

ANSI/IEEE Std 802.2-1985
ISO/OSI 802.2

LOCAL AREA NETWORKS

Logical Link Control



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An American National Standard

IEEE Standards for
Local Area Networks:

Logical Link Control



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Local Area Networks:
Logical Link Control

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

Approved July 16, 1984

IEEE Standards Board

Approved December 28, 1984

American National Standards Institute

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Details concerning its use within the federal government are contained in FIPS PUB 107, Local Area Networks: Base Band Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specifications and Link Layer Protocol. For a complete list of the publications available in the FEDERAL INFORMATION PROCESSING STANDARDS Series, write to the Standards Processing Coordinator, Institute for Computer Sciences and Technology, National Bureau of Standards, Gaithersburg, MD 20899, U.S.A.

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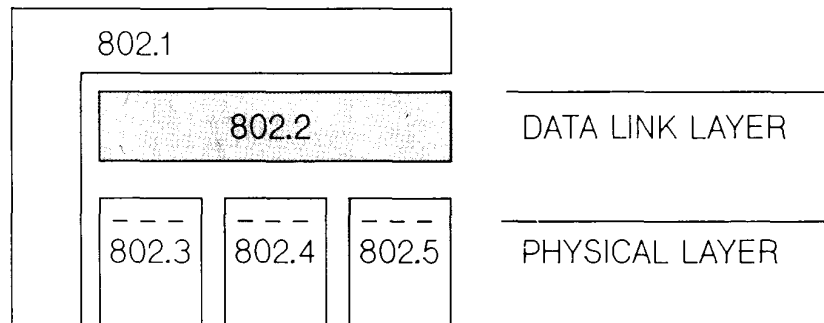
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Foreword

(This Foreword is not a part of ANSI/IEEE Std 802.2-1985, IEEE Standard Logical Link Control.)

This standard is part of a family of standards for Local Area Networks (LANs). The relationship between this 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 ISO Open System Interconnection Reference Model. The access standards define three types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. The standards defining these technologies are

- (1) ANSI/IEEE Std 802.3-1985 (ISO DIS 8802/3), a bus utilizing CSMA/CD as the access method
- (2) ANSI/IEEE Std 802.4-1985 (ISO DIS 8802/4), a bus utilizing token passing as the access method
- (3) ANSI/IEEE Std 802.5-1985,¹ a ring utilizing token passing as the access method.

Other access methods (for example, metropolitan area networks) are under investigation.

ANSI/IEEE Std 802.2 (ISO DIS 8802/2), IEEE Standard Logical Link Control protocol, is used in conjunction with the medium access standards.

A companion document, IEEE 802.1² describes the relationship among these standards and their relationship to the ISO Open System Interconnection Reference Model in more detail. This companion document will contain internetworking and network management issues.

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

¹ Publication anticipated for early 1985.

² In preparation.

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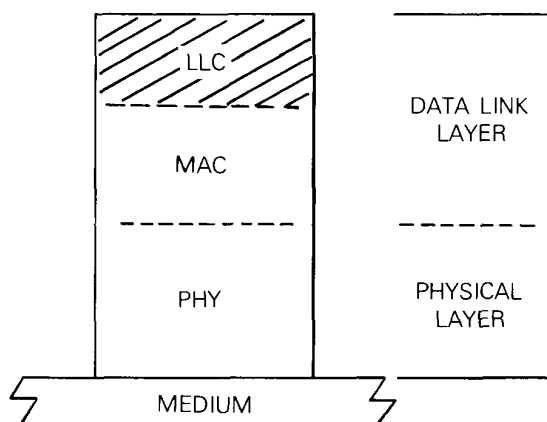
1. Introduction

1.1 Scope and Purpose. This standard is one of a set of standards produced to facilitate the interconnection of computers and terminals on a local area network (LAN). It is related to the other standards by the Reference Model for Open Systems Interconnection.

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

This standard describes the functions, and features and protocol of the Logical Link Control (LLC) Sublayer in the IEEE/Std 802 Local Area Network Protocol. The LLC sublayer constitutes the top sublayer in the Data Link Layer (see Fig 1-1) and is common to the various medium access methods that are defined and

Fig 1-1
Relationship to LAN Reference Model



supported by the IEEE/Std 802 activity. Separate 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 802 architectural reference model.

This standard describes the LLC Sublayer Interface Service Specifications to the Network Layer (Layer 3), to the MAC Sublayer, and to the LLC Sublayer Management function. The interface service specification to the Network Layer provides a description of the various services that the Logical Link Control Sublayer, plus underlying layers and sublayers, offer to the Network Layer, as viewed from the Network Layer. The interface 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 interface 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 Interface Service Specifications are given in the form of primitives that represent in an abstract way the logical exchange 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 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 local area network. The LLC Procedures are independent of the type of medium access method used in the particular local area network.

To satisfy a broad range of potential applications, two types of data link control operation are included (see Section 4). The first type of operation (see Section 6) provides a data-link-connectionless 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 standard in terms of "logical data links". The second type of operation (see Section 7) provides a data-link-connection-oriented service across a data link comparable to existing data link control procedures provided in national and international standards such as ADCCP (see 1.3 (3)) or HDLC (see 1.3 (1)). 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 standard in terms of "data link connections."

This standard identifies two distinct "classes" of LLC operation. Class I provides data-link-connectionless service only. Class II provides data-link-connection-oriented service plus data-link-connectionless service. Either class of operation may be supported.

The basic protocols described herein are peer protocols for use in multi-station

multi-access environments. Because of the multi-station, multi-access 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 over a single physical medium. Each unique to-from pairing at the Data Link Layer shall define a separate logical data link or data link connection with separate logical parameters and variables. Except where noted, the procedures described in this chapter 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.

1.2 Standards Compatibility. The peer protocol procedures defined in Section 5 utilize some of the concepts and principles, as well as commands and responses, of the balanced link control procedures known as Asynchronous Balanced Mode (ABM), as defined in ISO 7809-1984 and ANSI X3.66-1979. (The ABM procedures provided the basis upon which the CCITT Recommendation X.25 Level 2 LAPB procedures were defined.) The frame structure defined for the Data Link Layer procedures as a whole is defined in part in Section 3 of this standard section and in part in those standards that define the various medium access control (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 local area network.

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 or ANSI Data Link Layer standard.

1.3 References.

(1) ISO

ISO/DRS 4335 Revised, Information processing systems, Data communications, High-level data link control procedures, Consolidation of elements of procedures

ISO 7809-1984, Information processing systems, Data communications, High-level data link control procedures, Consolidation of classes of procedures

ISO 7498-1984, Information processing systems, Open systems interconnection, Basic reference model

(2) CCITT

Recommendation X.25, Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode on public data networks

Draft Recommendation X.200, Reference model on open systems interconnection for CCITT applications

(3) ANSI

X3.66-1979, American National Standard for Advanced Data Communications Control Procedures (ADCCP)

1.4 Acronyms and Definitions

1.4.1 Acronyms

ABM	Asynchronous Balanced Mode
ACK	ACKnowledge
ADCCP	Advanced Data Communication Control Procedures
ADM	Asynchronous Disconnected Mode
ANSI	American National Standards Institute
C	Command
CCITT	International Telegraph and Telephone Consultative Committee
COMVII	COMmission VII
C/R	Command/Response
DA	Destination Address
DCE	Data Circuit-terminating Equipment
DIS	Draft International Standard
DISC	DISConnect
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
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LAN	Local Area Network
LAPB	Link Access Procedure, Balanced
LLC	Logical Link Control
LSAP	Link layer Service Access Point
LSB	Least Significant Bit
LSDU	Link layer Service Data Unit
M	Modifier function bit
MAC	Medium Access Control
N(R)	Receive sequence Number

N(S)	Send sequence Number
OSI	Open Systems Interconnection
P	Poll
PDU	Protocol Data Unit
P/F	Poll/Final
PHY	PHYsical
R	Response
REJ	REJect
RNR	Receive Not Ready
RR	Receive Ready
S	Supervisory format
S	Supervisory function bit
SA	Source Address
SABME	Set Asynchronous Balanced Mode Extended
SAP	Service Access Point
SSAP	Source Service Access Point
TEST	TEST
U	Unnumbered format
UA	Unnumbered Acknowledgment
UI	Unnumbered Information
V(R)	Receive state Variable
V(S)	Send state Variable
XID	eXchange IDentification

1.4.2 Definitions

For the purpose of this standard the following definitions apply:

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

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

basic status. An LLC's capability to send or receive a PDU containing an information field.

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

command PDU. All PDU's transmitted by a LLC in which the C/R bit is equal to "0."

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:

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

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.

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, transmission and interpretation.

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

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.

group (multi-cast) DSAP address. A destination address assigned to a collection of LLC's to facilitate their being addressed collectively. The least significant bit shall be set equal to "1."

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.

information field (I). 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 PDU's are not interpreted at the LLC sublayer.

invalid frame. A PDU that either: a. Does not contain an integral number of octets, b. Does not contain at least two address octets and a control octet, c. Is identified by the physical layer or MAC sublayer as containing data bit errors.

LLC. That part of a data station that supports the logical link control functions of one or more logical links. The LLC generates command PDU's and response PDU's for transmission, and interprets received command PDU's and response

PDU's. Specific responsibilities assigned to a LLC include:

- (1) Initiation of control signal interchange
- (2) Organization of data flow
- (3) Interpretation of received command PDU's and generation of appropriate response PDU's
- (4) Actions regarding error control and error recovery functions in the LLC Sublayer.

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

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

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

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

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.

protocol data unit (PDU). The sequence of contiguous octets delivered as a unit from or to 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.

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 PDU's.

response PDU. All PDU's sent by a LLC in which the C/R bit is equal to "1."

services. The capabilities and features provided by an N-layer to an N-user.

service class (use in primitives). A parameter used to convey the type of service required or desired (eg, priority).

2. LLC Sublayer Interface Service Specifications

This section covers the services required of, or by, the Logical Link Control (LLC) Sublayer at the logical interfaces with the Network Layer, the MAC Sublayer, and the LLC Sublayer Management function.

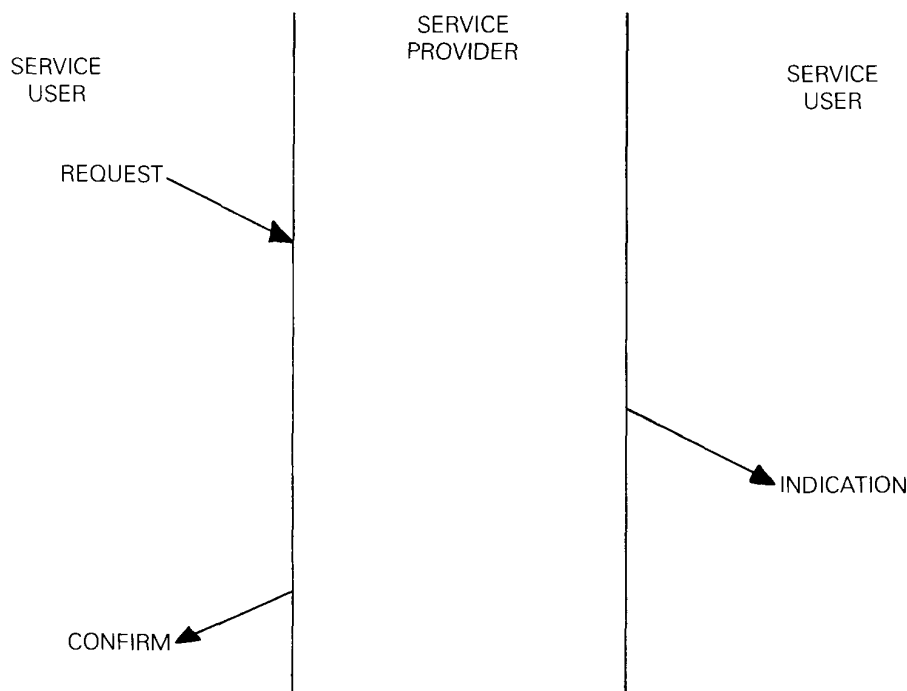
In general, the services of a layer (or sublayer) are the capabilities which it offers to a user in the next higher layer (or sublayer). In order to provide its

service, a layer (or sublayer) builds its functions on the services which it requires from the next lower layer (or sublayer). Fig 2-1 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.

Services are specified by describing the information flow at the interface between the n-user and the n-layer (or sublayer). This information flow is modeled by discrete, instantaneous interface 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 which characterize each service. A service may have one or more related primitives which constitute the interface activity which is related to the particular service. Each service primitive may have zero or more parameters which convey the information required to provide the service.

Fig 2-1
Service Primitives



Primitives are of three generic types:

- REQUEST** The request primitive is passed from the n-user to the n-layer (or sublayer) to request that a service be initiated.
- 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 which 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).
- 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). This primitive may indicate either failure to comply or some level of compliance. It does not necessarily indicate any activity at the remote peer interface.

Possible relationships among primitive types are illustrated by the time sequence diagrams shown in Fig 2-2. The figure also indicates the logical relationship of the primitive types. Primitive types which occur earlier in time and are connected by dotted lines in the diagrams are the logical antecedents of subsequent primitive types. Note that the logical and time relationship of the indication and the confirm primitive types are specified by the semantics of a particular service.

2.1 Network Layer/LLC Sublayer Interface Service Specification. This section specifies the services required of the Logical Link Control (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.

Two forms of service are provided—*unacknowledged connectionless* and *connection-oriented*:

Unacknowledged Connectionless Service. The data transfer service that provides the means by which network entities can exchange link service data units (LSDU's) without the establishment of a data link level connection. The data transfer can be point-to-point, multi-cast, or broadcast.

Connection-Oriented 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 LSAP's.

The connections establishment service provides the means by which a network entity can request, or be notified of, the establishment of data link layer connections.

The connection-oriented data transfer service provides the means by which a network entity can send or receive LSDU's over a data link layer connection. This service also provides data link layer sequencing, flow control, and error recovery.

The connection reset service provides the means by which established connections can be returned to the initial state.

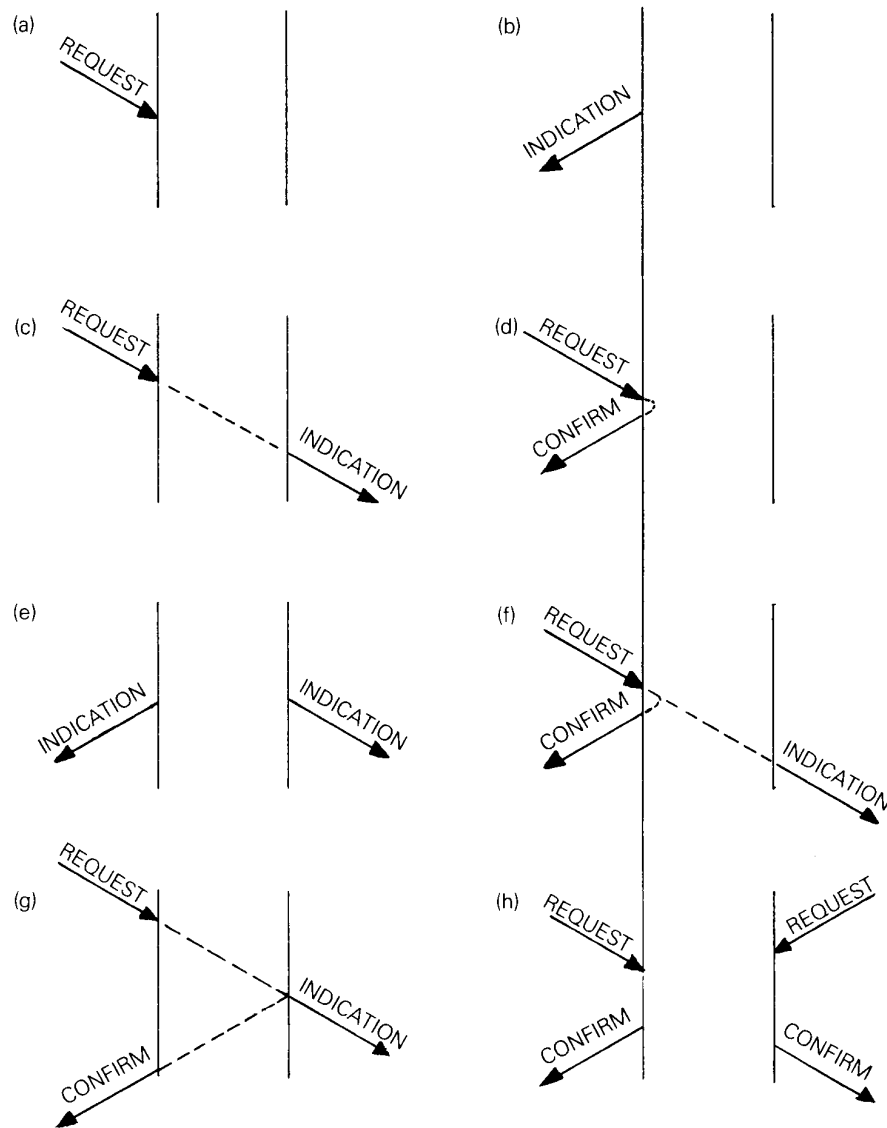


Fig 2-2
Time Sequence Diagram

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.

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.

2.1.1 Overview of Interactions.**2.1.1.1 Unacknowledged Connectionless Services.**

2.1.1.1.1 Unacknowledged Connectionless Data Transfer. The primitives associated with unacknowledged connectionless data transfer are:

L_DATA.request

L_DATA.indication

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

2.1.1.2 Connection-Oriented Services.

2.1.1.2.1 Connection Establishment. The service primitives associated with connection establishment are:

L_CONNECT.request

L_CONNECT.indication

L_CONNECT.confirm

The L_CONNECT.request primitive is passed to the LLC sublayer to request that a logical link connection be established between a local LSAP and a remote LSAP. The L_CONNECT.indication primitive is passed from the LLC sublayer to indicate the results of an attempt by a remote entity to establish a connection to a local LSAP. The L_CONNECT.confirm primitive is passed from the LLC sublayer to convey the results of the previous associated L_CONNECT.request primitive.

2.1.1.2.2 Connection-Oriented Data Transfer. The primitives associated with connection-oriented data transfer are:

L_DATA_CONNECT.request

L_DATA_CONNECT.indication

L_DATA_CONNECT.confirm

The L_DATA_CONNECT.request primitive is passed to the LLC sublayer to request that an LSDU be sent using connection-oriented procedures. The L_DATA_CONNECT.indication primitive is passed from the LLC sublayer to indicate the arrival of an LSDU. The L_DATA_CONNECT.confirm primitive is passed by the LLC sublayer to convey the results of the previously associated L_DATA_CONNECT.request primitive.

2.1.1.2.3 Connection Termination. The primitives associated with connection termination are:

L_DISCONNECT.request

L_DISCONNECT.indication

L_DISCONNECT.confirm

The L_DISCONNECT.request primitive is passed to the LLC sublayer to request the immediate termination of a link connection. The L_DISCONNECT.indication primitive is passed from the LLC sublayer to indicate to the network layer that a connection has been terminated. The L_DISCONNECT.confirm primitive is passed by the LLC sublayer to convey the results of the previous associated L_DISCONNECT.request primitive.

2.1.1.2.4 Connection Reset. The primitives associated with connection resetting are:

L_RESET.request
L_RESET.indication
L_RESET.confirm

The L_RESET.request primitive is passed to the LLC sublayer to request that a connection be immediately reset to the initial state. The L_RESET.indication primitive is passed from the LLC sublayer to indicate that a connection has been reset. The L_RESET.confirm primitive is passed from the LLC sublayer to convey the results of the previous associated L_RESET.request primitive.

2.1.1.2.5 Connection Flow Control. The primitives associated with connection flow control are:

L_CONNECTION_FLOWCONTROL.request
L_CONNECTION_FLOWCONTROL.indication

The L_CONNECTION_FLOWCONTROL.request primitive is passed to the LLC sublayer to control the flow from the LLC sublayer of L_DATA_CONNECT.indication primitives related to a connection. The L_CONNECTION_FLOWCONTROL.indication primitive is passed from the LLC sublayer to control the flow from the network layer of L_DATA_CONNECT.request primitives related to a connection.

2.1.2. Detailed Service Specifications. This section 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 LLC sublayer may provide local confirm mechanisms for request type primitives.

The "local_address" and "remote_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-oriented services may make use of a locally significant connection identifier to imply local and remote address parameters. The "l_sdu" parameter may be provided by actually passing the link service data unit, by passing a pointer, or by other means. The "service_class" parameter provides the priority associated with the data unit transfer. The "service_class" parameter is passed transparently to the underlying MAC sublayer via the appropriate LLC/MAC primitives, see 2.2. The "status" parameter indicates the degree of success associated with the data unit transfer. 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.

2.1.2.1 L_DATA.request.

2.1.2.1.1 Function. This primitive is the service request primitive for the unacknowledged connectionless data transfer service.

2.1.2.1.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DATA.request(  
    local_address,  
    remote_address,  
    l_sdu,  
    service_class  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's involved in the data unit transfer. The `remote_address` may specify either an individual or group address. The `l_sdu` parameter specifies the link service data unit to be transferred by the link layer entity. The `service_class` parameter specifies the priority desired for the data unit transfer.

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

2.1.2.1.4 Effect on Receipt. Receipt of this primitive causes the LLC sublayer to attempt to send the LSDU using unacknowledged connectionless procedures.

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

A possible logical sequence of primitives associated with successful unacknowledged connectionless data unit transfer is illustrated in Fig 2-2 (c).

2.1.2.2 L_DATA.indication.

2.1.2.2.1 Function. This primitive is the service indication primitive for the unacknowledged connectionless data unit transfer service.

2.1.2.2.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DATA.indication(  
    local_address,  
    remote_address,  
    l_sdu,  
    service_class  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's involved in the data unit transfer. The local address may be the address of a local LSAP, or may be a group address specifying multiple LSAP's, including a local LSAP. The `l_sdu` parameter specifies the link service data unit

which has been received by the LLC sublayer entity. The `service_class` parameter specifies the priority desired for the data unit transfer.

2.1.2.2.3 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.

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

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

In the absence of errors, the contents of the `l_sdu` parameter are logically complete and unchanged relative to the `l_sdu` parameter in the associated `L_DATA.request` primitive.

2.1.2.3 L_CONNECT.request.

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

2.1.2.3.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_CONNECT.request(  
    local_address,  
    remote_address,  
    service_class  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's which are to be connected. The `service_class` parameter specifies the priority desired for the connection.

2.1.2.3.3 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 service class, to a remote LSAP.

2.1.2.3.4 Effect on Receipt. The receipt of this primitive by the LLC sublayer causes the local LLC entity to initiate the establishment of a connection with the remote LLC entity.

2.1.2.3.5 Additional Comments. A possible logical sequence of primitives associated with successful connection establishment is illustrated in Fig 2-2 (g).

2.1.2.4 L_CONNECT.indication.

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

2.1.2.4.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_CONNECT.indication(  
    local_address,  
    remote_address,  
    status,  
    service_class  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's which are to be connected. One status code must indicate a successful connection attempt. Other status codes indicate the reason for failure. The `service_class` parameter indicates the priority desired for the connection, if the attempt was successful.

2.1.2.4.3 When Generated. This primitive is passed from the LLC sublayer to the network layer to indicate either that a connection of a certain service class has been established, or that a connection attempt has been refused.

2.1.2.4.4 Effect on Receipt. The network entity may use this connection for data unit transfer.

2.1.2.4.5 Additional Comments. The basis for connection refusal by the LLC sublayer is implementation dependent but may include such reasons as access permission, or unacceptable connection service class.

If the network layer entity does not wish to maintain a connection, then a `L_DISCONNECT.request` primitive is issued.

2.1.2.5 L_CONNECT.confirm.

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

2.1.2.5.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_CONNECT.confirm(
    local_address,
    remote_address,
    status,
    service_class
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's which are to be connected. One status code must indicate a successful connection attempt. Other status codes indicate the reason for failure. The `service_class` parameter indicates the priority provided for the connection, if the attempt was successful.

2.1.2.5.3 When Generated. This primitive is passed by the LLC sublayer to the network layer to convey the results of the previous associated `L_CONNECT.request` primitive. The results indicate either that the connection attempt was successful, or that a connection of the specified service class could not be achieved.

2.1.2.5.4 Effect on Receipt. The network entity may use this connection for data unit transfer.

2.1.2.5.5 Additional Comments. If the connection attempt was successful, this primitive indicates that the remote LLC sublayer entity received and positively acknowledged the connection attempt, and that it passed an `L_CONNECT.indication` to the remote user network entity.

2.1.2.6 L_DATA_CONNECT.request.

2.1.2.6.1 Function. This primitive is the service request primitive for the connection-oriented data unit transfer service.

2.1.2.6.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DATA_CONNECT.request(  
    local_address,  
    remote_address,  
    l_sdu  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's of the connection. The `l_sdu` parameter specifies the link service data unit to be transferred by the LLC sublayer entity.

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

2.1.2.6.4 Effect on Receipt. The receipt of this primitive by the LLC sublayer causes the LLC sublayer to transfer the LSDU over the specified connection using connection-oriented procedures.

2.1.2.6.5 Additional Comments. A possible logical sequence of primitives associated with successful connection-oriented data unit transfer is illustrated in Fig 2-2(g).

2.1.2.7 L_DATA_CONNECT.indication.

2.1.2.7.1 Function. This primitive is the service indication primitive for the connection-oriented data unit transfer service.

2.1.2.7.2 Semantics of the Service Primitive. The primitive shall provide parameters, as follows:

```
L_DATA_CONNECT.indication(  
    local_address,  
    remote_address,  
    l_sdu  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's of the connection. The `l_sdu` parameter specifies the link service data unit which has been received by the LLC sublayer entity.

2.1.2.7.3 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.

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

2.1.2.7.5 Additional Comments. The `L_DATA_CONNECT.request` primitive does not contain a `service_class` parameter because service class must be uniform for all `L_DATA_CONNECT.requests` in a particular connection.

In the absence of errors, the contents of the `l_sdu` parameter are logically complete and unchanged relative to the `l_sdu` parameter in the associated `L_DATA.request` primitive.

2.1.2.8 L_DATA_CONNECT.confirm.

2.1.2.8.1 Function. This primitive is the service confirm primitive for the connection-oriented data unit transfer service.

2.1.2.8.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DATA_CONNECT.confirm(  
    local_address,  
    remote_address,  
    status  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's of the connection. The status parameter indicates the success or failure of the one or more previous associated connection-oriented data unit transfer request(s).

2.1.2.8.3 When Generated. This primitive is passed from the LLC sublayer to the network layer to indicate the success or failure of the one or more previous associated connection-oriented data unit transfer request(s).

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

2.1.2.8.5 Additional Comments. If the transfer was successful this primitive indicates that the remote LLC sublayer entity received and positively acknowledged the LSDU.

2.1.2.9 L_DISCONNECT.request.

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

2.1.2.9.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DISCONNECT.request(  
    local_address,  
    remote_address,  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's of the connection to be terminated.

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

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

2.1.2.9.5 Additional Comments. All unacknowledged LSDU's 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 (ie, 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 Fig 2-2(g).

2.1.2.10 L_DISCONNECT.indication.

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

2.1.2.10.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DISCONNECT.indication(  
    local_address,  
    remote_address,  
    reason  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's 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.

2.1.2.10.3 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.

2.1.2.10.4 Effect on Receipt. The network entity may no longer use this connection for data unit transfer.

2.1.2.10.5 Additional Comments. All unacknowledged LSDU's 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 (ie, without loss of data) is the responsibility of a higher layer protocol.

2.1.2.11 L_DISCONNECT.confirm.

2.1.2.11.1 Function. This primitive is the service confirm primitive for the connection termination service.

2.1.2.11.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_DISCONNECT._confirm(  
    local_address,  
    remote_address,  
    status  
)
```

The `local_address` and `remote_address` parameters specify the local and remote LSAP's of the terminated connection. The `status` parameter indicates whether or not the remote LLC sublayer entity acknowledged the disconnection attempt.

2.1.2.11.3 When Generated. This primitive is passed from the LLC sublayer to the network layer to inform the network layer entity when connection termination is complete.

2.1.2.11.4 Effect on Receipt. The network entity may no longer use this connection for data unit transfer.

2.1.2.11.5 Additional Comments. The `L_DISCONNECT.confirm` primi-

tive indicates that the remote LLC sublayer has acknowledged the disconnect. The remote LLC sublayer entity is expected to pass an L_DISCONNECT.indication to the remote user network layer.

2.1.2.12 L_RESET.request.

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

2.1.2.12.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_RESET.request(  
    local_address,  
    remote_address  
)
```

The local_address and remote_address parameters specify the local and remote LSAP's of the connection to be reset.

2.1.2.12.3 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.

2.1.2.12.4 Effect on Receipt. Receipt of this primitive causes immediate resetting of the connection.

2.1.2.12.5 Additional Comments. All unacknowledged LSDU's 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 (ie, 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 Fig 2-2(g).

2.1.2.13 L_RESET.indication.

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

2.1.2.13.2 Semantics of the Service Primitive. The primitive shall provide parameters as follows:

```
L_RESET.indication(  
    local_address,  
    remote_address,  
    reason  
)
```

The local_address and remote_address parameters specify the local and remote LSAP's of the reset connection. The reason parameter specifies the reason for the connection reset. One of the reason codes indicates that the reset was requested by a remote network entity. All other codes indicate that the reset originated within the LLC sublayer, (as shown in Fig 2-2(e)) and may optionally provide implementation dependent information about the cause of the reset.

2.1.2.13.3 When Generated. This primitive is passed from the LLC sublayer to the network layer to indicate that the connection has been reset.