an acknowledge capability in the medium access control sublayer was used for the data unit transfer.

2.2.2.18.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate the arrival of a non-null, non-duplicate LSDU from a remote network layer entity.

2.2.2.18.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.18.5 Additional comments

This primitive is independent of any connection with the remote LSAP.

2.2.2.19 DL-DATA-ACK-STATUS indication

2.2.2.19.1 Function

This primitive is the service status indication primitive for the acknowledged connectionless-mode data unit transfer service.

2.2.2.19.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-DATA-ACK-STATUS indication (
    source_address,
    destination_address,
    priority,
    service_class,
    status
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs involved in the data unit transfer. The `priority` parameter specifies the priority provided for the data unit transfer. The `service_class` parameter specifies whether or not an acknowledge capability in the medium access control sublayer was used for the data unit transfer. The `status` parameter indicates the success or failure of the previous associated acknowledged connectionless-mode data unit transfer request. One status code must indicate complete compliance with the corresponding request. Other codes indicate failure to comply with the request and the reason for the failure.

2.2.2.19.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate the success or failure of the previous associated acknowledged connectionless-mode data unit transfer request.

2.2.2.19.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.19.5 Additional comments

This primitive is independent of any connection with the remote LSAP. For this primitive to convey useful information, it is required that sufficient implicit context information be passed with the DL-DATA-ACK request primitive and the DL-DATA-ACK-STATUS indication primitive to allow the network layer to correlate the status to the appropriate previous request. Success of the data unit transfer request indicates that an LSDU has been transmitted correctly, and for the case of a non-null LSDU, to the best of the LLC sublayer's knowledge (acknowledgment received), the remote LLC sublayer entity has initiated an DL-DATA-ACK indication primitive to a remote network layer entity.

Unsuccessful statuses may indicate various failures at the local or remote stations, such as inability to transfer the request PDU, or no response PDU received from the remote LLC.

2.2.2.20 DL-REPLY request

2.2.2.20.1 Function

This primitive is the service request primitive for the acknowledged connectionless-mode data unit exchange service. This primitive can be used to request a previously prepared data unit from another station, or to exchange data units with another station.

2.2.2.20.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-REPLY request (
    source_address,
    destination_address,
    data,
    priority,
    service_class
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs involved in the data unit exchange. The `data` parameter specifies the link service data unit to be transferred by the LLC sublayer entity. The `priority` parameter specifies the priority desired for the data unit exchange. The `service_class` parameter specifies whether or not an acknowledge capability in the medium access control sublayer is to be used for the data unit exchange.

2.2.2.20.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request a previously prepared data unit from another LSAP, or to exchange data units with another LSAP using acknowledged connectionless-mode data unit exchange procedures.

2.2.2.20.4 Effect on receipt

Receipt of this primitive causes the LLC sublayer to attempt to send the LSDU using acknowledged connectionless-mode data unit exchange procedures.

2.2.2.20.5 Additional comments

This primitive can be passed with a null (having zero length) `data` parameter for the purpose of requesting data only (without sending data). The support of the data unit exchange function in which a non-null LSDU may be contained in the DL-REPLY request primitive is optional in a Type 3 LLC. This primitive is independent of any connection with the remote LSAP. A possible sequence of DL-REPLY primitives associated with a successful acknowledged connectionless-mode data unit exchange is illustrated in figure 3, item (h).

2.2.2.21 DL-REPLY indication

2.2.2.21.1 Function

This primitive is the service indication primitive for the acknowledged connectionless-mode data unit exchange service.

2.2.2.21.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-REPLY indication (
    source_address,
    destination_address,
    data,
    priority,
    service_class
)
```

The `source_address` and `destination_address` parameters specify the local and remote LSAPs involved in the data unit exchange. The `data` parameter specifies the link service data unit that has been received by the LLC

sublayer entity. The priority parameter specifies the priority provided for the data unit exchange. The service_class parameter specifies whether or not an acknowledge capability in the medium access control sublayer was used for the data unit exchange.

2.2.2.21.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate either a successful request of an LSDU from the remote network layer entity, or exchange of LSDUs with a remote network layer entity.

2.2.2.21.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.21.5 Additional comments

This primitive is independent of any connection with the remote LSAP. The transfer of a previously prepared LSDU to a requesting station does not destroy the original copy of the LSDU. Subsequent requests for data by any station will cause the transfer of the same LSDU, until the DL-REPLY-UPDATE request primitive is used to replace the LSDU with new information. The support of the data unit exchange function in which a non-null LSDU may be contained in the DL-REPLY indication primitive is optional in a Type 3 LLC.

2.2.2.22 DL-REPLY-STATUS indication

2.2.2.22.1 Function

This primitive is the service status indication primitive for the acknowledged connectionless-mode data unit exchange service.

2.2.2.22.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-REPLY-STATUS indication (
    source_address,
    destination_address,
    data,
    priority,
    service_class,
    status
)
```

The source_address and destination_address parameters specify the local and remote LSAPs involved in the data unit exchange. The data parameter specifies the link service data unit that has been received by the LLC sublayer entity. The priority parameter specifies the priority provided for the data unit exchange. The service_class parameter specifies whether or not an acknowledge capability in the medium access control sublayer was used for the data unit exchange. The status parameter indicates the success or failure of the previous associated acknowledged connectionless-mode data unit exchange request. One status code must indicate complete compliance with the corresponding request. Other codes indicate failure to comply with the request and the reason for the failure.

2.2.2.22.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate the success or failure of the previous associated acknowledged connectionless-mode data unit exchange request.

2.2.2.22.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.22.5 Additional comments

This primitive is independent of any connection with the remote LSAP. For this primitive to convey useful information, it is required that sufficient implicit context information be passed with the DL-REPLY request primitive and the DL-REPLY-STATUS indication primitive to allow the network layer to correlate the status to the appropriate previous request. Success of the data unit exchange request indicates that an LSDU has been transferred correctly, and for the case of a non-null LSDU, to the best of the LLC sublayer's knowledge (acknowledgment received), the remote LLC sublayer entity has initiated a DL-REPLY indication primitive to a remote network layer entity. Further, if an LSDU was requested from the remote LLC, success indicates that the required LSDU was successfully transferred. Unsuccessful statuses may indicate various failures at the local or remote stations, such as inability to transfer the request PDU, no response PDU received from the remote LLC, or no LSDU available at the remote LLC.

2.2.2.23 DL-REPLY-UPDATE request

2.2.2.23.1 Function

This primitive is the service request primitive for the reply data unit preparation service.

2.2.2.23.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-REPLY-UPDATE request (
    source_address,
    data
)
```

The source_address parameter specifies the local LSAP to be associated with the data unit preparation. The data parameter specifies the link service data unit to be held by LLC, in preparation for transfer at a later time when requested.

2.2.2.23.3 When generated

This primitive is passed from the network layer to the LLC sublayer to request that an LSDU be associated with a local LSAP and held by LLC.

2.2.2.23.4 Effect on receipt

The receipt of this primitive by the LLC sublayer causes the LLC sublayer to associate the LSDU with a local LSAP and hold the LSDU for future access.

2.2.2.23.5 Additional comments

Once an LSDU has been associated with a local LSAP, that LSDU can be transferred to other stations using the acknowledged connectionless-mode response PDU as often as requested by other stations (without the need for additional DL-REPLY-UPDATE request primitives from the network layer). A subsequent DL-REPLY-UPDATE request primitive from the network layer for the specified LSAP serves to replace the currently associated LSDU with a new LSDU.

A possible sequence of DL-REPLY-UPDATE primitives associated with successful reply data unit preparation is illustrated in figure 3, item (i).

2.2.2.24 DL-REPLY-UPDATE-STATUS indication

2.2.2.24.1 Function

This primitive is the service indication primitive for the reply data unit preparation service.

2.2.2.24.2 Semantics of the service primitive

The primitive shall provide parameters as follows:

```
DL-REPLY-UPDATE-STATUS indication (
                                     source_address,
                                     status
                                   )
```

The source_address parameter specifies the local LSAP associated with the data unit preparation. The status parameter indicates the success or failure of the previous associated data unit preparation request.

2.2.2.24.3 When generated

This primitive is passed from the LLC sublayer to the network layer to indicate the success or failure of the previous associated data unit preparation request.

2.2.2.24.4 Effect on receipt

The effect on receipt of this primitive by the network layer is unspecified.

2.2.2.24.5 Additional comments

If the status is successful, this primitive indicates that the LLC sublayer has associated the LSDU with the local LSAP. A failure status indicates that the LSDU could not be associated with the local LSAP (possibly because of inability to access a shared data area). For this primitive to convey useful information, it is required that sufficient implicit context information be passed with the DL-REPLY-UPDATE request primitive and the DL-REPLY-UPDATE-STATUS indication primitive to allow the network layer to correlate the status to the appropriate previous request.