Data Link Provider Interface Specification

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Trademarks:

1. Introduction

This document specifies a STREAMS kernel-level instantiation of the ISO Data Link Service Definition DIS 8886[1] and Logical Link Control DIS 8802/2 (LLC)[2]. Where the two standards do not conform, DIS 8886 prevails.

The Data Link Provider Interface (DLPI) enables a data link service user to access and use any of a variety of conforming data link service providers without special knowledge of the provider’s protocol. Specifically, the interface is intended to support X.25 LAPB, BX.25 level 2, SDLC, ISDN LAPD, Ethernet™, CSMA/CD, FDDI, token ring, token bus, and Bisync. Among the expected data link service users are implementations of the OSI network layer and SNA path control.

The interface specifies access to data link service providers, and does not define a specific protocol implementation. Thus, issues of network management, protocol performance, and performance analysis tools are beyond the scope of this document and should be addressed by specific implementations of a data link provider. However, accompanying each provider implementation should be information that describes the protocol-specific behavior of that provider. Currently, there are plans to come up with a set of implementor’s agreements/guidelines for common data link providers. These agreements will address issues such as DLSAP address space, subsequent addresses, ppa access and control, QOS, supported services etc.

This specification assumes the reader is familiar with OSI Reference Model[4] terminology, OSI Data Link Services, and STREAMS.

1.1 Document Organization

This specification is organized as follows:

- Section 2, Model of the Data Link Layer, presents background on the structure of the data link layer of the OSI Reference Model, and explains the intended architecture in the STREAMS environment. Data link addressing concepts are also presented.
- Section 3, DLPI Services, presents an overview of the services provided by DLPI.
- Section 4, DLPI Primitives, describes the detailed syntax and semantics of each DLPI primitive that crosses the data link interface.
- Section 5, Quality of Data Link Service, describes the quality-of-service parameters supported by DLPI and the rules for negotiating/selecting the values of those parameters.
- Appendix A, Optional primitives to perform certain essential management functions.
- Appendix B, Allowable Sequence of DLPI Primitives, describes the allowable sequence of DLPI primitives that may be issued across the interface.
- Appendix C, Precedence of DLPI Primitives, presents a summary of the precedence of DLPI primitives as they are queued by the DLS provider and/or DLS user.
- Appendix D presents a Glossary of DLPI Terms and Acronyms.
- Appendix E, Guidelines for Protocol Independent DLS Users, summarizes guidelines a DLS user implementation must follow to be fully protocol-independent.
- Appendix F, Required Information for DLS Provider-Specific Addenda, presents the information that should be documented for each DLS provider implementation.
- Appendix G, DLPI Header File, presents the header file containing DLPI structure and constant definitions needed by a DLS user or provider implemented to use the interface.

2. Model of the Data Link Layer

The data link layer (layer 2 in the OSI Reference Model) is responsible for the transmission and error-free delivery of bits of information over a physical communications medium.

The model of the data link layer is presented here to describe concepts that are used throughout the specification of DLPI. It is described in terms of an interface architecture, as well as addressing concepts needed to identify different components of that architecture. The description of the model assumes familiarity with the OSI Reference Model.

2.1 Model of the Service Interface

Each layer of the OSI Reference Model has two standards:

- one that defines the services provided by the layer, and
- one that defines the protocol through which layer services are provided.

DLPI is an implementation of the first type of standard. It specifies an interface to the services of the data link layer. The following figure depicts the abstract view of DLPI.

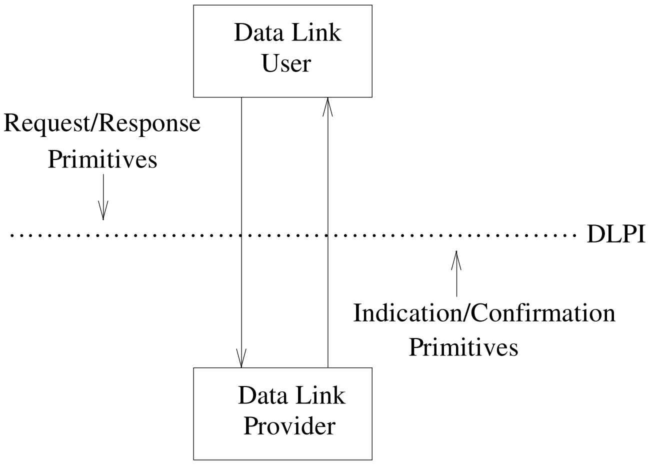


Figure 1. Abstract View of DLPI

The data link interface is the boundary between the network and data link layers of the OSI Reference Model. The network layer entity is the user of the services of the data link interface (DLS user), and the data link layer entity is the provider of those services (DLS provider). This interface consists of a set of primitives that provide access to the data link layer services, plus the rules for using those primitives (state transition rules). A data link interface service primitive might request a particular service or indicate a pending event.

To provide uniformity among the various UNIX system networking products, an effort is underway to develop service interfaces that map to the OSI Reference Model. A set of kernel-level interfaces, based on the STREAMS development environment, constitute a major portion of this effort. The service primitives that make up these interfaces are defined as STREAMS messages that are transferred between the user and provider of the service. DLPI is one such kernel-level interface, and is targeted for STREAMS protocol modules that either use or provide data link services. In addition, user programs that wish to access a STREAMS-based data link provider directly may do so using the *putmsg*(2) and *getmsg*(2) system calls.

Referring to the abstract view of DLPI (Figure 1), the DLS provider is configured as a STREAMS driver, and the DLS user accesses the provider using *open*(2) to establish a stream to the DLS provider. The stream acts as a communication endpoint between a DLS user and the DLS provider. After the stream is created, the DLS user and DLS provider communicate via the messages presented later in this specification.

DLPI is intended to free data link users from specific knowledge of the characteristics of the data link provider. Specifically, the definition of DLPI hopes to achieve the goal of allowing a DLS user to be implemented independent of a specific communications medium. Any data link provider (supporting any communications medium) that conforms to the DLPI specification may be substituted beneath the DLS user to provide the data link services. Support of a new DLS provider should not require any changes to the implementation of the DLS user.

2.2 Modes of Communication

The data link provider interface supports three modes of communication: connection, connectionless and acknowledged connectionless. The connection mode is circuit-oriented and enables data to be transferred over a pre-established connection in a sequenced manner. Data may be lost or corrupted in this service mode, however, due to provider-initiated resynchronization or connection aborts.

The connectionless mode is message-oriented and supports data transfer in self-contained units with no logical relationship required between units. Because there is no acknowledgement of each data unit transmission, this service mode can be unreliable in the most general case. However, a specific DLS provider can provide assurance that messages will not be lost, duplicated, or reordered.

The acknowledged connectionless mode provides the means by which a data link user can 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. The data unit transfer is point-to-point.

2.2.1 Connection-mode Service

The connection-mode service is characterized by four phases of communication: local management, connection establishment, data transfer, and connection release.

2.2.1.1 Local Management

This phase enables a DLS user to initialize a stream for use in communication and establish an identity with the DLS provider.

2.2.1.2 Connection Establishment

This phase enables two DLS users to establish a data link connection between them to exchange data. One user (the calling DLS user) initiates the connection establishment procedures, while another user (the called DLS user) waits for incoming connect requests. The called DLS user is identified by an address associated with its stream (as will be discussed shortly).

A called DLS user may either accept or deny a request for a data link connection. If the request is accepted, a connection is established between the DLS users and they enter the data transfer phase.

For both the calling and called DLS users, only one connection may be established per stream. Thus, the stream is the communication endpoint for a data link connection.

The called DLS user may choose to accept a connection on the stream where it received the connect request, or it may open a new stream to the DLS provider and accept the connection on this new, responding stream. By accepting the connection on a separate stream, the initial stream can be designated as a listening stream through which all connect requests will be processed. As each request arrives, a new stream (communication endpoint) can be opened to handle the connection, enabling subsequent requests to be queued on a single stream until they can be processed.

2.2.1.3 Data Transfer

In this phase, the DLS users are considered peers and may exchange data simultaneously in both directions over an established data link connection. Either DLS user may send data to its peer DLS user at any time. Data sent by a DLS user is guaranteed to be delivered to the remote user in the order in which it was sent.

2.2.1.4 Connection Release

This phase enables either the DLS user, or the DLS provider, to break an established connection. The release procedure is considered abortive, so any data that has not reached the destination user when the connection is released may be discarded by the DLS provider.

2.2.2 Connectionless-mode Service

The connectionless mode service does not use the connection establishment and release phases of the connection-mode service. The local management phase is still required to initialize a stream. Once initialized, however, the connectionless data transfer phase is immediately entered. Because there is no established connection, however, the connectionless data transfer phase requires the DLS user to identify the destination of each data unit to be transferred. The destination DLS user is identified by the address associated with that user (as will be discussed shortly).

Connectionless data transfer does not guarantee that data units will be delivered to the destination user in the order in which they were sent. Furthermore, it does not guarantee that a given data unit will reach the destination DLS user, although a given DLS provider may provide assurance that data will not be lost.

2.2.3 Acknowledged Connectionless-mode Service

The acknowledged connectionless mode service also does not use the connection establishment and release phases of the connection-mode service. The local management phase is still required to initialize a stream. Once initialized, the acknowledged connectionless data transfer phase is immediately entered.

Acknowledged connectionless data transfer guarantees that data units will be delivered to the destination user in the order in which they were sent. A data link user entity can send a data unit to the destination DLS User, request a previously prepared data unit from the destination DLS User, or exchange data units.

2.3 DLPI Addressing

Each user of DLPI must establish an identity to communicate with other data link users. This identity consists of two pieces. First, the DLS user must somehow identify the physical medium over which it will communicate. This is particularly evident on systems that are attached to multiple physical media. Second, the DLS user must register itself with the DLS provider so that the provider can deliver protocol data units destined for that user. The following figure illustrates the components of this identification approach, which are explained below.

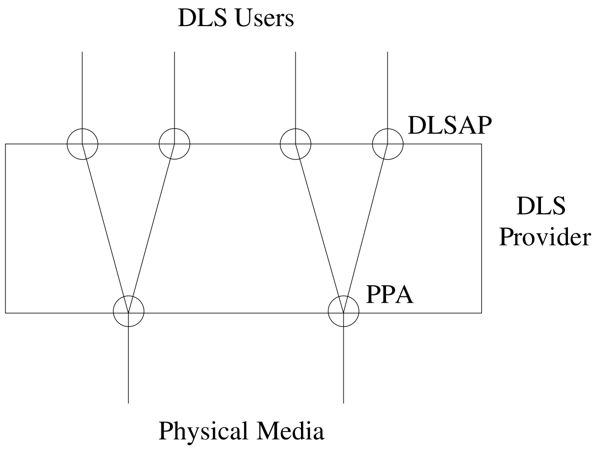


Figure 2. Data Link Addressing Components

2.3.1 Physical Attachment Identification

The physical point of attachment (PPA in Figure 2) is the point at which a system attaches itself to a physical communications medium. All communication on that physical medium funnels through the PPA. On systems where a DLS provider supports more than one physical medium, the DLS user must identify which medium it will communicate through. A PPA is identified by a unique *PPA identifier*. For media that support physical layer multiplexing of multiple channels over a single physical medium (such as the B and D channels of ISDN), the PPA identifier must identify the specific channel over which communication will occur.

Two styles of DLS provider are defined by DLPI, distinguished by the way they enable a DLS user to choose a particular PPA. The *style 1* provider assigns a PPA based on the major/minor device the DLS user opened. One possible implementation of a *style 1* driver would reserve a major device for each PPA the data link driver would support. This would allow the STREAMS *clone open* feature to be used for each PPA configured. This style of provider is appropriate when few PPAs will be supported.

If the number of PPAs a DLS provider will support is large, a *style 2* provider implementation is more suitable. The *style 2* provider requires a DLS user to explicitly identify the desired PPA using a special *attach* service primitive. For a *style 2* driver, the *open*(2) creates a stream between the DLS user and DLS provider, and the *attach* primitive then associates a particular PPA with that stream. The format of the PPA identifier is specific to the DLS provider, and should be described in the provider-specific addendum documentation.

DLPI provides a mechanism to get and/or modify the physical address. The primitives to handle these functions are described in Appendix A. The physical address value can be modified in a post-attached state. This would modify the value for all streams for that provider for a particular PPA. The physical address cannot be modified if even a single stream for that PPA is in the *bound* state.

The DLS User uses the supported primitives (DL_ATTACH_REQ, DL_BIND_REQ, DL_ENABMULTI_REQ, DL_PROMISCON_REQ) to define a set of enabled physical and SAP address components on a *per Stream* basis. It is invalid for a DLS Provider to ever send upstream a data message for which the DLS User on that stream has not requested. The burden is on the provider to enforce by any means that it chooses, the isolation of SAP and physical address space effects on a per-stream basis.

2.3.2 Data Link User Identification

A data link user’s identity is established by associating it with a data link service access point (DLSAP), which is the point through which the user will communicate with the data link provider. A DLSAP is identified by a *DLSAP address*.

The DLSAP address identifies a particular data link service access point that is associated with a stream (communication endpoint). A *bind* service primitive enables a DLS user to either choose a specific DLSAP by specifying its DLSAP address, or to determine the DLSAP associated with a stream by retrieving the bound DLSAP address. This DLSAP address can then be used by other DLS users to access a specific DLS user. The format of the DLSAP address is specific to the DLS provider, and should be described in the provider-specific addendum documentation. However, DLPI provides a mechanism for decomposing the DLSAP address into component pieces. The DL_INFO_ACK primitive returns the length of the SAP component of the DLSAP address, along with the total length of the DLSAP address.

Certain DLS Providers require the capability of binding on multiple DLSAP addresses. This can be achieved through subsequent binding of DLSAP addresses. DLPI supports *peer* and *hierarchical* binding of DLSAPs. When the User requests peer addressing, the DLSAP specified in a subsequent bind may be used in lieu of the DLSAP bound in the DL_BIND_REQ. This will allow for a choice to be made between a number of DLSAPs on a stream when determining traffic based on DLSAP values. An example of this would be to specify various ether_type values as DLSAPs. The DL_BIND_REQ, for example, could be issued with ether_type value of IP, and a subsequent bind could be issued with ether type value of ARP. The Provider may now multiplex off of the ether_type field and allow for either IP or ARP traffic to be sent up this stream.

When the DLS User requests hierarchical binding, the subsequent bind will specify a DLSAP that will be used in addition to the DLSAP bound using a DL_BIND_REQ. This will allow additional information to be specified, that will be used in a header or used for demultiplexing. An example of this would be to use hierarchical bind to specify the OUI (Organizationally Unique Identifier) to be used by SNAP.

If a DLS Provider supports peer subsequent bind operations, the first SAP that is bound is used as the source SAP when there is ambiguity.

DLPI supports the ability to associate several streams with a single DLSAP, where each stream may be a unique data link connection endpoint. However, not all DLS providers can support such configurations because some DLS providers may have no mechanism beyond the DLSAP address for distinguishing multiple connections. In such cases, the provider will restrict the DLS user to one stream per DLSAP.

2.4 The Connection Management Stream

The earlier description of the connection-mode service assumed that a DLS user bound a DLSAP to the stream it would use to receive connect requests. In some instances, however, it is expected that a given service may be accessed through any one of several DLSAPs. To handle this scenario, a separate stream would be required for each possible destination DLSAP, regardless of whether any DLS user actually requested a connection to that DLSAP. Obvious resource problems can result in this scenario.

To obviate the need for tying up system resources for all possible destination DLSAPs, a "connection management stream" utility is defined in DLPI. A connection management stream is one that receives any connect requests that are not destined for currently bound DLSAPs capable of receiving connect indications. With this mechanism, a special listener can handle incoming connect requests intended for a set of DLSAPs by opening a connection management stream to the DLS provider that will retrieve all connect requests arriving through a particular PPA. In the model, then, there may be a connection management stream per PPA.

3. DLPI Services

The various features of the DLPI interface are defined in terms of the services provided by the DLS provider, and the individual primitives that may flow between the DLS user and DLS provider.

The data link provider interface supports three modes of service: connection, connectionless and acknowledged connectionless. The connection mode is circuit-oriented and enables data to be transferred over an established connection in a sequenced manner. The connectionless mode is message-oriented and supports data transfer in self-contained units with no logical relationship required between units. The acknowledged connectionless mode is message-oriented and guarantees that data units will be delivered to the destination user in the order in which they were sent. This specification also defines a set of local management functions that apply to all modes of service.

The XID and TEST services that are supported by DLPI are listed below. The DLS User can issue an XID or TEST request to the DLS Provider. The Provider will transmit an XID or TEST frame to the peer DLS Provider. On receiving a response, the DLS Provider sends a confirmation primitive to the DLS User. On receiving an XID or TEST frame from the peer DLS Provider, the local DLS Provider sends up an XID or TEST indication primitive to the DLS User. The User must respond with an XID or TEST response frame to the Provider.

The services are tabulated below and described more fully in the remainder of this section.

Phase	*Service*	*Primitives*
Local Management	Information Reporting	DL_INFO_REQ, DL_INFO_ACK, DL_ERROR_ACK
	Attach	DL_ATTACH_REQ, DL_DETACH_REQ, DL_OK_ACK, DL_ERROR_ACK
	Bind	DL_BIND_REQ, DL_BIND_ACK, DL_SUBS_BIND_REQ, DL_SUBS_BIND_ACK, DL_UNBIND_REQ, DL_SUBS_UNBIND_REQ, DL_OK_ACK, DL_ERROR_ACK
	Other	DL_ENABMULTI_REQ, DL_DISABMULTI_REQ, DL_PROMISCON_REQ, DL_PROMISCOFF_REQ, DL_OK_ACK, DL_ERROR_ACK
Connection Establishment	Connection Establishment	DL_CONNECT_REQ, DL_CONNECT_IND, DL_CONNECT_RES, DL_CONNECT_CON, DL_DISCONNECT_REQ, DL_DISCONNECT_IND, DL_TOKEN_REQ, DL_TOKEN_ACK, DL_OK_ACK, DL_ERROR_ACK
Connection-mode Data Transfer	Data Transfer	DL_DATA_REQ, DL_DATA_IND
	Reset	DL_RESET_REQ, DL_RESET_IND, DL_RESET_RES, DL_RESET_CON, DL_OK_ACK, DL_ERROR_ACK
Connection Release	Connection Release	DL_DISCONNECT_REQ, DL_DISCONNECT_IND, DL_OK_ACK, DL_ERROR_ACK
Connectionless-mode Data Transfer	Data Transfer	DL_UNITDATA_REQ, DL_UNITDATA_IND
	QOS Management	DL_UDQOS_REQ, DL_OK_ACK, DL_ERROR_ACK
	Error Reporting	DL_UDERROR_IND
XID and TEST services	XID	DL_XID_REQ, DL_XID_IND, DL_XID_RES, DL_XID_CON
	TEST	DL_TEST_REQ, DL_TEST_IND, DL_TEST_RES, DL_TEST_CON
Acknowledged Connectionless-mode Data Transfer	Data Transfer	DL_DATA_ACK_REQ, DL_DATA_ACK_IND, DL_DATA_ACK_STATUS_IND, DL_REPLY_REQ, DL_REPLY_IND, DL_REPLY_STATUS_IND, DL_REPLY_UPDATE_REQ, DL_REPLY_UPDATE_STATUS_IND
	QOS Management	DL_UDQOS_REQ, DL_OK_ACK, DL_ERROR_ACK
	Error Reporting	DL_UDERROR_IND

TABLE 1. Cross-Reference of DLS Services and Primitives

3.1 Local Management Services

The local management services apply to the connection, connectionless and acknowledged connectionless modes of transmission. These services, which fall outside the scope of standards specifications, define the method for initializing a stream that is connected to a DLS provider. DLS provider information reporting services are also supported by the local management facilities.

3.1.1 Information Reporting Service

This service provides information about the DLPI stream to the DLS user. The message DL_INFO_REQ requests the DLS provider to return operating information about the stream. The DLS provider returns the information in a DL_INFO_ACK message.

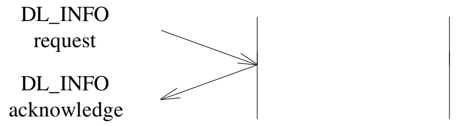


Figure 3. Message Flow: Information Reporting

3.1.2 Attach Service

The attach service assigns a physical point of attachment (PPA) to a stream. This service is required for *style 2* DLS providers (see section 2.3.1, *Physical Attachment Identification*) to specify the physical medium over which communication will occur. The DLS provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK. The normal message sequence is illustrated in the following figure.

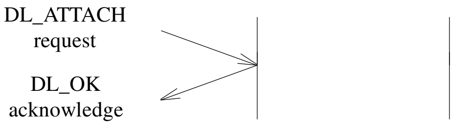


Figure 4. Message Flow: Attaching a Stream to a Physical Line.

A PPA may be disassociated with a stream using the DL_DETACH_REQ. The normal message sequence is illustrated in the following figure.

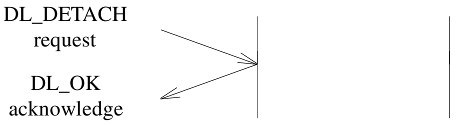


Figure 5. Message Flow: Detaching a Stream from a Physical Line.

3.1.3 Bind Service

The bind service associates a data link service access point (DLSAP) with a stream. The DLSAP is identified by a DLSAP address.

DL_BIND_REQ requests that the DLS provider bind a DLSAP to a stream. It also notifies the DLS provider to make the stream active with respect to the DLSAP for processing connectionless and acknowledged connectionless data transfer and connection establishment requests. Protocol-specific actions taken during activation should be described in DLS provider-specific addenda.

The DLS provider indicates success with a DL_BIND_ACK; failure with a DL_ERROR_ACK.

Certain DLS providers require the capability of binding on multiple DLSAP addresses. DL_SUBS_BIND_REQ provides that added capability. The DLS provider indicates success with a DL_SUBS_BIND_ACK; failure with a DL_ERROR_ACK.

The normal flow of messages is illustrated in the following figure.

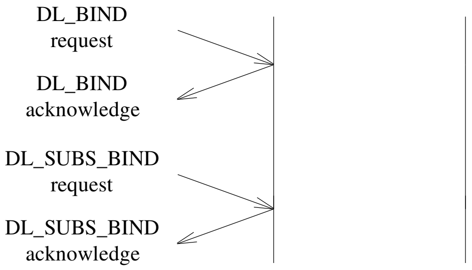


Figure 6. Message Flow: Binding a Stream to a DLSAP.

DL_UNBIND_REQ requests the DLS provider to unbind all DLSAP(s) from a stream. The DL_UNBIND_REQ also unbinds all the subsequently bound DLSAPs that have not been unbound. The DLS provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK.

DL_SUBS_UNBIND_REQ requests the DLS Provider to unbind the subsequently bound DLSAP. The DLS Provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK.

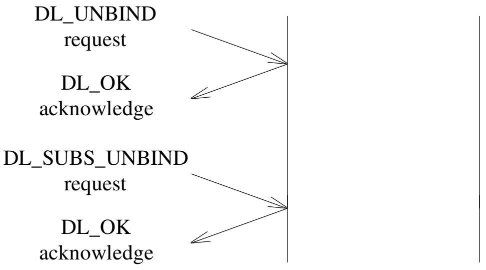


Figure 7. Message Flow: Unbinding a Stream from a DLSAP.

DL_ENABMULTI_REQ requests the DLS Provider to enable specific multicast addresses on a per stream basis. The Provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK.

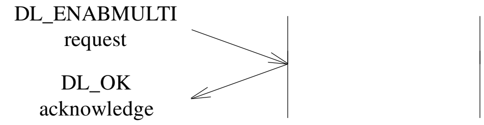


Figure 8. Message Flow: Enabling a specific multicast address on a Stream.

DL_DISABMULTI_REQ requests the DLS Provider to disable specific multicast addresses on a per Stream basis. The Provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK.

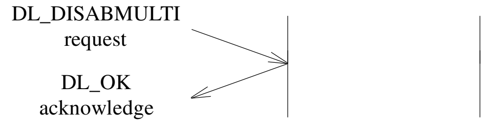


Figure 9. Message Flow: Disabling a specific multicast address on a Stream.

DL_PROMISCON_REQ requests the DLS Provider to enable promiscuous mode on a per Stream basis, either at the physical level or at the SAP level. The Provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK.

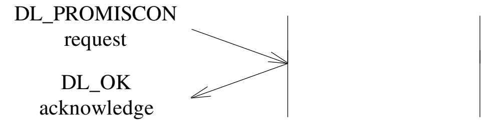


Figure 10. Message Flow: Enabling promiscuous mode on a Stream.

DL_PROMISCOFF_REQ requests the DLS Provider to disable promiscuous mode on a per Stream basis, either at the physical level or at the SAP level. The Provider indicates success with a DL_OK_ACK; failure with a DL_ERROR_ACK.

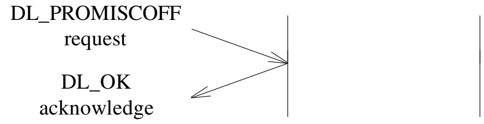


Figure 11. Message Flow: Disabling promiscuous mode on a Stream.

3.2 Connection-mode Services

The connection-mode services enable a DLS user to establish a data link connection, transfer data over that connection, reset the link, and release the connection when the conversation has terminated.

3.2.1 Connection Establishment Service

The connection establishment service establishes a data link connection between a local DLS user and a remote DLS user for the purpose of sending data. Only one data link connection is allowed on each stream.

3.2.1.1 Normal Connection Establishment

In the connection establishment model, the calling DLS user initiates connection establishment, while the called DLS user waits for incoming requests. DL_CONNECT_REQ requests that the DLS provider establish a connection. DL_CONNECT_IND informs the called DLS user of the request, which may be accepted using DL_CONNECT_RES. DL_CONNECT_CON informs the calling DLS user that the connection has been established.

The normal sequence of messages is illustrated in the following figure.

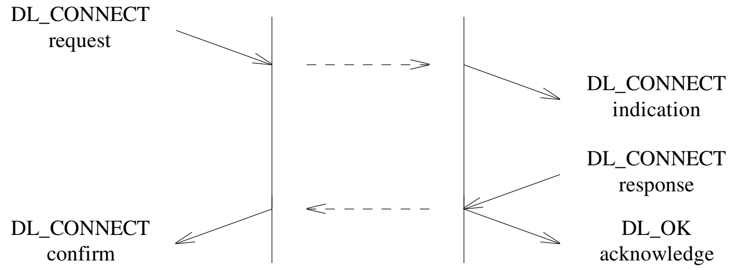


Figure 12. Message Flow: Successful Connection Establishment

Once the connection is established, the DLS users may exchange user data using DL_DATA_REQ and DL_DATA_IND.

The DLS user may accept an incoming connect request on either the stream where the connect indication arrived or an alternate, responding stream. The responding stream is indicated by a token in the DL_CONNECT_RES. This token is a value associated with the responding stream, and is obtained by issuing a DL_TOKEN_REQ on that stream. The DLS provider responds to this request by generating a token for the stream and returning it to the DLS user in a DL_TOKEN_ACK. The normal sequence of messages for obtaining a token is illustrated in the following figure.

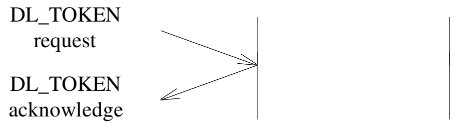


Figure 13. Message Flow: Token Retrieval

In the typical connection establishment scenario, the called DLS user processes one connect indication at a time, accepting the connection on another stream. Once the user responds to the current connect indication, the next connect indication (if any) can be processed. DLPI also enables the called DLS user to multi-thread incoming connect indications. The user can receive multiple connect indications before responding to any of them. This enables the DLS user to establish priority schemes on incoming connect requests.

3.2.1.2 Connection Establishment Rejections

In certain situations, the connection establishment request cannot be completed. The following paragraphs describe the occasions under which DL_DISCONNECT_REQ and DL_DISCONNECT_IND primitives will flow during connection establishment, causing the connect request to be aborted.

The following figure illustrates the situation where the called DLS user chooses to reject the connect request by issuing DL_DISCONNECT_REQ instead of DL_CONNECT_RES.

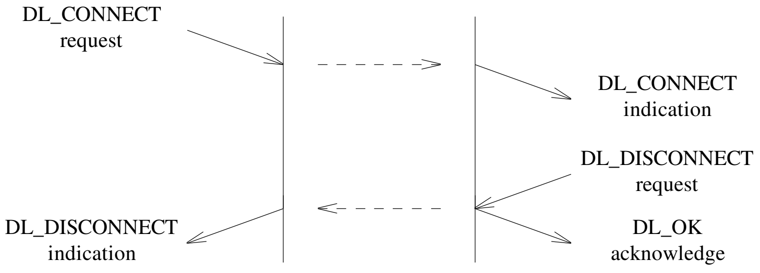


Figure 14. Message Flow: Called DLS User Rejection of Connection Establishment Attempt

The following figure illustrates the situation where the DLS provider rejects a connect request for lack of resources or other reason. The DLS provider sends DL_DISCONNECT_IND in response to DL_CONNECT_REQ.

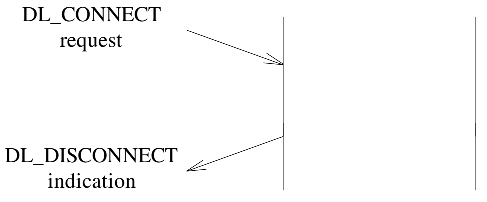


Figure 15. Message Flow: DLS Provider Rejection of a Connection Establishment Attempt

The following figures illustrate the situation where the calling DLS user chooses to abort a previous connection attempt. The DLS user issues DL_DISCONNECT_REQ at some point following a DL_CONNECT_REQ. The resulting sequence of primitives depends on the relative timing of the primitives involved, as defined in the following time sequence diagrams.

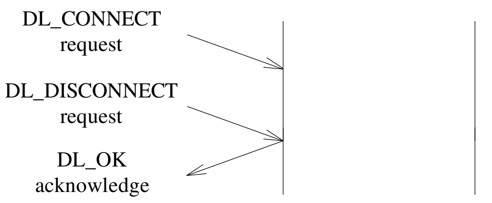


Figure 16. Message Flow: Both Primitives are Destroyed by Provider

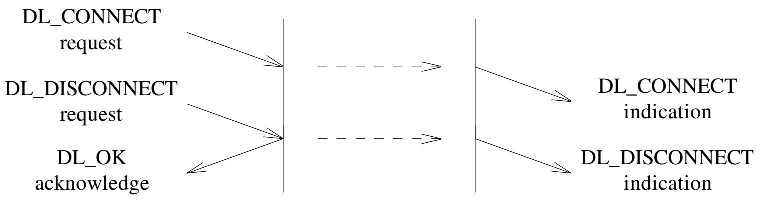


Figure 17. Message Flow: DL_DISCONNECT Indication Arrives before DL_CONNECT Response is Sent

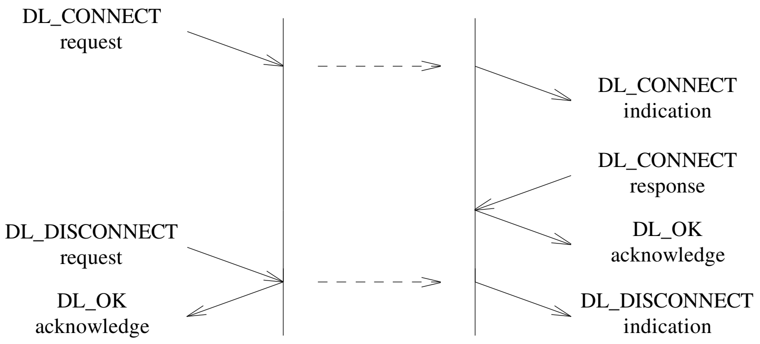


Figure 18. Message Flow: DL_DISCONNECT Indication Arrives after DL_CONNECT Response is Sent

3.2.2 Data Transfer Service

The connection-mode data transfer service provides for the exchange of user data in either direction or in both directions simultaneously between DLS users. Data is transmitted in logical groups called data link service data units (DLSDUs). The DLS provider preserves both the sequence and boundaries of DLSDUs as they are transmitted.

Normal data transfer is neither acknowledged nor confirmed. It is up to the DLS users, if they so choose, to implement a confirmation protocol.

Each DL_DATA_REQ primitive conveys a DLSDU from the local DLS user to the DLS provider. Similarly, each DL_DATA_IND primitive conveys a DLSDU from the DLS provider to the remote DLS user. The normal flow of messages is illustrated in the figure below.

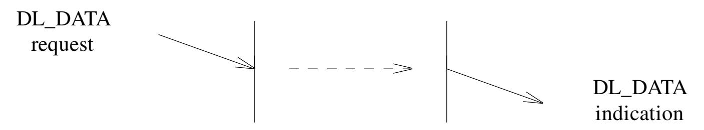


Figure 19. Message Flow: Normal Data Transfer

3.2.3 Connection Release Service

The connection release service provides for the DLS users or the DLS provider to initiate the connection release. Connection release is an abortive operation, and any data in transit (has not been delivered to the DLS user) may be discarded.

DL_DISCONNECT_REQ requests that a connection be released. DL_DISCONNECT_IND informs the DLS user that a connection has been released. Normally, one DLS user requests disconnection and the DLS provider issues an indication of the ensuing release to the other DLS user, as illustrated by the message flow in the following figure.

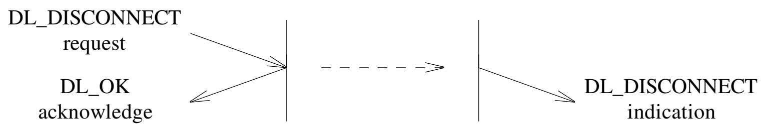


Figure 20. Message Flow: DLS User-Invoked Connection Release

The next figure illustrates that when two DLS users independently invoke the connection release service, neither receives a DL_DISCONNECT_IND.

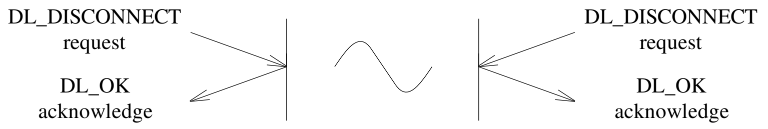


Figure 21. Message Flow: Simultaneous DLS User Invoked Connection Release

The next figure illustrates that when the DLS provider initiates the connection release service, each DLS user receives a DL_DISCONNECT_IND.

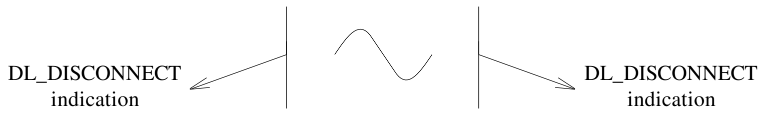


Figure 22. Message Flow: DLS Provider Invoked Connection Release

The next figure illustrates that when the DLS provider and the local DLS user simultaneously invoke the connection release service, the remote DLS user receives a DL_DISCONNECT_IND.

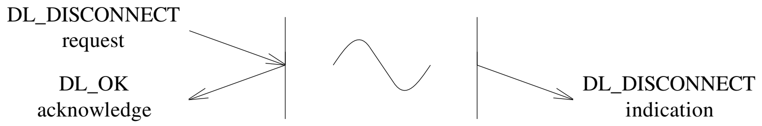


Figure 23. Message Flow: Simultaneous DLS User & DLS Provider Invoked Connection Release

3.2.4 Reset Service

The reset service may be used by the DLS user to resynchronize the use of a data link connection, or by the DLS provider to report detected loss of data unrecoverable within the data link service.

Invocation of the reset service will unblock the flow of DLSDUs if the data link connection is congested; DLSDUs may be discarded by the DLS provider. The DLS user or users that did not invoke the reset will be notified that a reset has occurred. A reset may require a recovery procedure to be performed by the DLS users.

The interaction between each DLS user and the DLS provider will be one of the following:

- a DL_RESET_REQ from the DLS user, followed by a DL_RESET_CON from the DLS provider;
- a DL_RESET_IND from the DLS provider, followed by a DL_RESET_RES from the DLS user.

The DL_RESET_REQ acts as a synchronization mark in the stream of DLSDUs that are transmitted by the issuing DLS user; the DL_RESET_IND acts as a synchronization mark in the stream of DLSDUs that are received by the peer DLS user. Similarly, the DL_RESET_RES acts as a synchronization mark in the stream of DLSDUs that are transmitted by the responding DLS user; the DL_RESET_CON acts as a synchronization mark in the stream of DLSDUs that are received by the DLS user which originally issued the reset.

The resynchronizing properties of the reset service are that:

- No DLSDU transmitted by the DLS user *before* the synchronization mark in that transmitted stream will be delivered to the other DLS user *after* the synchronization mark in that received stream.
- The DLS provider will discard all DLSDUs submitted before the issuing of the DL_RESET_REQ that have not been delivered to the peer DLS user when the DLS provider issues the DL_RESET_IND.
- The DLS provider will discard all DLSDUs submitted before the issuing of the DL_RESET_RES that have not been delivered to the initiator of the DL_RESET_REQ when the DLS provider issues the DL_RESET_CON.
- No DLSDU transmitted by a DLS user *after* the synchronization mark in that transmitted stream will be delivered to the other DLS user *before* the synchronization mark in that received stream.

The complete message flow depends on the origin of the reset, which may be the DLS provider or either DLS user. The following figure illustrates the message flow for a reset invoked by one DLS user.

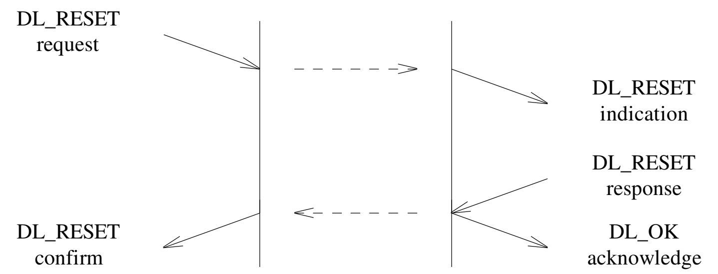


Figure 24. Message Flow: DLS User-Invoked Connection Reset

The following figure illustrates the message flow for a reset invoked by both DLS users simultaneously.

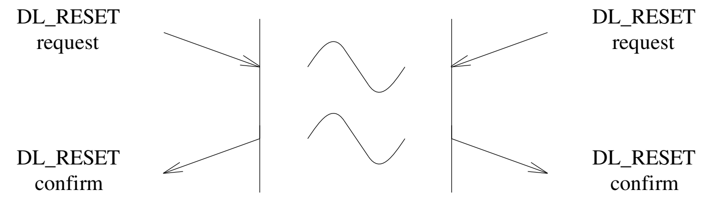


Figure 25. Message Flow: Simultaneous DLS User-Invoked Connection Reset

The following figure illustrates the message flow for a reset invoked by the DLS provider.

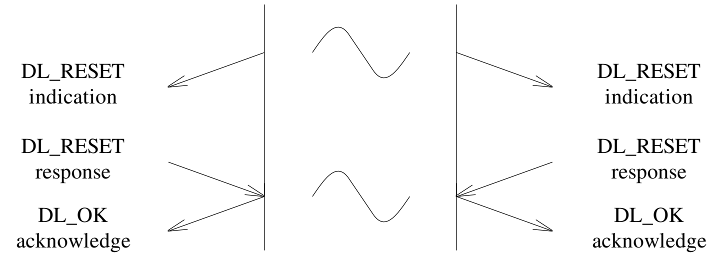


Figure 26. Message Flow: DLS Provider-Invoked Connection Reset

The following figure illustrates the message flow for a reset invoked simultaneously by one DLS user and the DLS provider.

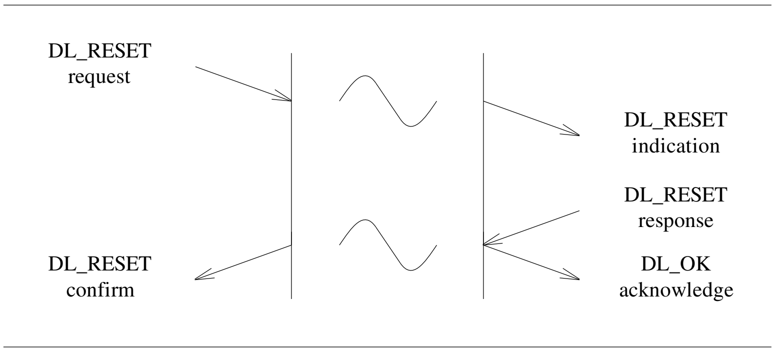


Figure 27. Message Flow: Simultaneous DLS User & DLS Provider Invoked Connection Reset

3.3 Connectionless-mode Services

The connectionless-mode services enable a DLS user to transfer units of data to peer DLS users without incurring the overhead of establishing and releasing a connection. The connectionless service does not, however, guarantee reliable delivery of data units between peer DLS users (e.g. lack of flow control may cause buffer resource shortages that result in data being discarded).

Once a stream has been initialized via the local management services, it may be used to send and receive connectionless data units.

3.3.1 Connectionless Data Transfer Service

The connectionless data transfer service provides for the exchange of user data (DLSDUs) in either direction or in both directions simultaneously without having to establish a data link connection. Data transfer is neither acknowledged nor confirmed, and there is no end-to-end flow control provided. As such, the connectionless data transfer service cannot guarantee reliable delivery of data. However, a specific DLS provider can provide assurance that messages will not be lost, duplicated, or reordered.

DL_UNITDATA_REQ conveys one DLSDU to the DLS provider. DL_UNITDATA_IND conveys one DLSDU to the DLS user. The normal flow of messages is illustrated in the figure below.

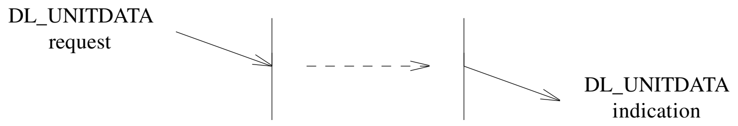


Figure 28. Message Flow: Connectionless Data Transfer

3.3.2 QOS Management Service

The QOS (Quality of Service) management service enables a DLS user to specify the quality of service it can expect for each invocation of the connectionless data transfer service. The DL_UDQOS_REQ directs the DLS provider to set the QOS parameters to the specified values. The normal flow of messages is illustrated in the figure below.

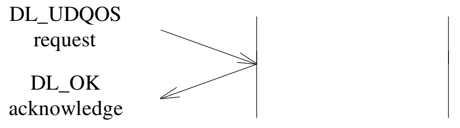
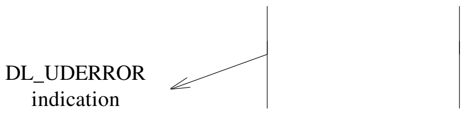


Figure 29. Message Flow: Connectionless Data Transfer

3.3.3 Error Reporting Service

The connectionless-mode error reporting service may be used to notify a DLS user that a previously sent data unit either produced an error or could not be delivered. This service does not, however, guarantee that an error indication will be issued for every undeliverable data unit.



3.3.4 XID and TEST Service

The XID and TEST service enables the DLS User to issue an XID or TEST request to the DLS Provider. On receiving a response for the XID or TEST frame transmitted to the peer DLS Provider, the DLS Provider sends up an XID or TEST confirmation primitive to the DLS User. On receiving an XID or TEST frame from the peer DLS Provider, the local DLS Provider sends up an XID or TEST indication respectively to the DLS User. The DLS User must respond with an XID or TEST response primitive.

If the DLS User requested automatic handling of the XID or TEST response, at bind time, the DLS Provider will send up an error acknowledgement on receiving an XID or TEST request. Also, no indications will be generated to the DLS User on receiving XID or TEST frames from the remote side.

The normal flow of messages is illustrated in the figure below.

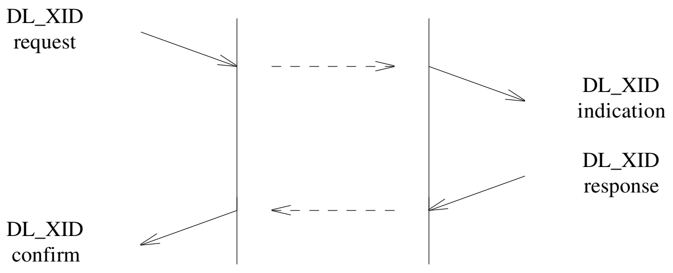


Figure 30. Message Flow: XID Service

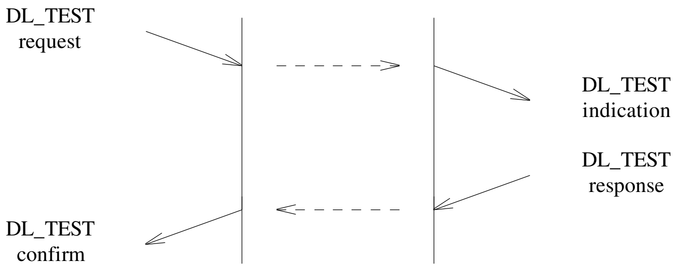


Figure 31. Message Flow: TEST Service

3.4 Acknowledged Connectionless-mode Services

The acknowledged connectionless-mode services are designed for general use for the reliable transfer of informations between peer DLS Users. These services are intended for applications that require acknowledgement of cross-LAN data unit transfer, but wish to avoid the complexity that is viewed as being associated with the connection-mode services. Although the exchange service is connectionless, in-sequence delivery is guaranteed for data sent by the initiating station.

3.4.1 Acknowledged Connectionless-mode Data Transfer Services

The acknowledged connectionless-mode data transfer services provide the means by which the DLS Users can exchange DLSDUs which are acknowledged at the LLC sublayer, without the establishment of a Data Link connection. The services provide a means by which a local DLS User can send a data unit to the peer DLS User, request a previously prepared data unit, or exchange data units with the peer DLS User.

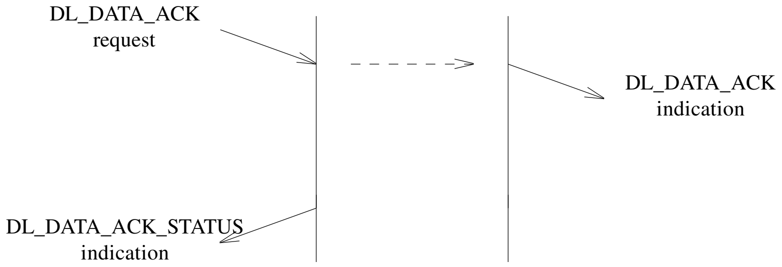


Figure 32. Message Flow: Acknowledged Connectionless-Mode Data Unit Transmission service

The next figure illustrates the acknowledged connectionless-mode data unit exchange service.

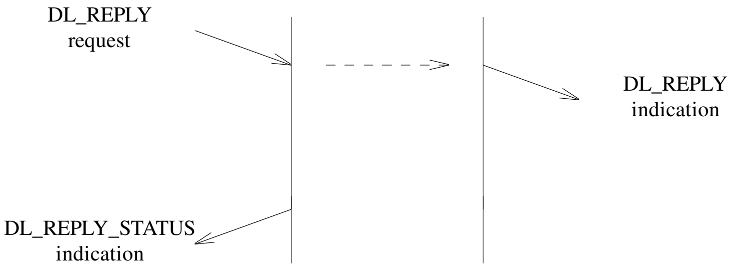


Figure 33. Message Flow: Acknowledged Connectionless-Mode Data Unit Exchange service

The next figure illustrates the Reply Data Unit Preparation service.

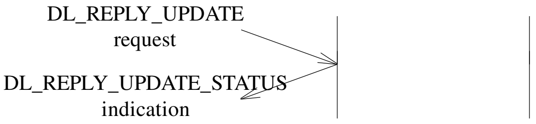


Figure 34. Message Flow: Acknowledged Connectionless-Mode Reply Data Unit Preparation Service

3.4.2 QOS Management Service

The Quality of Service (QOS) management service enables a DLS User to specify the quality of service it can expect for each invocation of the acknowledged connectionless data transfer service. The DL_UDQOS_REQ directs the DLS provider to set the QOS parameters to the specified values. The normal flow of messages is illustrated in section 3.3.2, (Connectionless mode services).

3.4.3 Error Reporting Service

The acknowledged connectionless mode error reporting service is the same as the unacknowledged connectionless-mode error reporting service. For the message flow, refer to section 3.3.3.

3.5 An Example

To bring it all together, the following example illustrates the primitives that flow during a complete, connection-mode sequence between stream open and stream close.

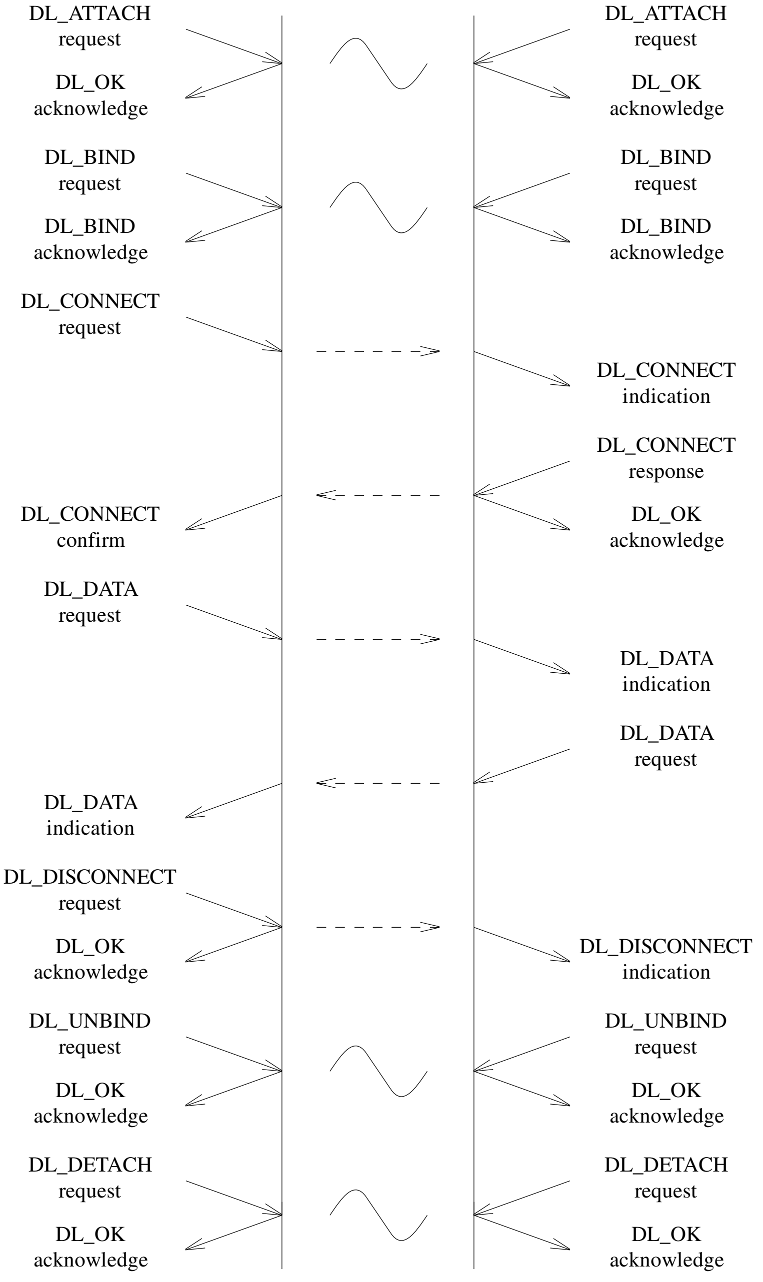


Figure 35. Message Flow: A Connection-mode Example

4. DLPI Primitives

The kernel-level interface to the data link layer defines a STREAMS-based message interface between the provider of the data link service (DLS provider) and the consumer of the data link service (DLS user). STREAMS provides the mechanism in which DLPI primitives may be passed between the DLS user and DLS provider.

Before DLPI primitives can be passed between the DLS user and the DLS provider, the DLS user must establish a stream to the DLS provider using *open*(2). The DLS provider must therefore be configured as a STREAMS driver. When interactions between the DLS user and DLS provider have completed, the stream may be closed.

The STREAMS messages used to transport data link service primitives across the interface have one of the following formats:

- One M_PROTO message block followed by zero or more M_DATA blocks. The M_PROTO message block contains the data link layer service primitive type and all relevant parameters associated with the primitive. The M_DATA block(s) contain any DLS user data that might be associated with the service primitive.
- One M_PCPROTO message block containing the data link layer service primitive type and all relevant parameters associated with the service primitive.
- One or more M_DATA message blocks conveying user data.

The information contained in the M_PROTO or M_PCPROTO message blocks must begin on a byte boundary that is appropriate for structure alignment (e.g. word-aligned on the AT&T 3B2 Computer). STREAMS will allocate buffers that begin on such a boundary. However, these message blocks may contain information whose representation is described by a length and an offset within the block. An example is the DLSAP address (*dl_addr_length* and *dl_addr_offset*) in the DL_BIND_ACK primitive. The offset of such information within the message block is not guaranteed to be properly aligned for casting the appropriate data type (such as an *int* or a *structure*).

Appendix B defines the sequence in which DLPI primitives can be passed between DLS user and DLS provider, and Appendix C summarizes the precedence rules associated with each primitive for ordering the primitives on the DLS provider and DLS user queues.

The following sections describe the format of the primitives that support the services described in the previous section. The primitives are grouped into four general categories for presentation:

- Local Management Service Primitives
- Connection-mode Service Primitives
- Connectionless-mode Service Primitives
- Acknowledged Connectionless-mode Service Primitives

4.1 Local Management Service Primitives

This section describes the local management service primitives that are common to the connection, connectionless and acknowledged connectionless service modes. These primitives support the Information Reporting, Attach, Bind, enabling/disabling of multicast addresses and turning on/off the promiscuous mode. Once a stream has been opened by a DLS user, these primitives initialize the stream, preparing it for use.

4.1.1 PPA Initialization / De-initialization

The PPA associated with each stream must be initialized before the DLS provider can transfer data over the medium. The initialization and de-initialization of the PPA is a network management issue, but DLPI must address the issue because of the impact such actions will have on a DLS user. More specifically, DLPI requires the DLS provider to initialize the PPA associated with a stream at some point before it completes the processing of the DL_BIND_REQ. Guidelines for initialization and de-initialization of a PPA by a DLS provider are presented here.

A DLS provider may initialize a PPA using the following methods:

- pre-initialized by some network management mechanism before the DL_BIND_REQ is received; or
- automatic initialization on receipt of a DL_BIND_REQ or DL_ATTACH_REQ.

A specific DLS provider may support either of these methods, or possibly some combination of the two, but the method implemented has no impact on the DLS user. From the DLS user's viewpoint, the PPA is guaranteed to be initialized on receipt of a DL_BIND_ACK. For automatic initialization, this implies that the DL_BIND_ACK may not be issued until the initialization has completed.

If pre-initialization has not been performed and/or automatic initialization fails, the DLS provider will fail the DL_BIND_REQ. Two errors, DL_INITFAILED and DL_NOTINIT, may be returned in the DL_ERROR_ACK response to a DL_BIND_REQ if PPA initialization fails. DL_INITFAILED is returned when a DLS provider supports automatic PPA initialization, but the initialization attempt failed. DL_NOTINIT is returned when the DLS provider requires pre-initialization, but the PPA is not initialized before the DL_BIND_REQ is received.

A DLS provider may handle PPA de-initialization using the following methods:

- automatic de-initialization upon receipt of the final DL_DETACH_REQ (for *style 2* providers) or DL_UNBIND_REQ (for *style 1* providers), or upon closing of the last stream associated with the PPA;
- automatic de-initialization after expiration of a timer following the last DL_DETACH_REQ, DL_UNBIND_REQ, or close as appropriate; or
- no automatic de-initialization; administrative intervention is required to de-initialize the PPA at some point after it is no longer being accessed.

A specific DLS provider may support any of these methods, or possibly some combination of them, but the method implemented has no impact on the DLS user. From the DLS user's viewpoint, the PPA is guaranteed to be initialized and available for transmission until it closes or unbinds the stream associated with the PPA.

DLS provider-specific addendum documentation should describe the method chosen for PPA initialization and de-initialization.

4.1.2 Message DL_INFO_REQ (*dl_info_req_t*)

Requests information of the DLS provider about the DLPI stream. This information includes a set of provider-specific parameters, as well as the current state of the interface.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
     ulong          dl_primitive;
} dl_info_req_t;
```

Parameters

dl_primitive
conveys DL_INFO_REQ.

State

The message is valid in any state in which a local acknowledgement is not pending, as described in Appendix B, *Allowable Sequence of DLPI Primitives*.

New State

The resulting state is unchanged.

Response

The DLS provider responds to the information request with a DL_INFO_ACK.

4.1.3 Message DL_INFO_ACK (*dl_info_ack_t*)

This message is sent in response to DL_INFO_REQ; it conveys information about the DLPI stream to the DLS user.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef  struct  {
      ulong          dl_primitive;
      ulong          dl_max_sdu;
      ulong          dl_min_sdu;
      ulong          dl_addr_length;
      ulong          dl_mac_type;
      ulong          dl_reserved;
      ulong          dl_current_state;
      long            dl_sap_length;
      ulong          dl_service_mode;
      ulong          dl_qos_length;
      ulong          dl_qos_offset;
      ulong          dl_qos_range_length;
      ulong          dl_qos_range_offset;
      ulong          dl_provider_style;
      ulong          dl_addr_offset;
      ulong          dl_version;
      ulong          dl_brdcst_addr_length;
      ulong          dl_brdcst_addr_offset;
      ulong          dl_growth;
}  dl_info_ack_t;
```

Parameters

dl_primitive

conveys DL_INFO_ACK.

dl_max_sdu

conveys the maximum number of bytes that may be transmitted in a DLSDU. This value must be a positive integer that is greater than or equal to the value of *dl_min_sdu*.

dl_min_sdu

conveys the minimum number of bytes that may be transmitted in a DLSDU. The value is never less than one.

dl_addr_length

conveys the length, in bytes, of the provider's DLSAP address. In the case of a hierarchical subsequent bind, the length returned is the total length i.e Physical address + SAP + subsequent address length.

dl_mac_type

conveys the type of medium supported by this DLPI stream. Possible values include:

DL_CSMACD	The medium is Carrier Sense Multiple Access with Collision Detection (ISO 8802/3).
DL_TPB	The medium is Token-Passing Bus (ISO 8802/4).

DL_TPR	The medium is Token-Passing Ring (ISO 8802/5).
DL_METRO	The medium is Metro Net (ISO 8802/6).
DL_ETHER	The medium is Ethernet Bus.
DL_HDLC	The medium is a bit synchronous communication line.
DL_CHAR	The medium is a character synchronous communication line (e.g. BISYNC).
DL_CTCA	The medium is a channel-to-channel adapter.
DL_FDDI	The medium is a Fiber Distributed Data Interface.
DL_OTHER	Any other medium not listed above.

dl_reserved

is a reserved field whose value must be set to zero.

dl_current_state

conveys the state of the DLPI interface for the stream when the DLS provider issued this acknowledgement. See Appendix B for a list of DLPI states and an explanation of each.

dl_sap_length

indicates the current length of the SAP component of the DLSAP address. It may have a negative, zero or positive value. A positive value indicates the ordering of the SAP and PHYSICAL component within the DLSAP address as SAP component followed by PHYSICAL component. A negative value indicates PHYSICAL followed by the SAP. A zero value indicates that no SAP has yet been bound. The absolute value of the dl_sap_length provides the length of the SAP component within the DLSAP address.

dl_service_mode

if returned before the DL_BIND_REQ is processed, this conveys which service modes (connection-mode, connectionless-mode or acknowledged connectionless-mode, or any comibination of these modes) the DLS provider can support. It contains a bit-mask specifying one or more than one of the following values:

DL_CODLS	connection-oriented data link service;
DL_CLDLS	connectionless data link service;
DL_ACLDLS	acknowledged connectionless data link service;

Once a specific service mode has been bound to the stream, this field returns that specific service mode.

dl_qos_length

conveys the length, in bytes, of the negotiated/selected values of the quality of service (QOS) parameters. Section 5, *Quality of Data Link Service*, describes quality of service and its associated parameters completely. For connection-mode service, the returned values are those agreed during negotiation. For connectionless-mode service, the values are those currently selected by the DLS user. If quality of service has not yet been negotiated, default values will be returned; these values correspond to those that will be applied by the DLS provider on a connect request in connection-mode service, or those that will be applied to each data unit transmission in connectionless-mode service. If the DLS provider supports both connection-mode and connectionless-mode services but the DLS user has not yet bound a specific service mode, the DLS provider may return either connection-mode or connectionless-mode QOS parameter values.

The QOS values are conveyed in the structures defined in section 5.3, *QOS Data Structures*. For any parameter the DLS provider does not support or cannot determine, the corresponding entry will be set to DL_UNKNOWN. If the DLS provider does not support any QOS parameters, this length field will be set to zero.

dl_qos_offset
conveys the offset from the beginning of the M_PCPROTO block where the current quality of service parameters begin.

dl_qos_range_length
conveys the length, in bytes, of the available range of QOS parameter values supported by the DLS provider. For connection-mode service, this is the range available to the calling DLS user in a connect request. For connectionless-mode, this is the range available for each data unit transmission. If the DLS provider supports both connection-mode and connectionless-mode services but the DLS user has not yet bound a specific service mode, the DLS provider may return either connection-mode or connectionless-mode QOS parameter values.

The range of available QOS values is conveyed in the structures defined in section 5.3, *QOS Data Structures*. For any parameter the DLS provider does not support or cannot determine, the corresponding entry will be set to DL_UNKNOWN. If the DLS provider does not support any QOS parameters, this length field will be set to zero.

dl_qos_range_offset
conveys the offset from the beginning of the M_PCPROTO block where the available range of quality of service parameters begins.

dl_provider_style
conveys the style of DLS provider associated with the DLPI stream (see section 2.3.1, *Physical Attachment Identification*). The following provider classes are defined:

DL_STYLE1	The PPA is implicitly attached to the DLPI stream by opening the appropriate major/minor device number.
DL_STYLE2	The DLS user must explicitly attach a PPA to the DLPI stream using DL_ATTACH_REQ.

DLS users implemented in a protocol-independent manner must access this parameter to determine whether the DLS attach service must be invoked explicitly.

dl_addr_offset
conveys the offset of the address that is bound to the associated stream. If the DLS user issues a DL_INFO_REQ prior to binding a DLSAP, the value of *dl_addr_len* will be 0 and consequently indicate that there has been no address bound.

dl_version
indicates the current version of the dlpi that's supported.

dl_brdcst_addr_length
indicates the length of the physical broadcast address.

dl_brdcst_addr_offset
indicates the offset of the physical broadcast address from the beginning of the PCPROTO block.

dl_growth
conveys a growth field for future use. The value of this field will be zero.

State

The message is valid in any state in response to a DL_INFO_REQ.

New State

The resulting state is unchanged.

4.1.4 Message DL_ATTACH_REQ (*dl_attach_req_t*)

Requests the DLS provider associate a physical point of attachment (PPA) with a stream. DL_ATTACH_REQ is needed for *style 2* DLS providers to identify the physical medium over which communication will transpire. The request may not be issued to a *style 1* DLS provider; doing so may cause errors.

The DLS provider may initialize the physical line on receipt of this primitive or the DL_BIND_REQ. Otherwise, the line must be initialized through some management mechanism before this request is issued by the DLS user. Either way, the physical link must be initialized and ready for use on successful completion of the DL_BIND_REQ.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
typedef struct {
     ulong         dl_primitive;
     ulong         dl_ppa;
} dl_attach_req_t;
```

Parameters

dl_primitive
conveys DL_ATTACH_REQ.

dl_ppa
conveys the identifier of the physical point of attachment to be associated with the stream. The format of the identifier is provider-specific, and it must contain sufficient information to distinguish the desired PPA from all possible PPAs on a system.

At a minimum, this must include identification of the physical medium over which communication will transpire. For media that multiplex multiple channels over a single physical medium, this identifier should also specify a specific channel to be used for communication (where each channel on a physical medium is associated with a separate PPA).

Because of the provider-specific nature of this value, DLS user software that is to be protocol independent should avoid hard-coding the PPA identifier. The DLS user should retrieve the necessary PPA identifier from some other entity (such as a management entity) and insert it without inspection into the DL_ATTACH_REQ.

State

The message is valid in state DL_UNATTACHED.

New State

The resulting state is DL_ATTACH_PENDING.

Response

If the attach request is successful, DL_OK_ACK is sent to the DLS user resulting in state DL_UNBOUND.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_BADPPA	The specified PPA is invalid.
DL_ACCESS	The DLS user did not have proper permission to use the requested PPA.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.1.5 Message DL_DETACH_REQ (*dl_detach_req_t*)

For *style 2* DLS providers, this requests the DLS provider detach a physical point of attachment (PPA) from a stream. The request may not be issued to a *style 1* DLS provider; doing so may cause errors.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
typedef struct {
      ulong          dl_primitive;
} dl_detach_req_t;
```

Parameters

dl_primitive
conveys DL_DETACH_REQ.

State

The message is valid in state DL_UNBOUND.

New State

The resulting state is DL_DETACH_PENDING.

Response

If the detach request is successful, DL_OK_ACK is sent to the DLS user resulting in state DL_UNATTACHED.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.1.6 Message DL_BIND_REQ (*dl_bind_req_t*)

Requests the DLS provider bind a DLSAP to the stream. The DLS user must identify the address of the DLSAP to be bound to the stream. For connection-mode service, the DLS user also indicates whether it will accept incoming connection requests on the stream. Finally, the request directs the DLS provider to activate the stream associated with the DLSAP.

A stream is viewed as active when the DLS provider may transmit and receive protocol data units destined to or originating from the stream. The PPA associated with each stream must be initialized upon completion of the processing of the DL_BIND_REQ (see section 4.1.1, *PPA Initialization / De-initialization*). More specifically, the DLS user is ensured that the PPA is initialized when the DL_BIND_ACK is received. If the PPA cannot be initialized, the DL_BIND_REQ will fail.

A stream may be bound as a "connection management" stream, such that it will receive all connect requests that arrive through a given PPA (see section 2.4, *The Connection Management Stream*). In this case, the dl_sap will be ignored.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
      ulong          dl_primitive;
      ulong          dl_sap;
      ulong          dl_max_conind;
      ushort         dl_service_mode;
      ushort         dl_conn_mgmt;
      ulong          dl_xidtest_flg;
}  dl_bind_req_t;
```

Parameters

dl_primitive

conveys DL_BIND_REQ.

dl_sap

conveys sufficient information to identify the DLSAP that will be bound to the DLPI stream (see section 2.3, *DLPI Addressing*, for a description of DLSAP addresses). The format of this information is specific to a given DLS provider, and may contain the full DLSAP address or some portion of that address sufficient to uniquely identify the DLSAP in question. The full address of the bound DLSAP will be returned in the DL_BIND_ACK.

The following rules are used by the DLS provider when binding a DLSAP address.

- The DLS provider must define and manage its DLSAP address space.
- DLPI allows the same DLSAP to be bound to multiple streams, but a given DLS provider may need to restrict its address space to allow one stream per DLSAP.
- The DLS provider may not be able to bind the specified DLSAP address for the following reasons:
  (1) the DLS provider may statically associate a specific DLSAP with each stream; or
  (2) the DLS provider may only support one stream per DLSAP and the DLS user attempted to bind a DLSAP that was already bound to another stream.

In case (1), the value of *dl_sap* is ignored by the DLS provider and the DL_BIND_ACK returns the DLSAP address that is already associated with the stream. In case (2), if the DLS provider cannot bind the given DLSAP to the stream, it may attempt to choose an alternate DLSAP and return that on the DL_BIND_ACK. If an alternate DLSAP cannot be chosen, the DLS provider will return a DL_ERROR_ACK and set *dl_errno* to DL_NOADDR.

Because of the provider-specific nature of the DLSAP address, DLS user software that is to be protocol independent should avoid hard-coding this value. The DLS user should retrieve the necessary DLSAP address from some other entity (such as a management entity or higher layer protocol entity) and insert it without inspection into the DL_BIND_REQ.

dl_max_conind

conveys the maximum number of outstanding DL_CONNECT_IND messages allowed on the DLPI stream. If the value is zero, the stream cannot accept any DL_CONNECT_IND messages. If greater than zero, the DLS user will accept DL_CONNECT_IND messages up to the given value before having to respond with a DL_CONNECT_RES or a DL_DISCONNECT_REQ (see section 4.2.1, *Multi-threaded Connection Establishment*, for details on how this value is used to support multi-threaded connect processing). The DLS provider may not be able to support the value supplied in *dl_max_conind*, as specified by the following rules.

- If the provider cannot support the specified number of outstanding connect indications, it should set the value down to a number it can support.
- Only one stream that is bound to the indicated DLSAP may have an allowed number of maximum outstanding connect indications greater than zero. If a DL_BIND_REQ specifies a value greater than zero, but another stream has already bound itself to the DLSAP with a value greater than zero, the DLS provider will fail the request, setting *dl_errno* to DL_BOUND on the DL_ERROR_ACK.
- If a stream with *dl_max_conind* greater than zero is used to accept a connection, the stream will be found busy during the duration of the connection, and no other streams may be bound to the same DLSAP with a value of *dl_max_conind* greater than zero. This restriction prevents more than one stream bound to the same DLSAP from receiving connect indications and accepting connections. Accepting a connection on such a stream is only allowed if there is just a single outstanding connect indication being processed.
- A DLS user should always be able to request a *dl_max_conind* value of zero, since this indicates to the DLS provider that the stream will only be used to originate connect requests.
- A stream with a negotiated value of *dl_max_conind* that is greater than zero may not originate connect requests.

This field is ignored in connectionless-mode service.

dl_service_mode

conveys the desired mode of service for this stream, and may contain one of the following:

DL_CODLS	connection-oriented data link service;
DL_CLDLS	connectionless data link service.
DL_ACLDLS	acknowledged connectionless data link service.

If the DLS provider does not support the requested service mode, a DL_ERROR_ACK will be generated, specifying DL_UNSUPPORTED.

dl_conn_mgmt

if non-zero, indicates that the stream is the "connection management" stream for the PPA to which the stream is attached. When an incoming connect request arrives, the DLS provider will first look for a stream bound with *dl_max_conind* greater than zero that is associated with the destination DLSAP. If such a stream is found, the connect indication will be issued on that stream. Otherwise, the DLS provider will issue the connect indication on the "connection management" stream for that PPA, if one exists. Only one "connection management" stream is allowed per PPA, so an attempt to bind a second "connection management" stream on a PPA will fail with the DLPI error set to DL_BOUND. When *dl_conn_mgmt* is non-zero, the value of *dl_sap* will be ignored. In connectionless-mode service, *dl_conn_mgmt* is ignored by the DLS provider.

dl_xidtest_flg

indicates to the DLS Provider that XID and/or TEST responses for this stream are to be automatically generated by the DLS Provider. The DLS Provider will not generate DL_XID_IND and/or DL_TEST_IND, and will error a DL_XID_REQ and/or DL_TEST_REQ. If the DLS Provider does not support automatic handling of XID and/or TEST responses, a DL_ERROR_ACK will be generated, specifying DL_NOAUTO, DL_NOXIDAUTO or DL_NOTESTAUTO. If the Provider receives an XID or TEST request from the DLS User, a DL_ERROR_ACK will be generated specifying DL_XIDAUTO or DL_TESTAUTO respectively.

The dl_xidtest_flg contains a bit-mask specifying zero or more of the following values:

DL_AUTO_XID	Automatically respond to XID commands.
DL_AUTO_TEST	Automatically respond to TEST commands.

State

The message is valid in state DL_UNBOUND.

New State

The resulting state is DL_BIND_PENDING.

Response

If the bind request is successful, DL_BIND_ACK is sent to the DLS user resulting in state DL_IDLE.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_BADADDR	The DLSAP address information was invalid or was in an incorrect format.
DL_INITFAILED	Automatic initialization of the PPA failed.
DL_NOTINIT	The PPA had not been initialized prior to this request.
DL_ACCESS	The DLS user did not have proper permission to use the requested DLSAP address.
DL_BOUND	The DLS user attempted to bind a second stream to a DLSAP with *dl_max_conind* greater than zero, or the DLS user attempted to bind a second "connection management" stream to a PPA.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_NOADDR	The DLS provider could not allocate a DLSAP address for this stream.
DL_UNSUPPORTED	The DLS provider does not support requested service mode on this stream.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.
DL_NOAUTO	Automatic handling of XID and TEST responses not supported.
DL_NOXIDAUTO	Automatic handling of XID response not supported.
DL_NOTESTAUTO	Automatic handling of TEST response not supported.

4.1.7 Message DL_BIND_ACK (*dl_bind_ack_t*)

Reports the successful bind of a DLSAP to a stream, and returns the bound DLSAP address to the DLS user. This primitive is generated in response to a DL_BIND_REQ.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
     ulong        dl_primitive;
     ulong        dl_sap;
     ulong        dl_addr_length;
     ulong        dl_addr_offset;
     ulong        dl_max_conind;
     ulong        dl_xidtest_flg;
} dl_bind_ack_t;
```

Parameters

dl_primitive
conveys DL_BIND_ACK.

dl_sap
conveys the DLSAP address information associated with the bound DLSAP. It corresponds to the *dl_sap* field of the associated DL_BIND_REQ, which contains either part or all of the DLSAP address. For that portion of the DLSAP address conveyed in the DL_BIND_REQ, this field contains the corresponding portion of the address for the DLSAP that was actually bound.

dl_addr_length
conveys the length of the complete DLSAP address that was bound to the DLPI stream (see section 2.3, *DLPI Addressing*, for a description of DLSAP addresses). The bound DLSAP is chosen according to the guidelines presented under the description of DL_BIND_REQ.

dl_addr_offset
conveys the offset from the beginning of the M_PCPROTO block where the DLSAP address begins.

dl_max_conind
conveys the allowed, maximum number of outstanding DL_CONNECT_IND messages to be supported on the DLPI stream. If the value is zero, the stream cannot accept any DL_CONNECT_IND messages. If greater than zero, the DLS user will accept DL_CONNECT_IND messages up to the given value before having to respond with a DL_CONNECT_RES or a DL_DISCONNECT_REQ. The rules for negotiating this value are presented under the description of DL_BIND_REQ.

dl_xidtest_flg
conveys the XID and TEST responses supported by the provider.

DL_AUTO_XID	XID response handled automatically.
DL_AUTO_TEST	TEST response handled automatically.

If no value is specified in dl_xidtest_flg, it indicates that automatic handling of XID and TEST responses is not supported by the Provider.

State

The message is valid in state DL_BIND_PENDING.

New State

The resulting state is DL_IDLE.

4.1.8 Message DL_UNBIND_REQ (*dl_unbind_req_t*)

Requests the DLS provider to unbind the DLSAP that had been bound by a previous DL_BIND_REQ from this stream. If one or more DLSAPs were bound to the stream using a DL_SUBS_BIND_REQ, and have not been unbound using a DL_SUBS_UNBIND_REQ, the DL_UNBIND_REQ will unbind all the subesquent DLSAPs for that stream along with the DLSAP bound using the previous DL_BIND_REQ.

At the successful completion of the request, the DLS user may issue a new DL_BIND_REQ for a potentially new DLSAP.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
typedef struct {
      ulong          dl_primitive;
} dl_unbind_req_t;
```

Parameters

dl_primitive
conveys DL_UNBIND_REQ.

State

The message is valid in state DL_IDLE.

New State

The resulting state is DL_UNBIND_PENDING.

Response

If the unbind request is successful, DL_OK_ACK is sent to the DLS user resulting in state DL_UNBOUND.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.1.9 Message DL_SUBS_BIND_REQ (*dl_subs_bind_req_t*)

Requests the DLS provider bind a subsequent DLSAP to the stream. The DLS user must identify the address of the subsequent DLSAP to be bound to the stream.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_subs_sap_offset;
     ulong          dl_subs_sap_length;
     ulong          dl_subs_bind_class;
} dl_subs_bind_req_t;
```

Parameters

dl_primitive
conveys DL_SUBS_BIND_REQ.

dl_subs_sap_offset
conveys the offset of the DLSAP from the beginning of the M_PROTO block.

dl_subs_sap_length
conveys the length of the specified DLSAP.

dl_subs_bind_class
Specifies either peer or hierarchical addressing

DL_PEER_BIND	specifies peer addressing. The DLSAP specified is used in lieu of the DLSAP bound in the BIND request.
DL_HIERARCHICAL_BIND	specifies hierarchical addressing. The DLSAP specified is used in addition to the DLSAP specified using the BIND request.

State

The message is valid in state DL_IDLE.

New State

The resulting state is DL_SUBS_BIND_PND.

Response

If the subsequent bind request is successful, DL_SUBS_BIND_ACK is sent to the DLS user resulting in state DL_IDLE.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_BADADDR	The DLSAP address information was invalid or was in an incorrect format.
DL_ACCESS	The DLS user did not have proper permission to use the requested DLSAP address.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A System error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

DL_UNSUPPORTED	Requested addressing class not supported.
DL_TOOMANY	Limit exceeded on the maximum number of DLSAPs per stream.

4.1.10 Message DL_SUBS_BIND_ACK (*dl_subs_bind_ack_t*)

Reports the succesful bind of a subsequent DLSAP to a stream, and returns the bound DLSAP address to the DLS user. This primitive is generated in response to a DL_SUBS_BIND_REQ.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_subs_sap_offset;
     ulong          dl_subs_sap_length;
} dl_subs_bind_ack_t;
```

Parameters

dl_primitive
conveys DL_SUBS_BIND_ACK.

dl_subs_sap_offset
conveys the offset of the DLSAP from the beginning of the M_PCPROTO block.

dl_subs_sap_length
conveys the length of the specified DLSAP.

State

The message is valid in state DL_SUBS_BIND_PND

New State

The resulting state is DL_IDLE.

4.1.11 Message DL_SUBS_UNBIND_REQ (*dl_subs_unbind_req_t*)

Requests the DLS Provider to unbind the DLSAP that had been bound by a previous DL_SUBS_BIND_REQ from this stream.

Message Format

The message consists of one M_PROTO message block, which contains the following structure:

```
typedef struct {
      ulong          dl_primitive;
      ulong          dl_subs_sap_offset;
      ulong          dl_subs_sap_length;
} dl_subs_unbind_req_t;
```

Parameters

dl_primitive
conveys DL_SUBS_UNBIND_REQ.

dl_subs_sap_offset
conveys the offset of the DLSAP from the beginning of the M_PROTO block.

dl_subs_sap_length
conveys the length of the specified DLSAP.

State

The message is valid in state DL_IDLE.

New State

The resulting state is DL_SUBS_UNBIND_PND.

Response

If the unbind request is successful, a DL_OK_ACK is sent to the DLS User. The resulting state is DL_IDLE.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for failure

DL_OUTSTATE	The primitive was issued from an invalid state
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.
DL_BADADDR	The DLSAP address information was invalid or was in an incorrect format.

4.1.12 Message DL_ENABMULTI_REQ (*dl_enabmulti_req_t*)

Requests the DLS Provider to enable specific multicast addresses on a per Stream basis. It is invalid for a DLS Provider to pass upstream messages that are destined for any address other than those explicitly enabled on that Stream by the DLS User.

Message Format

The message consists of one M_PROTO message block, which contains the following structure:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_addr_length;
      ulong dl_addr_offset;
} dl_enabmulti_req_t;
```

Parameters

dl_primitive
conveys DL_ENABMULTI_REQ

dl_addr_length
conveys the length of the multicast address

dl_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the multicast address begins

State

This message is valid in any state in which a local acknowledgement is not pending with the exception of DL_UNATTACH.

New State

The resulting state is unchanged.

Response

If the enable request is successful, a DL_OK_ACK is sent to the DLS user. If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for failure

DL_BADADDR	Address information was invalid or was in an incorrect format.
DL_TOOMANY	Too many multicast address enable attempts. Limit exceeded.
DL_OUTSTATE	The primitive was issued from an invalid state
DL_NOTSUPPORTED	The primitive is known, but not supported by the DLS Provider.

4.1.13 Message DL_DISABMULTI_REQ (*dl_disabmulti_req_t*)

Requests the DLS Provider to disable specific multicast addresses on a per Stream basis.

Message Format

The message consists of one M_PROTO message block, which contains the following structure:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_addr_length;
      ulong dl_addr_offset;
} dl_disabmulti_req_t;
```

Parameters

dl_primitive
conveys DL_DISABMULTI_REQ

dl_addr_length
conveys the length of the physical address

dl_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the multicast address begins

State

This message is valid in any state in which a local acknowledgement is not pending with the exception of DL_UNATTACH.

New State

The resulting state is unchanged.

Response

If the disable request is successful, a DL_OK_ACK is sent to the DLS user. If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for failure

DL_BADADDR	Address information was invalid or in an incorrect format.
DL_NOTENAB	Address specified is not enabled.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_NOTSUPPORTED	Primitive is known, but not supported by the DLS Provider.

4.1.14 Message DL_PROMISCON_REQ (*dl_promiscon_req_t*)

This primitive requests the DLS Provider to enable promiscuous mode on a per Stream basis, either at the physical level or at the SAP level.

The DL Provider will route all received messages on the media to the DLS User until either a DL_DETACH_REQ or a DL_PROMISCOFF_REQ is received or the Stream is closed.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_level;
} dl_promiscon_req_t;
```

Parameters

dl_primitive

conveys DL_PROMISCON_REQ

dl_level

indicates promiscuous mode at the physical or SAP level

DL_PROMISC_PHYS	indicates promiscuous mode at the physical level
DL_PROMISC_SAP	indicates promiscuous mode at the SAP level
DL_PROMISC_MULTI	indicates promiscuous mode for all multicast addresses

State

The message is valid in any state when there is no pending acknowledgement.

New State

The resulting state is unchanged.

Response

If enabling of promiscuous mode is successful, a DL_OK_ACK is returned. Otherwise, a DL_ERROR_ACK is returned.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state
DL_SYSERR	A System error has occurred and the UNIX System error is indicated in the DL_ERROR_ACK.
DL_NOTSUPPORTED	Primitive is known but not supported by the DLS Provider
DL_UNSUPPORTED	Requested service is not supplied by the provider.

4.1.15 Message DL_PROMISCOFF_REQ (*dl_promiscoff_req_t*)

This primitive requests the DLS Provider to disable promiscuous mode on a per Stream basis, either at the physical level or at the SAP level.

Message Format

The message consists of one M_PROTO message block, which contains the following structure.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_level;
} dl_promiscoff_req_t;
```

Parameters

dl_primitive

conveys DL_PROMISCOFF_REQ

dl_level

indicates promiscuous mode at the physical or SAP level

DL_PROMISC_PHYS	indicates promiscuous mode at the physical level
DL_PROMISC_SAP	indicates promiscuous mode at the SAP level
DL_PROMISC_MULTI	indicates promiscuous mode for all multicast addresses

State

The message is valid in any state in which the promiscuous mode is enabled and there is no pending acknowledgement.

New State

The resulting state is unchanged.

Response

If the promiscuous mode disabling is successful, a DL_OK_ACK is returned. Otherwise, a DL_ERROR_ACK is returned.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state
DL_SYSERR	A System error has occurred and the UNIX System error is indicated in the DL_ERROR_ACK.
DL_NOTSUPPORTED	Primitive is known but not supported by the DLS Provider
DL_NOTENAB	Mode not enabled.

4.1.16 Message DL_OK_ACK (*dl_ok_ack_t*)

Acknowledges to the DLS user that a previously issued request primitive was received successfully. It is only initiated for those primitives that require a positive acknowledgement.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
      ulong          dl_primitive;
      ulong          dl_correct_primitive;
} dl_ok_ack_t;
```

Parameters

dl_primitive
conveys DL_OK_ACK.

dl_correct_primitive
identifies the successfully received primitive that is being acknowledged.

State

The message is valid in response to a DL_ATTACH_REQ, DL_DETACH_REQ, DL_UNBIND_REQ, DL_CONNECT_RES, DL_RESET_RES, DL_DISCON_REQ, DL_SUBS_UNBIND_REQ, DL_PROMISCON_REQ, DL_ENABMULTI_REQ, DL_DISABMULTI_REQ or DL_PROMISCOFF_REQ from any of several states as defined in Appendix B.

New State

The resulting state depends on the current state and is defined fully in Appendix B.

4.1.17 Message DL_ERROR_ACK (*dl_error_ack_t*)

Informs the DLS user that a previously issued request or response was invalid. It conveys the identity of the primitive in error, a DLPI error code, and if appropriate, a UNIX system error code.

Whenever this primitive is generated, it indicates that the DLPI state is identical to what it was before the erroneous request or response.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
        ulong         dl_primitive;
        ulong         dl_error_primitive;
        ulong         dl_errno;
        ulong         dl_unix_errno;
} dl_error_ack_t;
```

Parameters

dl_primitive
conveys DL_ERROR_ACK.

dl_error_prim
identifies the primitive in error.

dl_errno
conveys the DLPI error code associated with the failure. See the individual request or response for the error codes that are applicable. In addition to those errors:

- DL_BADPRIM error is returned if an unrecognized primitive is issued by the DLS user.
- DL_NOTSUPPORTED error is returned if an unsupported primitive is issued by the DLS user.

dl_unix_errno
conveys the UNIX system error code associated with the failure. This value should be non-zero only when *dl_errno* is set to DL_SYSERR. It is used to report UNIX system failures that prevent the processing of a given request or response.

State

The message is valid in every state where an acknowledgement or confirmation of a previous request or response is pending.

New State

The resulting state is that from which the acknowledged request or response was generated.

4.2 Connection-mode Service Primitives

This section describes the service primitives that support the connection-mode service of the data link layer. These primitives support the connection establishment, connection-mode data transfer, and connection release services described earlier.

4.2.1 Multi-threaded Connection Establishment

In the connection establishment model, the calling DLS user initiates a request for a connection, and the called DLS user receives each request and either accepts or rejects it. In the simplest form (single-threaded), the called DLS user is passed a connect indication and the DLS provider holds any subsequent indications until a response for the current outstanding indication is received. At most one connect indication is outstanding at any time.

DLPI also enables a called DLS user to multi-thread connect indications and responses. This capability is desirable, for example, when imposing a priority scheme on all DLS users attempting to establish a connection. The DLS provider will pass all connect indications to the called DLS user (up to some pre-established limit as set by DL_BIND_REQ and DL_BIND_ACK). The called DLS user may then respond to the requests in any order.

To support multi-threading, a correlation value is needed to associate responses with the appropriate connect indication. A correlation value is contained in each DL_CONNECT_IND, and the DLS user must use this value in the DL_CONNECT_RES or DL_DISCONNECT_REQ primitive used to accept or reject the connect request. The DLS user can also receive a DL_DISCONNECT_IND with a correlation value when the calling DLS user or the DLS provider abort a connect request.

Once a connection has been accepted or rejected, the correlation value has no meaning to a DLS user. The DLS provider may reuse the correlation value in another DL_CONNECT_IND. Thus, the lifetime of a correlation value is the duration of the connection establishment phase, and as good programming practice it should not be used for any other purpose by the DLS provider.

The DLS provider assigns the correlation value for each connect indication. Correlation values must be unique among all outstanding connect indications on a given stream. The values may, but need not, be unique across all streams to the DLS provider. The correlation value must be a positive, non-zero value. There is no implied sequencing of connect indications using the correlation value; the values do not have to increase sequentially for each new connect indication.

4.2.2 Message DL_CONNECT_REQ (*dl_connect_req_t*)

Requests the DLS provider establish a data link connection with a remote DLS user. The request contains the DLSAP address of the remote (called) DLS user and quality of service parameters to be negotiated during connection establishment.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
     ulong        dl_primitive;
     ulong        dl_dest_addr_length;
     ulong        dl_dest_addr_offset;
     ulong        dl_qos_length;
     ulong        dl_qos_offset;
     ulong        dl_growth;
} dl_connect_req_t;
```

Parameters

dl_primitive
conveys DL_CONNECT_REQ.

dl_dest_addr_length
conveys the length of the DLSAP address that identifies the DLS user with whom a connection is to be established. If the called user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_qos_length
conveys the length of the quality of service (QOS) parameter values desired by the DLS user initiating a connection. The desired QOS values are conveyed in the appropriate structure defined in section 5.3, *QOS Data Structures*. A full specification of these QOS parameters and rules for negotiating their values is presented in section 5, *Quality of Data Link Service*.

If the DLS user does not wish to specify a particular QOS value, the value DL_QOS_DONT_CARE may be specified. If the DLS user does not care to specify any QOS parameter values, this field may be set to zero.

dl_qos_offset
conveys the offset from the beginning of the M_PROTO message block where the quality of service parameters begin.

dl_growth
defines a growth field for future enhancements to this primitive. Its value must be set to zero.

State

The message is valid in state DL_IDLE.

New State

The resulting state is DL_OUTCON_PENDING.

Response

There is no immediate response to the connect request. However, if the connect request is accepted by the called DLS user, DL_CONNECT_CON is sent to the calling DLS user, resulting in state DL_DATAXFER.

If the connect request is rejected by the called DLS user, the called DLS user cannot be reached, or the DLS provider and/or called DLS user do not agree on the specified quality of service, a DL_DISCONNECT_IND is sent to the calling DLS user, resulting in state DL_IDLE.

If the request is erroneous, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_BADADDR	The destination DLSAP address was in an incorrect format or contained invalid information.
DL_BADQOSPARAM	The quality of service parameters contained invalid values.
DL_BADQOSTYPE	The quality of service structure type was not supported by the DLS provider.
DL_ACCESS	The DLS user did not have proper permission to use the requested DLSAP address.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.2.3 Message DL_CONNECT_IND (*dl_connect_ind_t*)

Conveys to the local DLS user that a remote (calling) DLS user wishes to establish a data link connection. The indication contains the DLSAP address of the calling and called DLS user, and the quality of service parameters as specified by the calling DLS user and negotiated by the DLS provider.

The DL_CONNECT_IND also contains a number that allows the DLS user to correlate a subsequent DL_CONNECT_RES, DL_DISCONNECT_REQ, or DL_DISCONNECT_IND with the indication (see section 4.2.1, *Multi-threaded Connection Establishment*).

The number of outstanding DL_CONNECT_IND primitives issued by the DLS provider must not exceed the value of *dl_max_conind* as returned on the DL_BIND_ACK. If this limit is reached and an additional connect request arrives, the DLS provider must not pass the corresponding connect indication to the DLS user until a response is received for an already outstanding indication.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
      ulong         dl_primitive;
      ulong         dl_correlation;
      ulong         dl_called_addr_length;
      ulong         dl_called_addr_offset;
      ulong         dl_calling_addr_length;
      ulong         dl_calling_addr_offset;
      ulong         dl_qos_length;
      ulong         dl_qos_offset;
      ulong         dl_growth;
} dl_connect_ind_t;
```

Parameters

dl_primitive
conveys DL_CONNECT_IND.

dl_correlation
conveys the correlation number to be used by the DLS user to associate this message with the DL_CONNECT_RES, DL_DISCONNECT_REQ, or DL_DISCONNECT_IND that is to follow. This value, then, enables the DLS user to multi-thread connect indications and responses. All outstanding connect indications must have a distinct, non-zero correlation value set by the DLS provider.

dl_called_addr_length
conveys the length of the address of the DLSAP for which this DL_CONNECT_IND primitive is intended. This address is the full DLSAP address specified by the calling DLS user and is typically the value returned on the DL_BIND_ACK associated with the given stream.

dl_called_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the called DLSAP address begins.

dl_calling_addr_length
conveys the length of the address of the DLSAP from which the DL_CONNECT_REQ primitive was sent.

dl_calling_addr_offset

conveys the offset from the beginning of the M_PROTO message block where the calling DLSAP address begins.

dl_qos_length

conveys the range of quality of service parameter values desired by the calling DLS user and negotiated by the DLS provider. The range of QOS values is conveyed in the appropriate structure defined in section 5.3, *QOS Data Structures*. A full specification of these QOS parameters and rules for negotiating their values is presented in section 5, *Quality of Data Link Service*.

For any parameter the DLS provider does not support or cannot determine, the corresponding parameter values will be set to DL_UNKNOWN. If the DLS provider does not support any QOS parameters, this length field will be set to zero.

dl_qos_offset

conveys the offset from the beginning of the M_PROTO message block where the quality of service parameters begin.

dl_growth

defines a growth field for future enhancements to this primitive. Its value will be set to zero.

State

The message is valid in state DL_IDLE, or state DL_INCON_PENDING when the maximum number of outstanding DL_CONNECT_IND primitives has not been reached on this stream.

New State

The resulting state is DL_INCON_PENDING, regardless of the current state.

Response

The DLS user must eventually send either DL_CONNECT_RES to accept the connect request or DL_DISCONNECT_REQ to reject the connect request. In either case, the responding message must convey the correlation number received in the DL_CONNECT_IND. The DLS provider will use the correlation number to identify the connect request to which the DLS user is responding.

4.2.4 Message DL_CONNECT_RES (*dl_connect_res_t*)

Directs the DLS provider to accept a connect request from a remote (calling) DLS user on a designated stream. The DLS user may accept the connection on the same stream where the connect indication arrived, or on a different stream that has been previously bound. The response contains the correlation number from the corresponding DL_CONNECT_IND, selected quality of service parameters, and an indication of the stream on which to accept the connection.

After issuing this primitive, the DLS user may immediately begin transferring data using the DL_DATA_REQ primitive. If the DLS provider receives one or more DL_DATA_REQ primitives from the local DLS user before it has completed connection establishment, however, it must queue the data transfer requests internally until the connection is successfully established.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
      ulong          dl_primitive;
      ulong          dl_correlation;
      ulong          dl_resp_token;
      ulong          dl_qos_length;
      ulong          dl_qos_offset;
      ulong          dl_growth;
} dl_connect_res_t;
```

Parameters

dl_primitive

conveys DL_CONNECT_RES.

dl_correlation

conveys the correlation number that was received with the DL_CONNECT_IND associated with the connection request. The DLS provider will use the correlation number to identify the connect indication to which the DLS user is responding.

dl_resp_token

if non-zero, conveys the token associated with the responding stream on which the DLS provider is to establish the connection; this stream must be in the state DL_IDLE. The token value for a stream can be obtained by issuing a DL_TOKEN_REQ on that stream. If the DLS user is accepting the connection on the stream where the connect indication arrived, this value must be zero. See section 2.2.1.2, *Connection Establishment*, for a description of the connection response model.

dl_qos_length

conveys the length of the quality of service parameter values selected by the called DLS user. The selected QOS values are conveyed in the appropriate structure as defined in section 5.3, *QOS Data Structures*. A full specification of these QOS parameters and rules for negotiating their values is presented in section 5, *Quality of Data Link Service*.

If the DLS user does not care which value is selected for a particular QOS parameter, the value DL_QOS_DONT_CARE may be specified. If the DLS user does not care which values are selected for all QOS parameters, this field may be set to zero.

dl_qos_offset

conveys the offset from the beginning of the M_PROTO message block where the quality of service parameters begin.

dl_growth
defines a growth field for future enhancements to this primitive. Its value must be set to zero.

State

The primitive is valid in state DL_INCON_PENDING.

New State

The resulting state is DL_CONN_RES_PENDING.

Response

If the connect response is successful, DL_OK_ACK is sent to the DLS user. If no outstanding connect indications remain, the resulting state for the current stream is DL_IDLE; otherwise it remains DL_INCON_PENDING. For the responding stream (designated by the parameter *dl_resp_token*), the resulting state is DL_DATAXFER. If the current stream and responding stream are the same, the resulting state of that stream is DL_DATAXFER. These streams may only be the same when the response corresponds to the only outstanding connect indication.

If the request fails, DL_ERROR_ACK is returned on the stream where the DL_CONNECT_RES primitive was received, and the resulting state of that stream and the responding stream is unchanged.

Reasons for Failure

DL_BADTOKEN	The token for the responding stream was not associated with a currently open stream.
DL_BADQOSPARAM	The quality of service parameters contained invalid values.
DL_BADQOSTYPE	The quality of service structure type was not supported by the DLS provider.
DL_BADCORR	The correlation number specified in this primitive did not correspond to a pending connect indication.
DL_ACCESS	The DLS user did not have proper permission to use the responding stream.
DL_OUTSTATE	The primitive was issued from an invalid state, or the responding stream was not in a valid state for establishing a connection.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.
DL_PENDING	Current stream and responding stream is the same and there is more than one outstanding connect indication.

4.2.5 Message DL_CONNECT_CON (*dl_connect_con_t*)

Informs the local DLS user that the requested data link connection has been established. The primitive contains the DLSAP address of the responding DLS user and the quality of service parameters as selected by the responding DLS user.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef  struct  {
      ulong          dl_primitive;
      ulong          dl_resp_addr_length;
      ulong          dl_resp_addr_offset;
      ulong          dl_qos_length;
      ulong          dl_qos_offset;
      ulong          dl_growth;
}  dl_connect_con_t;
```

Parameters

dl_primitive
conveys DL_CONNECT_CON.

dl_resp_addr_length
conveys the length of the address of the responding DLSAP associated with the newly established data link connection.

dl_resp_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the responding DLSAP address begins.

dl_qos_length
conveys the length of the quality of service parameter values selected by the responding DLS user. The selected QOS values are conveyed in the appropriate structure defined in section 5.3, *QOS Data Structures*. A full specification of these QOS parameters and rules for negotiating their values is presented in section 5, *Quality of Data Link Service*.

For any parameter the DLS provider does not support or cannot determine, the corresponding parameter value will be set to DL_UNKNOWN. If the DLS provider does not support any QOS parameters, this length field will be set to zero.

dl_qos_offset
conveys the offset from the beginning of the M_PROTO message block where the quality of service parameters begin.

dl_growth
defines a growth field for future enhancements to this primitive. Its value will be set to zero.

State

The message is valid in state DL_OUTCON_PENDING.

New State

The resulting state is DL_DATAXFER.

4.2.6 Message DL_TOKEN_REQ (*dl_token_req_t*)

Requests that a connection response token be assigned to the stream and returned to the DLS user. This token can be supplied in the DL_CONNECT_RES primitive to indicate the stream on which a connection will be established.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
      ulong          dl_primitive;
} dl_token_req_t;
```

Parameters

dl_primitive
conveys DL_TOKEN_REQ.

State

The message is valid in any state in which a local acknowledgement is not pending, as described in Appendix B, *Allowable Sequence of DLPI Primitives*.

New State

The resulting state is unchanged.

Response

The DLS provider responds to the information request with a DL_TOKEN_ACK.

4.2.7 Message DL_TOKEN_ACK (*dl_token_ack_t*)

This message is sent in response to DL_TOKEN_REQ; it conveys the connection response token assigned to the stream.

Message Format

The message consists of one M_PCPROTO message block, which contains the following structure.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_token;
} dl_token_ack_t;
```

Parameters

dl_primitive
conveys DL_TOKEN_ACK.

dl_token
conveys the connection response token associated with the stream. This value must be a non-zero value. The DLS provider will generate a token value for each stream upon receipt of the first DL_TOKEN_REQ primitive issued on that stream. The same token value will be returned in response to all subsequent DL_TOKEN_REQ primitives issued on a stream.

State

The message is valid in any state in response to a DL_TOKEN_REQ.

New State

The resulting state is unchanged.

4.2.8 Message DL_DATA_REQ

Conveys a complete DLSDU from the DLS user to the DLS provider for transmission over the data link connection.

The DLS provider guarantees to deliver each DLSDU to the remote DLS user in the same order as received from the local DLS user. If the DLS provider detects unrecoverable data loss during data transfer, this may be indicated to the DLS user by a DL_RESET_IND, or by a DL_DISCONNECT_IND (if the connection is lost).

Message Format

The message consists of one or more M_DATA message blocks containing at least one byte of data.

To simplify support of a *read*(2)/*write*(2) interface to the data link layer, the DLS provider must recognize and process messages that consist of one or more M_DATA message blocks with no preceding M_PROTO message block. This message type may originate from the *write*(2) system call[1].

State

The message is valid in state DL_DATAXFER. If it is received in state DL_IDLE or DL_PROV_RESET_PENDING, it should be discarded without generating an error.

New State

The resulting state is unchanged.

Response

If the request is valid, no response is generated.

If the request is erroneous, a STREAMS M_ERROR message should be issued to the DLS user specifying an *errno* value of EPROTO. This action should be interpreted as a fatal, unrecoverable, protocol error. A request is considered erroneous under the following conditions.

— The primitive was issued from an invalid state. If the request is issued in state DL_IDLE or DL_PROV_RESET_PENDING, however, it is silently discarded with no fatal error generated.

— The amount of data in the current DLSDU is not within the DLS provider's acceptable bounds as specified by *dl_min_sdu* and *dl_max_sdu* in the DL_INFO_ACK.

Note (Support of Direct User-Level Access)

A STREAMS module would implement "more" field processing itself to support direct user-level access. This module could collect messages and send them in one larger message to the DLS provider, or break large DLSDUs passed to the DLS user into smaller messages. The module would only be pushed if the DLS user was a user-level process.

---

[1] This does not imply that DLPI will directly support a pure *read*(2)/*write*(2). If such an interface is desired, a STREAMS module could be implemented to be pushed above the DLS provider.

4.2.9 Message DL_DATA_IND

Conveys a DLSDU from the DLS provider to the DLS user. The DLS provider guarantees to deliver each DLSDU to the local DLS user in the same order as received from the remote DLS user. If the DLS provider detects unrecoverable data loss during data transfer, this may be indicated to the DLS user by a DL_RESET_IND, or by a DL_DISCONNECT_IND (if the connection is lost).

Message Format

The message consists of one or more M_DATA blocks containing at least one byte of data.

State

The message is valid in state DL_DATAXFER.

New State

The resulting state is unchanged.

4.2.10 Message DL_DISCONNECT_REQ (*dl_disconnect_req_t*)

Requests the DLS provider to disconnect an active data link connection or one that was in the process of activation, either outgoing or incoming, as a result of an earlier DL_CONNECT_IND or DL_CONNECT_REQ. If an incoming DL_CONNECT_IND is being refused, the correlation number associated with that connect indication must be supplied. The message indicates the reason for the disconnect.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_reason;
     ulong          dl_correlation;
} dl_disconnect_req_t;
```

Parameters

dl_primitive
conveys DL_DISCONNECT_REQ.

dl_reason
conveys the reason for the disconnect.

Reasons for Disconnect

DL_DISC_NORMAL_CONDITION
normal release of a data link connection

DL_DISC_ABNORMAL_CONDITION
abnormal release of a data link connection

DL_CONREJ_PERMANENT_COND
a permanent condition caused the rejection of a connect request

DL_CONREJ_TRANSIENT_COND
a transient condition caused the rejection of a connect request

DL_DISC_UNSPECIFIED
reason unspecified

dl_correlation
if non-zero, conveys the correlation number that was contained in the DL_CONNECT_IND being rejected (see section 4.2.1, *Multi-threaded Connection Establishment*). This value permits the DLS provider to associate the primitive with the proper DL_CONNECT_IND when rejecting an incoming connection. If the disconnect request is releasing a connection that is already established, or is aborting a previously sent DL_CONNECT_REQ, the value of *dl_correlation* should be zero.

State

The message is valid in any of the states: DL_DATAXFER, DL_INCON_PENDING, DL_OUTCON_PENDING, DL_PROV_RESET_PENDING, DL_USER_RESET_PENDING.

New State

The resulting state is one of the disconnect pending states, as defined in Appendix B.

Response

If the disconnect is successful, DL_OK_ACK is sent to the DLS user resulting in state DL_IDLE.

If the request fails, message DL_ERROR_ACK is returned, and the resulting state is unchanged.

Reasons for Failure

DL_BADCORR	The correlation number specified in this primitive did not correspond to a pending connect indication.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.2.11 Message DL_DISCONNECT_IND (*dl_disconnect_ind_t*)

Informs the DLS user that the data link connection on this stream has been disconnected, or that a pending connection (either DL_CONNECT_REQ or DL_CONNECT_IND) has been aborted.

The primitive indicates the origin and the cause of the disconnect.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef  struct  {
     ulong         dl_primitive;
     ulong         dl_originator;
     ulong         dl_reason;
     ulong         dl_correlation;
}  dl_disconnect_ind_t;
```

Parameters

dl_primitive
conveys DL_DISCONNECT_IND.

dl_originator
conveys whether the disconnect was DLS user or DLS provider originated (DL_USER or DL_PROVIDER, respectively).

dl_reason
conveys the reason for the disconnect.

Reasons for Disconnect

DL_DISC_PERMANENT_CONDITION
connection released due to permanent condition

DL_DISC_TRANSIENT_CONDITION
connection released due to transient condition

DL_CONREJ_DEST_UNKNOWN
unknown destination for connect request

DL_CONREJ_DEST_UNREACH_PERMANENT
could not reach destination for connect request - permanent condition

DL_CONREJ_DEST_UNREACH_TRANSIENT
could not reach destination for connect request - transient condition

DL_CONREJ_QOS_UNAVAIL_PERMANENT
requested quality of service parameters permanently unavailable during connection establishment

DL_CONREJ_QOS_UNAVAIL_TRANSIENT
requested quality of service parameters temporarily unavailable during connection establishment

DL_DISC_UNSPECIFIED
reason unspecified

dl_correlation
if non-zero, conveys the correlation number that was contained in the DL_CONNECT_IND that

is being aborted (see section 4.2.1, *Multi-threaded Connection Establishment*). This value permits the DLS user to associate the message with the proper DL_CONNECT_IND. If the disconnect indication is indicating the release of a connection that is already established, or is indicating the rejection of a previously sent DL_CONNECT_REQ, the value of *dl_correlation* will be zero.

State

The message is valid in any of the states: DL_DATAXFER, DL_INCON_PENDING, DL_OUTCON_PENDING, DL_PROV_RESET_PENDING, DL_USER_RESET_PENDING.

New State

The resulting state is DL_IDLE.

4.2.12 Message DL_RESET_REQ (*dl_reset_req_t*)

Requests that the DLS provider initiate the resynchronization of a data link connection. This service is abortive, so no guarantee of delivery can be assumed about data that is in transit when the reset request is initiated.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
      ulong          dl_primitive;
} dl_reset_req_t;
```

Parameters

dl_primitive
conveys DL_RESET_REQ.

State

The message is valid in state DL_DATAXFER.

New State

The resulting state is DL_USER_RESET_PENDING.

Response

There is no immediate response to the reset request. However, as resynchronization completes, DL_RESET_CON is sent to the initiating DLS user, resulting in state DL_DATAXFER.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.2.13 Message DL_RESET_IND (*dl_reset_ind_t*)

Informs the DLS user that either the remote DLS user is resynchronizing the data link connection, or the DLS provider is reporting loss of data for which it can not recover. The indication conveys the reason for the reset.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_originator;
     ulong          dl_reason;
} dl_reset_ind_t;
```

Parameters

dl_primitive
conveys DL_RESET_IND.

dl_originator
conveys whether the reset was originated by the DLS user or DLS provider (DL_USER or DL_PROVIDER, respectively).

dl_reason
conveys the reason for the reset.

Reasons for Reset

DL_RESET_FLOW_CONTROL
indicates flow control congestion

DL_RESET_LINK_ERROR
indicates a data link error situation

DL_RESET_RESYNCH
indicates a request for resynchronization of a data link connection.

State

The message is valid in state DL_DATAXFER.

New State

The resulting state is DL_PROV_RESET_PENDING.

Response

The DLS user should issue a DL_RESET_RES primitive to continue the resynchronization procedure.

4.2.14 Message DL_RESET_RES (*dl_reset_res_t*)

Directs the DLS provider to complete resynchronizing the data link connection.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
      ulong          dl_primitive;
} dl_reset_res_t;
```

Parameters

dl_primitive
conveys DL_RESET_RES.

State

The primitive is valid in state DL_PROV_RESET_PENDING.

New State

The resulting state is DL_RESET_RES_PENDING.

Response

If the reset response is successful, DL_OK_ACK is sent to the DLS user resulting in state DL_DATAXFER.

If the reset response is erroneous, DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_SYSERR	A system error has occurred and the UNIX system error is indicated in the DL_ERROR_ACK.

4.2.15 Message DL_RESET_CON (*dl_reset_con_t*)

Informs the reset-initiating DLS user that the reset has completed.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
      ulong          dl_primitive;
} dl_reset_con_t;
```

Parameters

dl_primitive
conveys DL_RESET_CON.

State

The message is valid in state DL_USER_RESET_PENDING.

New State

The resulting state is DL_DATAXFER.

4.3 Connectionless-mode Service Primitives

This section describes the primitives that support the connectionless-mode service of the data link layer. These primitives support the connectionless data transfer service described earlier.

4.3.1 Message DL_UNITDATA_REQ (*dl_unitdata_req_t*)

Conveys one DLSDU from the DLS user to the DLS provider for transmission to a peer DLS user.

Because connectionless data transfer is an unacknowledged service, the DLS provider makes no guarantees of delivery of connectionless DLSDUs. It is the responsibility of the DLS user to do any necessary sequencing or retransmission of DLSDUs in the event of a presumed loss.

Message Format

The message consists of one M_PROTO message block containing the structure shown below, followed by one or more M_DATA blocks containing at least one byte of data. The amount of user data that may be transferred in a single DLSDU is limited. This limit is conveyed by the parameter *dl_max_sdu* in the DL_INFO_ACK primitive.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_dest_addr_length;
     ulong          dl_dest_addr_offset;
     dl_priority_t   dl_priority;
} dl_unitdata_req_t;
```

Parameters

dl_primitive
conveys DL_UNITDATA_REQ.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS user. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_priority
indicates the priority value within the supported range for this particular DLSDU.

State

The message is valid in state DL_IDLE.

New State

The resulting state is unchanged.

Response

If the DLS provider accepts the data for transmission, there is no response. This does not, however, guarantee that the data will be delivered to the destination DLS user, since the connectionless data transfer is not a confirmed service.

If the request is erroneous, message DL_UDERROR_IND is returned, and the resulting state is unchanged.

If for some reason the request cannot be processed, the DLS provider may generate a DL_UDERROR_IND to report the problem. There is, however, no guarantee that such an error report will be generated for all undeliverable data units, since connectionless data transfer is not a confirmed service.

Reasons for Failure

DL_BADADDR	The destination DLSAP address was in an incorrect format or contained invalid information.
DL_BADDATA	The amount of data in the current DLSDU exceeded the DLS provider's DLSDU limit.
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_UNSUPPORTED	Requested priority not supplied by provider.

4.3.2 Message DL_UNITDATA_IND (*dl_unitdata_ind_t*)

Conveys one DLSDU from the DLS provider to the DLS user.

Message Format

The message consists of one M_PROTO message block containing the structure shown below, followed by one or more M_DATA blocks containing at least one byte of data. The amount of user data that may be transferred in a single DLSDU is limited. This limit is conveyed by the parameter *dl_max_sdu* in the DL_INFO_ACK primitive.

```
typedef struct {
     ulong         dl_primitive;
     ulong         dl_dest_addr_length;
     ulong         dl_dest_addr_offset;
     ulong         dl_src_addr_length;
     ulong         dl_src_addr_offset;
     ulong         dl_group_address;
} dl_unitdata_ind_t;
```

Parameters

dl_primitive
conveys DL_UNITDATA_IND.

dl_dest_addr_length
conveys the length of the address of the DLSAP where this DL_UNITDATA_IND is intended to be delivered.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the DLSAP address of the sending DLS user.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

dl_group_address
is set by the DLS Provider upon receiving and passing upstream a data message when the destination address of the data message is a multicast or broadcast address.

State

The message is valid in state DL_IDLE.

New State

The resulting state is unchanged.

4.3.3 Message DL_UDERROR_IND (*dl_uderror_ind_t*)

Informs the DLS user that a previously sent DL_UNITDATA_REQ produced an error or could not be delivered. The primitive indicates the destination DLSAP address associated with the failed request, and conveys an error value that specifies the reason for failure.

Message Format

The message consists of either one M_PROTO message block or one M_PCPROTO message block containing the structure shown below.

```
typedef struct {
      ulong         dl_primitive;
      ulong         dl_dest_addr_length;
      ulong         dl_dest_addr_offset;
      ulong         dl_unix_errno;
      ulong         dl_errno;
} dl_uderror_ind_t;
```

Parameters

dl_primitive
conveys DL_UDERROR_IND.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS user.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_unix_errno
conveys the UNIX system error code associated with the failure. This value should be non-zero only when *dl_errno* is set to DL_SYSERR. It is used to report UNIX system failures that prevent the processing of a given request.

dl_errno
conveys the DLPI error code associated with the failure. See **Reasons for Failure** in the description of DL_UNITDATA_REQ for the error codes that apply to an erroneous DL_UNITDATA_REQ. In addition, the error value DL_UNDELIVERABLE may be returned if the request was valid but for some reason the DLS provider could not deliver the data unit (e.g. due to lack of sufficient local buffering to store the data unit). There is, however, no guarantee that such an error report will be generated for all undeliverable data units, since connectionless data transfer is not a confirmed service.

State

The message is valid in state DL_IDLE.

New State

The resulting state is unchanged.

4.3.4 Message DL_UDQOS_REQ (*dl_udqos_req_t*)

Requests the DLS provider to apply the specified quality of service parameter values to subsequent data unit transmissions. These new values will remain in effect until another DL_UDQOS_REQ is issued.

Message Format

The message consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
     ulong          dl_primitive;
     ulong          dl_qos_length;
     ulong          dl_qos_offset;
} dl_udqos_req_t;
```

Parameters

dl_primitive

conveys DL_UDQOS_REQ.

dl_qos_length

conveys the length, in bytes, of the requested quality of service parameter values. The values are conveyed in the appropriate structure defined in section 5.3, *QOS Data Structures*. The available range of QOS values that may be selected is specified by the *dl_qos_range_length* and *dl_qos_range_offset* parameters in the DL_INFO_ACK primitive.

For any parameter whose value the DLS user does not wish to select, the value DL_QOS_DONT_CARE may be set and the DLS provider will maintain the current value for that parameter. See section 5, *Quality of Data Link Service*, for a full description of the quality of service parameters.

dl_qos_offset

conveys the offset from the beginning of the M_PROTO message block where the quality of service parameters begin.

State

The message is valid in state DL_IDLE.

New State

The resulting state is DL_UDQOS_PENDING.

Response

If the quality of service request is successful, DL_OK_ACK is sent to the DLS user and the resulting state is DL_IDLE.

If the request fails, message DL_ERROR_ACK is returned and the resulting state is unchanged.

Reasons for Failure

DL_BADQOSPARAM	The quality of service parameters contained values outside the range of those supported by the DLS provider.
DL_BADQOSTYPE	The quality of service structure type was not supported by the DLS provider.
DL_OUTSTATE	The primitive was issued from an invalid state.

4.4 Primitives to handle XID and TEST operations

This section describes the service primitives that support the XID and TEST operations. The DLS User can issue these primitives to the DLS Provider requesting the provider to send an XID or a TEST frame. On receipt of an XID or TEST frame from the remote side, the DLS Provider can send the appropriate indication to the User.

4.4.1 Message DL_TEST_REQ (*dl_test_req_t*)

Conveys one TEST command DLSDU from the DLS User to the DLS Provider for transmission to a peer DLS Provider.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_flag;
      ulong dl_dest_addr_length;
      ulong dl_dest_addr_offset;
} dl_test_req_t;
```

Parameters

dl_primitive
conveys DL_TEST_REQ

dl_flag
indicates flag values for the request as follows:

DL_POLL_FINAL indicates if the poll/final bit is set.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

State

The message is valid in states DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

Response

On an invalid TEST command request, a DL_ERROR_ACK is issued to the user. If the DLS Provider receives a response from the remote side, a DL_TEST_CON is issued to the DLS User. It is recommended that the DLS User use a timeout procedure to recover from a situation when there is no response from the peer DLS User.

Reasons for failure

DL_OUTSTATE	The primitive was issued from an invalid state
DL_BADADDR	The DLSAP address information was invalid or was in an incorrect format.
DL_SYSERR	A System error has occurred and the UNIX System error is indicated in the DL_ERROR_ACK.

DL_NOTSUPPORTED	Primitive is known but not supported by the DLS Provider
DL_TESTAUTO	Previous bind request specified automatic handling of TEST responses.
DL_UNSUPPORTED	Requested service not supplied by provider.

4.4.2 Message DL_TEST_IND (*dl_test_ind_t*)

Conveys the TEST response/indication DLSDU from the DLS Provider to the DLS User.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_flag;
     ulong    dl_dest_addr_length;
     ulong    dl_dest_addr_offset;
     ulong    dl_src_addr_length;
     ulong    dl_src_addr_offset;
} dl_test_ind_t;
```

Parameters

dl_primitive
conveys DL_TEST_IND

dl_flag
indicates the flag values associated with the received TEST frame:

DL_POLL_FINAL indicates if the poll/final bit is set.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the source DLSAP address. If the source user is implemented using DLPI, this address if the full DLSAP address returned on the DL_BIND_ACK.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

State

The message is valid in states DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

4.4.3 Message DL_TEST_RES (*dl_test_res_t*)

Conveys the TEST response DLSDU from the DLS User to the DLS Provider in response to a DL_TEST_IND.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_flag;
      ulong    dl_dest_addr_length;
      ulong    dl_dest_addr_offset;
} dl_test_res_t;
```

Parameters

dl_primitive
conveys DL_TEST_RES

dl_flag
indicates the flag values for the response as follows:

DL_POLL_FINAL indicates if the poll/final bit is set.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

State

The message is valid in states DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

4.4.4 Message DL_TEST_CON (*dl_test_con_t*)

Conveys the TEST response DLSDU from the DLS Provider to the DLS User in response to a DL_TEST_REQ.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_flag;
     ulong    dl_dest_addr_length;
     ulong    dl_dest_addr_offset;
     ulong    dl_src_addr_length;
     ulong    dl_src_addr_offset;
} dl_test_con_t;
```

Parameters

dl_primitive
conveys DL_TEST_RES

dl_flag
indicates the flag values for the request as follows:

DL_POLL_FINAL indicates if the poll/final bit is set.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the source DLSAP address. If the source user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

State

The message is valid in states DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

4.4.5 Message DL_XID_REQ (*dl_xid_req_t*)

Conveys one XID DLSDU from the DLS User to the DLS Provider for transmission to a peer DLS User.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_flag;
      ulong dl_dest_addr_length;
      ulong dl_dest_addr_offset;
} dl_xid_req_t;
```

Parameters

dl_primitive
conveys DL_XID_REQ

dl_flag
indicates the flag values for the response as follows:

DL_POLL_FINAL indicates status of the poll/final bit in the xid frame.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

State

The message is valid in state DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

Response

On an invalid XID request, a DL_ERROR_ACK is issued to the user. If the remote side responds to the XID request, a DL_XID_CON will be sent to the User. It is recommended that the DLS User use a timeout procedure on an XID_REQ. The timeout may be used if the remote side does not respond to the XID request.

Reasons for failure

DL_BADDATA	The amount of data in the current DLSDU exceeded the DLS Provider's DLSDU limit.
DL_XIDAUTO	Previous bind request specified Provider would handle XID.
DL_OUTSTATE	The primitive was issued from an invalid state
DL_BADADDR	The DLSAP address information was invalid or was in an incorrect format.

DL_SYSERR	A System error has occurred and the UNIX System error is indicated in the DL_ERROR_ACK.
DL_NOTSUPPORTED	Primitive is known but not supported by the DLS Provider

4.4.6 Message DL_XID_IND (*dl_xid_ind_t*)

Conveys an XID DLSDU from the DLS Provider to the DLS User.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_flag;
     ulong    dl_dest_addr_length;
     ulong    dl_dest_addr_offset;
     ulong    dl_src_addr_length;
     ulong    dl_src_addr_offset;
} dl_xid_ind_t;
```

Parameters

dl_primitive
conveys DL_XID_IND

dl_flag
conveys the flag values associated with the received XID frame.

DL_POLL_FINAL indicates if the received xid frame had the poll/final bit set.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the source DLSAP address. If the source user is implemented using DLPI, this address if the full DLSAP address returned on the DL_BIND_ACK.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

State

The message is valid in state DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

Response

The DLS User must respond with a DL_XID_RES.

4.4.7 Message DL_XID_RES (*dl_xid_res_t*)

Conveys an XID DLSDU from the DLS User to the DLS Provider in response to a DL_XID_IND.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_flag;
     ulong    dl_dest_addr_length;
     ulong    dl_dest_addr_offset;
} dl_xid_res_t;
```

Parameters

dl_primitive
conveys DL_XID_RES

dl_flag
conveys the flag values associated with the received XID frame.

DL_POLL_FINAL

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

State

The message is valid in states DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

4.4.8 Message DL_XID_CON (*dl_xid_con_t*)

Conveys an XID DLSDU from the DLS Provider to the DLS User in response to a DL_XID_REQ.

Message Format

The message consists of one M_PROTO message block, followed by zero or more M_DATA blocks containing zero or more bytes of data. The message structure is as follows:

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_flag;
     ulong    dl_dest_addr_length;
     ulong    dl_dest_addr_offset;
     ulong    dl_src_addr_length;
     ulong    dl_src_addr_offset;
} dl_xid_con_t;
```

Parameters

dl_primitive
conveys DL_XID_CON

dl_flag
conveys the flag values associated with the received XID frame.

DL_POLL_FINAL

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the source DLSAP address. If the source user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

State

The message is valid in states DL_IDLE and DL_DATAXFER.

New State

The resulting state is unchanged.

4.5 Acknowledged Connectionless-mode Service Primitives

This section describes the primitives that support the acknowledged connectionless-mode service of the data link layer. These primitives support the acknowledged connectionless data transfer service described earlier.

4.5.1 Message DL_DATA_ACK_REQ (*dl_data_ack_req_t*)

This request is passed to the Data Link Provider to request that a DLSDU be sent to a peer DLS User using acknowledged connectionless mode data unit transmission procedures.

Message Format

Consists of one M_PROTO message block containing the structure shown below, followed by one or more M_DATA blocks containing one or more bytes of data. The amount of user data that may be transferred in a single DLSDU is limited. This limit is conveyed by the parameter dl_max_sdu in the DL_INFO_ACK primitive.

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_correlation;
     ulong    dl_dest_addr_length;
     ulong    dl_dest_addr_offset;
     ulong    dl_src_addr_length;
     ulong    dl_src_addr_offset;
     ulong    dl_priority;
     ulong    dl_service_class;
} dl_data_ack_req_t;
```

Parameters

dl_primitive
conveys DL_DATA_ACK_REQ

dl_correlation
Conveys a unique identifier which will be returned in the DL_DATA_ACK_STATUS_IND primitive to allow the DLS User to correlate the status to the appropriate DL_DATA_ACK_REQ primitive.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the DLSAP address of the source DLS User.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

dl_priority
indicates the priority value within the supported range for this particular DLSDU.

dl_service_class
Specifies whether or not an acknowledge capability in the medium access control sublayer is to be used for the data unit transmission.

DL_RQST_RSP	Request acknowledgement service from the medium access control sublayer if supported

DL_RQST_NORSP	No acknowledgement service requested from the medium access control sublayer.

State

This message is valid in state DL_IDLE.

New State

The resulting state is unchanged.

Response

If the request is erroneous, message DL_ERROR_ACK is returned, and the resulting state is unchanged.

If the DLS Provider accepts the data for transmission, a DL_DATA_ACK_STATUS_IND is returned. This indication will indicate the success or failure of the data transmission. Although the exchange service is connectionless, in-sequence delivery is guaranteed for data sent by the initiating station.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_BADADDR	The destination DLSAP address was in an incorrect format or contained invalid information.
DL_NOTSUPPORTED	Primitive is valid, but not supported.
DL_BADDATA	The amount of data in the current DLSDU exceeded the DLS provider's DLSDU limit.
DL_UNSUPPORTED	Requested service or priority not supported by Provider (Request with response at the Medium Access Control sublayer).

4.5.2 Message DL_DATA_ACK_IND (*dl_data_ack_ind_t*)

Conveys one DLSDU from the DLS Provider to the DLS User. This primitive indicates the arrival of a non-null, non-duplicate DLSDU from a peer Data Link User entity.

Message Format

Consists of one M_PROTO message block containing the structure shown below, followed by one or more M_DATA blocks containing one or more bytes of data. The amount of user data that may be transferred in a single DLSDU is limited. This limit is conveyed by the parameter dl_max_sdu in the DL_INFO_ACK primitive.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_dest_addr_length;
      ulong    dl_dest_addr_offset;
      ulong    dl_src_addr_length;
      ulong    dl_src_addr_offset;
      ulong    dl_priority;
      ulong    dl_service_class;
} dl_data_ack_ind_t;
```

Parameters

dl_primitive
conveys DL_DATA_ACK_IND

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the DLSAP address of the source DLS User.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins. address returned on the DL_BIND_ACK.

dl_priority
priority provided for the data unit transmission.

dl_service_class
Specifies whether or not an acknowledge capability in the medium access control sublayer is to be used for the data unit transmission.

DL_RQST_RSP	Use acknowledgement service in the medium access control sublayer.
DL_RQST_NORSP	No acknowledgement service to be used in the medium access control sublayer.

State

This message is valid in state DL_IDLE.

New State

The resulting state is unchanged.

4.5.3 Message DL_DATA_ACK_STATUS_IND (*dl_data_ack_status_ind_t*)

Conveys the results of the previous associated DL_DATA_ACK_REQ from the DLS Provider to the DLS User.

Message Format

Consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_correlation;
      ulong    dl_status;
} dl_data_ack_status_ind_t;
```

Parameters

dl_primitive

conveys DL_DATA_ACK_STATUS_IND

dl_correlation

conveys the unique identifier passed with the DL_DATA_ACK_REQ primitive, to allow the DLS User correlate the status to the appropriate DL_DATA_ACK_REQ.

dl_status

indicates the success or failure of the previous associated acknowledged connectionless-mode data unit transmission request.

DL_CMD_OK	Command accepted.
DL_CMD_RS	Unimplemented or inactivated service.
DL_CMD_UE	LLC User Interface error
DL_CMD_PE	Protocol error
DL_CMD_IP	Permanent implementation dependent error
DL_CMD_UN	Resources temporarily unavailable.
DL_CMD_IT	Temporary implementation dependent error.

State

This message is valid in state DL_IDLE.

New State

The resulting state is unchanged.

4.5.4 Message DL_REPLY_REQ (*dl_reply_req_t*)

This request primitive is passed to the DLS Provider by the DLS User to request that a DLSDU be returned from a peer DLS Provider or that DLSDUs be exchanged between stations using acknowledged connectionless mode data unit exchange procedures.

Message Format

Consists of one M_PROTO message block containing the structure shown below, followed by one or more M_DATA blocks with one or more bytes of data.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_correlation;
      ulong    dl_dest_addr_length;
      ulong    dl_dest_addr_offset;
      ulong    dl_src_addr_length;
      ulong    dl_src_addr_offset;
      ulong    dl_priority;
      ulong    dl_service_class;
} dl_reply_req_t;
```

Parameters

dl_primitive
conveys DL_REPLY_REQ

dl_correlation
Conveys a unique identifier which will be returned in the DL_REPLY_STATUS_IND primitive to allow the DLS User to correlate the status to the appropriate DL_REPLY_REQ primitive.

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the DLSAP address of the source DLS User.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

dl_priority
priority provided for the data unit transmission.

dl_service_class
Specifies whether or not an acknowledge capability in the medium access control sublayer is to be used for the data unit transmission.

State

This primitive is valid in state DL_IDLE.

New State

The resulting state is unchanged.

Response

If the request is erroneous, message DL_ERROR_ACK is returned, and the resulting state is unchanged.

If the message is valid, a DL_REPLY_STATUS_IND is returned. This will indicate the success or failure of the previous associated acknowledged connectionless-mode data unit exchange.

Reasons for Failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_BADADDR	The destination DLSAP address was in an incorrect format or contained invalid information.
DL_NOTSUPPORTED	Primitive is valid, but not supported.
DL_BADDATA	The amount of data in the current DLSDU exceeded the DLS provider's DLSDU limit.
DL_UNSUPPORTED	Requested service not supported by Provider (Request with response at the Medium Access Control sublayer).

4.5.5 Message DL_REPLY_IND (*dl_reply_ind_t*)

This primitive is the service indication primitive for the acknowledged connectionless-mode data unit exchange service. It is passed from the DLS Provider to the DLS User to indicate either a successful request of a DLSDU from the peer data link user entity, or exchange of DLSDUs with a peer data link user entity.

Message Format

Consists of one M_PROTO message block containing the structure shown below, followed by zero or more M_DATA blocks.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_dest_addr_length;
      ulong    dl_dest_addr_offset;
      ulong    dl_src_addr_length;
      ulong    dl_src_addr_offset;
      ulong    dl_priority;
      ulong    dl_service_class;
} dl_reply_ind_t;
```

Parameters

dl_primitive
conveys DL_REPLY_IND

dl_dest_addr_length
conveys the length of the DLSAP address of the destination DLS User. If the destination user is implemented using DLPI, this address is the full DLSAP address returned on the DL_BIND_ACK.

dl_dest_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the destination DLSAP address begins.

dl_src_addr_length
conveys the length of the DLSAP address of the source DLS User.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

dl_priority
priority provided for the data unit transmission.

dl_service_class
Specifies whether or not an acknowledge capability in the medium access control sublayer is to be used for the data unit transmission.

State

This primitive is valid in state DL_IDLE.

New State

The resulting state is unchanged.

4.5.6 Message DL_REPLY_STATUS_IND (*dl_reply_status_ind_t*)

This indication primitive is passed from the DLS Provider to the DLS User to indicate the success or failure of the previous associated acknowledged connectionless mode data unit exchange request.

Message Format

Consists of one M_PROTO message block containing the structure shown below, followed by zero or more M_DATA blocks.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_correlation;
      ulong    dl_status;
} dl_reply_status_ind_t;
```

Parameters

dl_primitive

conveys DL_REPLY_STATUS_IND

dl_correlation

conveys the unique identifier passed with the DL_REPLY_REQ primitive, to allow the DLS User correlate the status to the appropriate DL_REPLY_REQ.

dl_status

Indicates the success or failure of the previous associated acknowledged connectionless-mode data unit exchange request.

DL_CMD_OK	Command accepted.
DL_CMD_RS	Unimplemented or inactivated service.
DL_CMD_UE	LLC User Interface error
DL_CMD_PE	Protocol error
DL_CMD_IP	Permanent implementation dependent error
DL_CMD_UN	Resources temporarily available.
DL_CMD_IT	Temporary implementation dependent error.
DL_RSP_OK	Response DLSDU present.
DL_RSP_RS	Unimplemented or inactivated service.
DL_RSP_NE	Response DLSDU never submitted.
DL_RSP_NR	Response DLSDU not requested.
DL_RSP_UE	LLC User interface error.
DL_RSP_IP	Permanent implementation dependent error.
DL_RSP_UN	Resources temporarily unavailable.
DL_RSP_IT	Temporary implementation dependent error.

State

This primitive is valid in state DL_IDLE.

New State

The resulting state is unchanged.

4.5.7 Message DL_REPLY_UPDATE_REQ (*dl_reply_update_req_t*)

Conveys a DLSDU to the DLS Provider from the DLS User to be held by the DLS Provider and sent out at a later time when requested to do so by the peer DLS Provider.

Message Format

Consists of one M_PROTO message block containing the structure shown below, followed by one or more M_DATA blocks.

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_correlation;
      ulong    dl_src_addr_length;
      ulong    dl_src_addr_offset;
} dl_reply_update_req_t;
```

Parameters

dl_primitive
conveys DL_REPLY_UPDATE_REQ

dl_correlation
conveys context specific information to be returned in the DL_REPLY_UPDATE_STATUS_IND primitive to allow the DLS User correlate the status to the appropriate previous request.

dl_src_addr_length
conveys the length of the DLSAP address of the source DLS User.

dl_src_addr_offset
conveys the offset from the beginning of the M_PROTO message block where the source DLSAP address begins.

State

This primitive is valid in state DL_IDLE.

New State

The resulting state is unchanged.

Response

If the request is erroneous, a DL_ERROR_ACK is returned with the appropriate error code. Otherwise, a DL_REPLY_UPDATE_STATUS_IND is returned, which indicates the success or failure of the DL_REPLY_UPDATE_REQ.

Reasons for failure

DL_OUTSTATE	The primitive was issued from an invalid state.
DL_BADDATA	The amount of data in the DLSDU exceeded the DLS Provider's DLSDU limit.
DL_NOTSUPPORTED	Primitive is known, but not supported.

4.5.8 Message DL_REPLY_UPDATE_STATUS_IND (*dl_reply_update_status_ind_t*)

This primitive is the service confirmation primitive for the reply data unit preparation service. This primitive is sent to the DL User from the DLS Provider to indicate the success or failure of the previous associated data unit preparation request.

Message Format

Consists of one M_PROTO message block containing the structure shown below.

```
typedef struct {
     ulong    dl_primitive;
     ulong    dl_correlation;
     ulong    dl_status;
} dl_reply_update_req_t;
```

Parameters

dl_primitive
conveys DL_UPDATE_STATUS_IND

dl_correlation
Indicates the context information passed with the DL_REPLY_UPDATE_REQ to allow the DLS User correlate the status with the appropriate previous request.

dl_status
indicates the success or failure of the previous associated data unit preparation request.

DL_CMD_OK	Command accepted.
DL_CMD_RS	Unimplemented or inactivated service.
DL_CMD_UE	LLC User Interface error
DL_CMD_PE	Protocol error
DL_CMD_IP	Permanent implementation dependent error
DL_CMD_UN	Resources temporarily available.
DL_CMD_IT	Temporary implementation dependent error.
DL_RSP_OK	Response DLSDU present.
DL_RSP_RS	Unimplemented or inactivated service.
DL_RSP_NE	Response DLSDU never submitted.
DL_RSP_NR	Response DLSDU not requested.
DL_RSP_UE	LLC User interface error.
DL_RSP_IP	Permanent implementation dependent error.
DL_RSP_UN	Resources temporarily unavailable.
DL_RSP_IT	Temporary implementation dependent error.

State

This primitive is valid in state DL_IDLE.

New State

The resulting state is unchanged.

5. Quality of Data Link Service

The quality of data link service is defined by the term "Quality of Service" (QOS), and describes certain characteristics of transmission between two DLS users. These characteristics are attributable solely to the DLS provider, but are observable by the DLS users. The visibility of QOS characteristics enables a DLS user to determine, and possibly negotiate, the characteristics of transmission needed to communicate with the remote DLS user.

5.1 Overview of Quality of Service

Quality of service characteristics apply to both the connection and connectionless modes of service. The semantics for each mode are discussed below.

5.1.1 Connection-mode Service

"Quality of Service" (QOS) refers to certain characteristics of a data link connection as observed between the connection endpoints. QOS describes the specific aspects of a data link connection that are attributable to the DLS provider.

QOS is defined in terms of QOS parameters. The parameters give DLS users a means of specifying their needs. These parameters are divided into two groups, based on how their values are determined:

- QOS parameters that are negotiated on a per-connection basis during connection establishment; and
- QOS parameters that are not negotiated during connection establishment. The values are determined or known through other methods, usually administrative.

The QOS parameters that can be negotiated during connection establishment are: throughput, transit delay, priority, and protection. The QOS parameters for throughput and transit delay are negotiated end-to-end between the two DLS users and the DLS provider. The QOS parameters for priority and protection are negotiated locally by each DLS user with the DLS provider. The QOS parameters that cannot be negotiated are residual error rate and resilience. Section 5.4, *Procedures for QOS Negotiation and Selection* describes the rules for QOS negotiation.

Once the connection is established, the agreed QOS values are not renegotiated at any point. There is no guarantee by any DLS provider that the original QOS values will be maintained, and the DLS users are not informed if QOS changes. The DLS provider also need only record those QOS values selected at connection establishment for return in response to the DL_INFO_REQ primitive.

5.1.2 QOS for Connectionless-mode and Acknowledged Connectionless-mode Service

The QOS for connectionless-mode and acknowledged connectionless-mode service refers to characteristics of the data link layer between two DLSAPs, attributable to the DLS provider. The QOS applied to each DL_UNITDATA_REQ/DL_DATA_ACK_REQ primitive may be independent of the QOS applied to preceding and following DL_UNITDATA_REQ/DL_DATA_ACK_REQ primitives. QOS cannot be negotiated between two DLS users as in the connection-mode service.

Every DL_UNITDATA_REQ/DL_DATA_ACK_REQ primitive may have certain QOS values associated with it. The supported range of QOS parameter values is made known to the DLS user in response to the DL_INFO_REQ primitive. The DLS user may select specific QOS parameter values to be associated with subsequent data unit transmissions using the DL_UDQOS_REQ primitive. This selection is a strictly local management function. If different QOS values are to be associated with each transmission, DL_UDQOS_REQ may be issued to alter those values before each DL_UNITDATA_REQ/DL_DATA_ACK_REQ is issued.

5.2 QOS Parameter Definitions

This section describes the quality of service parameters supported by DLPI for both connection-mode and connectionless-mode services. The following table summarizes the supported parameters. It indicates to which service mode (connection, connectionless, or both) the parameter applies. For those parameters supported by the connection-mode service, the table also indicates whether the parameter value is negotiated during connection establishment. If so, the table further indicates whether the QOS values are negotiated end-to-end among both DLS users and the DLS provider, or locally for each DLS user independently with the DLS provider.

Parameter	*Service Mode*	*Negotiation*
throughput	connection	end-to-end
transit delay	both	end-to-end
priority	both	local
protection	both	local
residual error rate	both	none
resilience	connection	none

5.2.1 Throughput

Throughput is a connection-mode QOS parameter that has end-to-end significance. It is defined as the total number of DLSDU bits successfully transferred by a DL_DATA_REQ/DL_DATA_IND primitive sequence divided by the input/output time, in seconds, for that sequence. Successful transfer of a DLSDU is defined to occur when the DLSDU is delivered to the intended user without error, in proper sequence, and before connection termination by the receiving DLS user.

The input/output time for a DL_DATA_REQ/DL_DATA_IND primitive sequence is the greater of:

- the time between the first and last DL_DATA_REQ in a sequence; and
- the time between the first and last DL_DATA_IND in the sequence.

Throughput is only meaningful for a sequence of complete DLSDUs.

Throughput is specified and negotiated for the transmit and receive directions independently at connection establishment. The throughput specification defines the target and minimum acceptable values for a connection. Each specification is an average rate.

The DLS user can delay the receipt or sending of DLSDUs. The delay caused by a DLS user is not included in calculating the average throughput values.

Parameter Format

```
typedef struct {
     long          dl_target_value;
     long          dl_accept_value;
} dl_through_t;
```

This typedef is used to negotiate the transmit and receive throughput values.

dl_target_value
specifies the desired throughput value for the connection in bits/second.

dl_accept_value
specifies the minimum acceptable throughput value for the connection in bits/second.

5.2.2 Transit Delay

Connection and connectionless modes can specify a transit delay, which indicates the elapsed time between a DL_DATA_REQ or DL_UNITDATA_REQ primitive and the corresponding DL_DATA_IND or DL_UNITDATA_IND primitive. The elapsed time is only computed for DLSDUs successfully transferred, as described previously for throughput.

In connection mode, transit delay is negotiated on an end-to-end basis during connection establishment. For each connection, transit delay is negotiated for the transmit and receive directions separately by specifying the target value and maximum acceptable value. For connectionless-mode service, a DLS user selects a particular value within the supported range using the DL_UDQOS_REQ primitive, and the value may be changed for each DLSDU submitted for connectionless transmission.

The transit delay for an individual DLSDU may be increased if the receiving DLS user flow controls the interface. The average and maximum transit delay values exclude any DLS user flow control of the interface. The values are specified in milliseconds, and assume a DLSDU size of 128 octets.

Parameter Format

```
typedef struct {
     long          dl_target_value;
     long          dl_accept_value;
} dl_transdelay_t;
```

This typedef is used to negotiate the transmit and receive transit delay values.

dl_target_value
specifies the desired transit delay value.

dl_accept_value
specifies the maximum acceptable transit delay value.

5.2.3 Priority

Priority is negotiated locally between each DLS user and the DLS provider in connection-mode service, and can also be specified for connectionless-mode service. The specification of priority is concerned with the relationship between connections or the relationship between connectionless data transfer requests. The parameter specifies the relative importance of a connection with respect to:

- the order in which connections are to have their QOS degraded, if necessary; and
- the order in which connections are to be released to recover resources, if necessary;

For connectionless-mode service, the parameter specifies the relative importance of unitdata objects with respect to gaining use of shared resources.

For connection-mode service, each DLS user negotiates a particular priority value with the DLS provider during connection establishment. The value is specified by a minimum and a maximum within a given range. For connectionless-mode service, a DLS user selects a particular priority value within the supported range using the DL_UDQOS_REQ primitive, and the value may be changed for each DLSDU submitted for connectionless transmission.

This parameter only has meaning in the context of some management entity or structure able to judge relative importance. The priority has local significance only, with a value of zero being the highest priority and 100 being the lowest priority.

Parameter Format

```
typedef struct {
      long          dl_min;
      long          dl_max;
} dl_priority_t;
```

dl_min
specifies the minimum acceptable priority.

dl_max
specifies the maximum desired priority.

5.2.4 Protection

Protection is negotiated locally between each DLS user and the DLS provider in connection-mode service, and can also be specified for connectionless-mode service. Protection is the extent to which a DLS provider attempts to prevent unauthorized monitoring or manipulation of DLS user-originated information. Protection is specified by a minimum and maximum protection option within the following range of possible protection options:

DL_NONE	DLS provider will not protect any DLS user data
DL_MONITOR	DLS provider will protect against passive monitoring
DL_MAXIMUM	DLS provider will protect against modification, replay, addition, or deletion of DLS user data

For connection-mode service, each DLS user negotiates a particular value with the DLS provider during connection establishment. The value is specified by a minimum and a maximum within a given range. For connectionless-mode service, a DLS user selects a particular value within the supported range using the DL_UDQOS_REQ primitive, and the value may be changed for each DLSDU submitted for connectionless transmission. Protection has local significance only.

Parameter Format

```
typedef struct {
      long          dl_min;
      long          dl_max;
} dl_protect_t;
```

dl_min

specifies the minimum acceptable protection.

dl_max

specifies the maximum desired protection.

5.2.5 Residual Error Rate

Residual error rate is the ratio of total incorrect, lost and duplicate DLSDUs to the total DLSDUs transferred between DLS users during a period of time. The relationship between these quantities is defined below:

$$RER = \frac{DLSDU_l + DLSDU_i + DLSDU_e}{DLSDU_{tot}}$$

where

$DLSDU_{tot}$ = total DLSDUs transferred, which is the total of $DLSDU_l$, $DLSDU_i$, $DLSDU_e$, and correctly received DLSDUs.

$DLSDU_e$ = DLSDUs received 2 or more times.

$DLSDU_i$ = incorrectly received DLSDUs.

$DLSDU_l$ = DLSDUs sent, but not received.

Parameter Format

```
long           dl_residual_error;
```

The residual error value is scaled by a factor of 1,000,000, since the parameter is stored as a long integer in the QOS data structures. Residual error rate is not a negotiated QOS parameter. Its value is determined by procedures outside the definition of DLPI. It is assumed to be set by an administrative mechanism, which is informed of the value by network management.

5.2.6 Resilience

Resilience is meaningful in connection mode only, and represents the probability of either: DLS provider-initiated disconnects or DLS provider-initiated resets during a time interval of 10,000 seconds on a connection.

Resilience is not a negotiated QOS parameter. Its value is determined by procedures outside the definition of DLPI. It is assumed to be set by an administrative mechanism, which is informed of the value by network management.

Parameter Format

```
typedef struct {
     long           dl_disc_prob;
     long           dl_reset_prob;
} dl_resilience_t;
```

dl_disc_prob
specifies the probability of receiving a provider-initiated disconnect, scaled by 10000.

dl_reset_prob
specifies the probability of receiving a provider-initiated reset, scaled by 10000.

5.3 QOS Data Structures

To simplify the definition of the primitives containing QOS parameters and the discussion of QOS negotiation, the QOS parameters are organized into four structures. This section defines the structures and indicates which structures apply to which primitives.

Each structure is tagged with a type field contained in the first four bytes of the structure, similar to the tagging of primitives. The type field has been defined because of the current volatility of QOS parameter definition within the international standards bodies. If new QOS parameter sets are defined in the future for the data link layer, the type field will enable DLPI to accommodate these sets without breaking existing DLS user or provider implementations. However, DLS user and provider software should be cognizant of the possibility that new QOS structure types may be defined in future issues of the DLPI specification. If a DLS provider receives a structure type that it does not understand in a given primitive, the error DL_BADQOSTYPE should be returned to the DLS user in a DL_ERROR_ACK primitive.

Currently the following QOS structure types are defined:

DL_QOS_CO_RANGE1	QOS range structure for connection-mode service for Issue 1 of DLPI
DL_QOS_CO_SEL1	QOS selection structure for connection-mode service for Issue 1 of DLPI
DL_QOS_CL_RANGE1	QOS range structure for connectionless-mode service for Issue 1 of DLPI
DL_QOS_CL_SEL1	QOS selection structure for connectionless-mode service for Issue 1 of DLPI

The syntax and semantics of each structure type is presented in the remainder of this section.

5.3.1 Structure DL_QOS_CO_RANGE1

Structure type DL_QOS_CO_RANGE1 enables a DLS user and DLS provider to pass between them a range of QOS parameter values in the connection-mode service. The format of this structure type is:

```
typedef struct {
     ulong                  dl_qos_type;
     dl_through_t           dl_rcv_throughput;
     dl_transdelay_t        dl_rcv_trans_delay;
     dl_through_t           dl_xmt_throughput;
     dl_transdelay_t        dl_xmt_trans_delay;
     dl_priority_t          dl_priority;
     dl_protect_t           dl_protection;
     long                   dl_residual_error;
     dl_resilience_t        dl_resilience;
} dl_qos_co_range1_t;
```

where the value of *dl_qos_type* is DL_QOS_CO_RANGE1. The fields of this structure correspond to the parameters defined in section 5.2, *QOS Parameter Definitions*. The throughput and transit delay parameters are specified for each direction of transmission on a data link connection.

This structure type is returned in the *dl_qos_range_length* and *dl_qos_range_offset* fields of the DL_INFO_ACK, and specifies the supported ranges of service quality supported by the DLS provider. In other words, it specifies the available range of QOS parameter values that may be specified on a DL_CONNECT_REQ.

For the DL_CONNECT_REQ and DL_CONNECT_IND primitives, this structure specifies the negotiable range of connection-mode QOS parameter values. See section 5.4, *Procedures for QOS Negotiation and Selection*, for the semantics of this structure in these primitives.

5.3.2 Structure DL_QOS_CO_SEL1

Structure type DL_QOS_CO_SEL1 conveys selected QOS parameter values for connection-mode service between the DLS user and DLS provider. The format of this structure type is:

```
typedef struct {
     ulong               dl_qos_type;
     long                dl_rcv_throughput;
     long                dl_rcv_trans_delay;
     long                dl_xmt_throughput;
     long                dl_xmt_trans_delay;
     long                dl_priority;
     long                dl_protection;
     long                dl_residual_error;
     dl_resilience_t     dl_resilience;
} dl_qos_co_sel1_t;
```

where the value of *dl_qos_type* is DL_QOS_CO_SEL1. The fields of this structure correspond to the parameters defined in section 5.2, *QOS Parameter Definitions*. The throughput and transit delay parameters are specified for each direction of transmission on a data link connection.

This structure type is returned in the *dl_qos_length* and *dl_qos_offset* fields of the DL_INFO_ACK, and specifies the current or default QOS parameter values associated with a stream. Default values are returned prior to connection establishment, and currently negotiated values are returned when a connection is active on the stream.

The structure type is used in the DL_CONNECT_RES to enable the responding DLS user to select particular QOS parameter values from the available range. The DL_CONNECT_CON primitive returns the selected values to the calling DLS user in this structure. See section 5.4, *Procedures for QOS Negotiation and Selection*, for the semantics of this structure in these primitives.

5.3.3 Structure DL_QOS_CL_RANGE1

Structure type DL_QOS_CL_RANGE1 enables a DLS user and DLS provider to pass between them a range of QOS parameter values in the connectionless-mode service. The format of this structure type is:

```
typedef struct {
     ulong              dl_qos_type;
     dl_transdelay_t    dl_trans_delay;
     dl_priority_t      dl_priority;
     dl_protect_t       dl_protection;
     long               dl_residual_error;
} dl_qos_cl_range1_t;
```

where the value of *dl_qos_type* is DL_QOS_CL_RANGE1. The fields of this structure correspond to the parameters defined in section 5.2, *QOS Parameter Definitions*.

This structure type is returned in the *dl_qos_range_length* and *dl_qos_range_offset* fields of the DL_INFO_ACK, and specifies the range of connectionless-mode QOS parameter values supported by the DLS provider on the stream. The DLS user may select specific values from this range using the DL_UDQOS_REQ primitive, as described in section 5.4, *Procedures for QOS Negotiation and Selection*.

5.3.4 Structure DL_QOS_CL_SEL1

Structure type DL_QOS_CL_SEL1 conveys selected QOS parameter values for connectionless-mode service between the DLS user and DLS provider. The format of this structure type is:

```
typedef struct {
     ulong                dl_qos_type;
     long                 dl_trans_delay;
     long                 dl_priority;
     long                 dl_protection;
     long                 dl_residual_error;
} dl_qos_cl_sel1_t;
```

where the value of *dl_qos_type* is DL_QOS_CL_SEL1. The fields of this structure correspond to the parameters defined in section 5.2, *QOS Parameter Definitions*.

This structure type is returned in the *dl_qos_length* and *dl_qos__offset* fields of the DL_INFO_ACK, and specifies the current or default QOS parameter values associated with a stream. Default values are returned until the DLS user issues a DL_UDQOS_REQ to change the values, after which the currently selected values will be returned. The structure type is also used in the DL_UDQOS_REQ primitive to enable a DLS user to select particular QOS parameter values from the supported range, as described in section 5.4, *Procedures for QOS Negotiation and Selection*.

5.4 Procedures for QOS Negotiation and Selection

This section describes the methods used for negotiating and/or selecting QOS parameter values. In the connection-mode service, some QOS parameter values may be negotiated during connection establishment. For connectionless-mode service, parameter values may be selected for subsequent data transmission.

Throughout this section, two special QOS values are referenced. These are defined for all the parameters used in QOS negotiation and selection. The values are:

DL_UNKNOWN	This value indicates that the DLS provider does not know the value for the field or does not support that parameter.
DL_QOS_DONT_CARE	This value indicates that the DLS user does not care to what value the QOS parameter is set.

These values are used to distinguish between DLS providers that support and negotiate QOS parameters and those that cannot. The following sections include the interpretation of these values during QOS negotiation and selection.

5.4.1 Connection-mode QOS Negotiation

The current connection-mode QOS parameters can be divided into three types as follows:

- Those that are negotiated end-to-end between peer DLS users and the DLS provider during connection establishment (throughput and transit delay);
- those that are negotiated locally between each DLS user and the DLS provider during connection establishment (priority and protection); and
- those that cannot be negotiated (residual error rate and resilience).

The rules for processing these three types of parameters during connection establishment are described in this section.

The current definition of most existing data link protocols does not describe a mechanism for negotiating QOS parameters during connection establishment. As such, DLPI does not require every DLS provider implementation to support QOS negotiation. If a given DLS provider implementation cannot support QOS negotiation, two alternatives are available:

- The DLS provider may specify that any or all QOS parameters are unknown. This is indicated to the DLS user in the DL_INFO_ACK, where the values in the QOS range field (indicated by *dl_qos_range_length* and *dl_qos_range_offset*) and the current QOS field (indicated by *dl_qos_length* and *dl_qos_offset*) of this primitive are set to DL_UNKNOWN. This value will also be indicated on the DL_CONNECT_IND and DL_CONNECT_CON primitives. If the DLS provider does not support any QOS parameters, the QOS length field may be set to zero in each of these of these primitives.
- The DLS provider may interpret QOS parameters with strictly local significance, and their values in the DL_CONNECT_IND primitive will be set to DL_UNKNOWN.

A DLS user need not select a specific value for each QOS parameter. The special QOS parameter value, DL_QOS_DONT_CARE, is used if the DLS user does not care what quality of service is provided for a particular parameter. The negotiation procedures presented below explain the exact semantics of this value during connection establishment.

If QOS parameters are supported by the DLS provider, the provider will define a set of default QOS parameter values that are used whenever DL_QOS_DONT_CARE is specified for a QOS parameter value. These default values can be defined for all DLS users or can be defined on a per DLS user basis. The default parameter value set is returned in the QOS field (indicated by *dl_qos_length* and *dl_qos_offset*) of the DL_INFO_ACK before a DLS user negotiates QOS parameter values.

DLS provider addendum documentation must describe the known ranges of support for the QOS parameters and the default values, and also specify whether they are used in a local manner only.

The following procedures are used to negotiate QOS parameter values during connection establishment.

(1) The DL_CONNECT_REQ specifies the DLS user's desired range of QOS values in the *dl_qos_co_range1_t* structure. The target and least-acceptable values are specified for throughput and transit delay, as described in section 5.2.1, *Throughput*, and section 5.2.2, *Transit Delay*. The target value is the value desired by the calling DLS user for the QOS parameters. The least-acceptable value is the lowest value the calling user will accept. These values are specified separately for both the transmit and receive directions of the connection.

If either value is set to DL_QOS_DONT_CARE the DLS provider will supply a default value, subject to the following consistency constraints:

— If DL_QOS_DONT_CARE is specified for the target value, the value chosen by the DLS provider may not be less than the least-acceptable value.

— If DL_QOS_DONT_CARE is specified for the least-acceptable value, the value set by the DLS provider cannot be greater than the target value.

— If DL_QOS_DONT_CARE is specified for both the target and least-acceptable value, the DLS provider is free to select any value, without constraint, for the target and least-acceptable values.

For priority and protection, the DL_CONNECT_REQ specifies a minimum and maximum desired value as defined in section 5.2.3, *Priority*, and section 5.2.4, *Protection*. As with throughput and transit delay, the DLS user may specify a value of DL_QOS_DONT_CARE for either the minimum or maximum value. The DLS provider will interpret this value subject to the following consistency constraints:

— If DL_QOS_DONT_CARE is specified for the maximum value, the value chosen by the DLS provider may not be less than the minimum value.

— If DL_QOS_DONT_CARE is specified for the minimum value, the value set by the DLS provider cannot be greater than the maximum value.

— If DL_QOS_DONT_CARE is specified for both the minimum and maximum values, the DLS provider is free to select any value, without constraint, for the maximum and minimum values.

The values of the residual error rate and resilience parameters in the DL_CONNECT_REQ have no meaning and are ignored by the DLS provider.

If the value of *dl_qos_length* in the DL_CONNECT_REQ is set to zero by the DLS user, the DLS provider should treat all QOS parameter values as if they were set to DL_QOS_DONT_CARE, selecting any value in its supported range.

If the DLS provider cannot support throughput, transit delay, priority, and protection values within the ranges specified in the DL_CONNECT_REQ, a DL_DISCONNECT_IND should be sent to the calling DLS user.

(2) If the requested ranges of values for throughput and transit delay in the DL_CONNECT_REQ are acceptable to the DLS provider, the QOS parameters will be adjusted to values the DLS provider will support. Only the target value may be adjusted, and it is set to a value the DLS provider is willing to provide (which may be of lower QOS than the target value). The least-acceptable value cannot be modified. The updated QOS range is then sent to the called DLS user in the *dl_qos_co_range1_t* structure of the DL_CONNECT_IND, where it is interpreted as the available range of service.

If the requested range of values for priority and protection in the DL_CONNECT_REQ is acceptable to the DLS provider, an appropriate value within the range is selected and saved for each parameter; these selected values will be returned to the DLS user in the corresponding DL_CONNECT_CON primitive. Because priority and protection are negotiated locally, the DL_CONNECT_IND will not contain values selected during negotiation with the calling DLS user. Instead, the DLS provider will offer a range of values in the DL_CONNECT_IND that will be supported locally for the called DLS user.

The DLS provider will also include the supported values for residual error rate and resilience in the DL_CONNECT_IND that is passed to the called DLS user.

If the DLS provider does not support negotiation of throughput, transit delay, priority, or protection, a value of DL_UNKNOWN should be set in the least-acceptable, target, minimum, and maximum value fields of the DL_CONNECT_IND. Also, if the DLS provider does not support any particular QOS parameter, DL_UNKNOWN should be specified in all value fields for that parameter. If the DLS provider does not support any QOS parameters, the value of *dl_qos_length* may be set to zero in the DL_CONNECT_IND.

(3) Upon receiving the DL_CONNECT_IND, the called DLS user examines the QOS parameter values and selects a specific value from the proffered range of the throughput, transit delay, priority, and

protection parameters. If the called DLS user does not agree on values in the given range, the connection should be refused with a DL_DISCONNECT_REQ primitive. Otherwise, the selected values are returned to the DLS provider in the *dl_qos_co_sel1_t* structure of the DL_CONNECT_RES primitive.

The values of residual error rate and resilience in the DL_CONNECT_RES are ignored by the DLS provider. These parameters may not be negotiated by the called DLS user. The selected values of throughput and transit delay are meaningful, however, and are adopted for the connection by the DLS provider. Similarly, the selected priority and protection values are adopted with local significance for the called DLS user.

If the user specifies DL_QOS_DONT_CARE for either throughput, transit delay, priority, or protection on the DL_CONNECT_RES, the DLS provider will select a value from the range specified for that parameter in the DL_CONNECT_IND primitive. Also, a value of zero in the *dl_qos_length* field of the DL_CONNECT_RES is equivalent to DL_QOS_DONT_CARE for all QOS parameters.

(4) Upon completion of connection establishment, the values of throughput and transit delay as selected by the called DLS user are returned to the calling DLS user in the *dl_qos_co_sel1_t* structure of the DL_CONNECT_CON primitive. The values of priority and protection that were selected by the DLS provider from the range indicated in the DL_CONNECT_REQ will also be returned in the DL_CONNECT_CON. This primitive will also contain the values of residual error rate and resilience associated with the newly established connection. The DLS provider also saves the negotiated QOS parameter values for the connection, so that they may be returned in response to a DL_INFO_REQ primitive.

As with DL_CONNECT_IND, if the DLS provider does not support negotiation of throughput, transit delay, priority, or protection, a value of DL_UNKNOWN should be returned in the selected value fields. Furthermore, if the DLS provider does not support any particular QOS parameter, DL_UNKNOWN should be specified in all value fields for that parameter, or the value of *dl_qos_length* may be set to zero in the DL_CONNECT_CON primitive.

5.4.2 Connectionless-mode QOS Selection

This section describes the procedures for selecting QOS parameter values that will be associated with the transmission of connectionless data or acknowledged connectionless data.

As with connection-mode protocols, the current definition of most existing (acknowledged) connectionless data link protocols does not define a quality of service concept. As such, DLPI does not require every DLS provider implementation to support QOS parameter selection. The DLS provider may specify that any or all QOS parameters are unsupported. This is indicated to the DLS user in the DL_INFO_ACK, where the values in the supported range field (indicated by *dl_qos_range_length* and *dl_qos_range_offset*) and the current QOS field (indicated by *dl_qos_length* and *dl_qos_offset*) of this primitive are set to DL_UNKNOWN. If the DLS provider supports no QOS parameters, the QOS length fields in the DL_INFO_ACK may be set to zero.

If the DLS provider supports QOS parameter selection, the DL_INFO_ACK primitive will specify the supported range of parameter values for transit delay, priority, protection and residual error rate. Default values are also returned in the DL_INFO_ACK.

For each DL_UNITDATA_REQ/DL_DATA_ACK_REQ, the DLS provider should apply the currently selected QOS parameter values to the transmission. If no values have been selected, the default values should be used.

At any point during data transfer, the DLS user may issue a DL_UDQOS_REQ primitive to select new values for the transit delay, priority, and protection parameters. These values are selected using the *dl_qos_cl_sel1_t* structure. The residual error rate parameter is ignored by this primitive and cannot be set by a DLS user.

In the DL_UDQOS_REQ, the DLS user need not require a specific value for every QOS parameter. DL_QOS_DONT_CARE may be specified if the DLS user does not care what quality of service is provided for a particular parameter. When specified, the DLS provider should retain the current (or default if no previous selection has occurred) value for that parameter.

REFERENCES

1. International Organization for Standardization, "Data Link Service Definition for Open Systems Interconnection," DIS 8886, February 1987.
2. International Organization for Standardization, "Logical Link Control," DIS 8802/2, 1985.
4. CCITT Recommendation X.200, "Reference Model of Open Systems Interconnection for CCITT Applications," 1984.

Appendix A — Optional Primitives to perform Essential Management Functions

This appendix presents the optional primitives to perform essential management functions. The management functions supported are *get* and *set* of physical address, and statistics gathering.

A.1 Message DL_PHYS_ADDR_REQ (*dl_phys_addr_req_t*)

This primitive requests the DLS provider to return either the default (factory) or the current value of the physical address associated with the stream depending upon the value of the address type selected in the request.

Message Format

The message consists of one M_PROTO message block containing the structure shown below:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_addr_type;
} dl_phys_addr_req_t;
```

Parameters

dl_primitive

conveys DL_PHYS_ADDR_REQ;

dl_addr_type

conveys the type of address requested - factory physical address or current physical address

DL_FACT_PHYS_ADDR	factory physical address
DL_CURR_PHYS_ADDR	current physical address

State

The message is valid in any attached state in which a local acknowledgement is not pending. For a style 2 provider, this would be after a PPA is attached using the DL_ATTACH_REQ. For a Style 1 provider, the PPA is implicitly attached after the stream is opened.

New State

The resulting state is unchanged.

Response

The provider responds to the request with a DL_PHYS_ADDR_ACK if the request is supported. Otherwise, a DL_ERROR_ACK is returned.

Reasons for failure

DL_NOTSUPPORTED	Primitive is known, but not supported by the DLS Provider.
DL_OUTSTATE	The primitive was issued from an invalid state.

A.2 Message DL_PHYS_ADDR_ACK (*dl_phys_addr_ack_t*)

This primitive returns the value for the physical address to the link user in response to a DL_PHYS_ADDR_REQ.

Message Format

The message consists of M_PCPROTO message block containing the following structure:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_addr_length;
      ulong dl_addr_offset;
} dl_phys_addr_ack_t;
```

Parameters

dl_primitive
conveys DL_PHYS_ADDR_ACK

dl_addr_length
conveys length of the physical address.

dl_addr_offset
conveys the offset from the beginning of the M_PCPROTO message block.

State

The message is valid in any state in response to a DL_PHYS_ADDR_REQ.

New State

The resulting state is unchanged.

A.3 Message DL_SET_PHYS_ADDR_REQ (*dl_set_phys_addr_req_t*)

Sets the physical address value for all streams for that provider for a particular PPA.

Message Format

The message consists of M_PROTO message block which contains the following structure:

```
typedef struct {
      ulong dl_primitive;
      ulong dl_addr_length;
      ulong dl_addr_offset;
} dl_set_phys_addr_req_t;
```

Parameters

dl_primitive

conveys DL_SET_PHYS_ADDR_REQ

dl_addr_offset

conveys the offset from the beginning of the M_PROTO message block

dl_addr_length

conveys the length of the requested hardware address

State

The message is valid in any attached state in which a local acknowledgement is not pending. For a Style 2 provider, this would be after a PPA is attached using the DL_ATTACH_REQ. For a Style 1 provider, the PPA is implicitly attached after the stream is opened.

New State

The resulting state is unchanged

Response

The provider responds to the request with a DL_OK_ACK on successful completion. Otherwise, a DL_ERROR_ACK is returned.

Reasons for failure

DL_BADADDR	The address information was invalid or was in an incorrect format.
DL_NOTSUPPORTED	Primitive is known, but not supported by the DLS Provider.
DL_SYSERR	A system error has occurred
DL_OUTSTATE	The primitive was issued from an invalid state.
DL_BUSY	One or more streams for that particular PPA are in the DL_BOUND state.

A.4 Message DL_GET_STATISTICS_REQ (*dl_get_statistics_req_t*)

Directs the DLS provider to return statistics

Message Format

The message consists of one M_PROTO message block containing the structure shown below:

```
typedef struct {
      ulong    dl_primitive;
} dl_get_statistics_req_t;
```

Parameters

dl_primitive

conveys DL_GET_STATISTICS_REQ

State

The message is valid in any state in which a local acknowledgement is not pending.

New State

The resulting state is unchanged

Response

The DLS Provider responds to this request with a DL_GET_STATISTICS_ACK if the primitive is supported. Otherwise, a DL_ERROR_ACK is returned.

Reasons for failure

DL_NOTSUPPORTED	Primitive is known but not supported by the DLS Provider.

A.5 Message DL_GET_STATISTICS_ACK (*dl_get_statistics_ack_t*)

Returns statistics in reponse to the DL_GET_STATISTICS_REQ. The contents of the statistics block is defined in the DLS Provider specific addendum.

Message Format

The message consists of one M_PCPROTO message block containing the structure shown below:

```
typedef struct {
      ulong    dl_primitive;
      ulong    dl_stat_length;
      ulong    dl_stat_offset;
} dl_get_statistics_ack_t;
```

Parameters

dl_primitive
conveys DL_GET_STATISTICS_ACK

dl_stat_len
conveys the length of the statistics structure

dl_stat_offset
conveys the offset from the beginning of the M_PCROTO message block where the statistics information resides.

State

The message is valid in any state in which a local acknowledgement is not pending.

New State

The resulting state is unchanged

Appendix B — Allowable Sequence of DLPI Primitives

This appendix presents the allowable sequence of DLPI primitives. The sequence is described using a state transition table that defines possible states as viewed by the DLS user. The state transition table describes transitions based on the current state of the interface and a given DLPI event. Each transition consists of a state change and possibly an interface action. The states, events, and related transition actions are described below, followed by the state transition table itself.

B.1 DLPI States

The following table describes the states associated with DLPI. It presents the state name used in the state transition table, the corresponding DLPI state name used throughout this specification, a brief description of the state, and an indication of whether the state is valid for connection-oriented data link service (DL_CODLS), connectionless data link service (DL_CLDLS), acknowledged connectionless data link service (ACLDLS) or all.

STATE	DLPI STATE	DESCRIPTION	SERVICE TYPE
0) UNATTACHED	DL_UNATTACHED	Stream opened but PPA not attached	ALL
1) ATTACH PEND	DL_ATTACH_PENDING	The DLS user is waiting for an acknowledgement of a DL_ATTACH_REQ	ALL
2) DETACH PEND	DL_DETACH_PENDING	The DLS user is waiting for an acknowledgement of a DL_DETACH_REQ	ALL
3) UNBOUND	DL_UNBOUND	Stream is attached but not bound to a DLSAP	ALL
4) BIND PEND	DL_BIND_PENDING	The DLS user is waiting for an acknowledgement of a DL_BIND_REQ	ALL
5) UNBIND PEND	DL_UNBIND_PENDING	The DLS user is waiting for an acknowledgement of a DL_UNBIND_REQ	ALL
6) IDLE	DL_IDLE	The stream is bound and activated for use - connection establishment or connectionless data transfer may take place	ALL
7) UDQOS PEND	DL_UDQOS_PENDING	The DLS user is waiting for an acknowledgement of a DL_UDQOS_REQ	DL_CLDLS
8) OUTCON PEND	DL_OUTCON_PENDING	An outgoing connection is pending - the DLS user is waiting for a DL_CONNECT_CON	DL_CODLS
9) INCON PEND	DL_INCON_PENDING	An incoming connection is pending - the DLS provider is waiting for a DL_CONNECT_RES	DL_CODLS
10) CONN_RES PEND	DL_CONN_RES_PENDING	The DLS user is waiting for an acknowledgement of a DL_CONNECT_RES	DL_CODLS
11) DATAXFER	DL_DATAXFER	Connection-mode data transfer may take place	DL_CODLS
12) USER RESET PEND	DL_USER_RESET_PENDING	A user-initiated reset is pending - the DLS user is waiting for a DL_RESET_CON	DL_CODLS
13) PROV RESET PEND	DL_PROV_RESET_PENDING	A provider-initiated reset is pending - the DLS provider is waiting for a DL_RESET_RES	DL_CODLS
14) RESET_RES PEND	DL_RESET_RES_PENDING	The DLS user is waiting for an acknowledgement of a DL_RESET_RES	DL_CODLS

STATE	DLPI STATE	DESCRIPTION	SERVICE TYPE
15) DISCON 8 PEND	DL_DISCON8_PENDING	The DLS user is waiting for an acknowledgement of a DL_DISCONNECT_REQ issued from the DL_OUTCON_PENDING state	DL_CODLS
16) DISCON 9 PEND	DL_DISCON9_PENDING	The DLS user is waiting for an acknowledgement of a DL_DISCONNECT_REQ issued from the DL_INCON_PENDING state	DL_CODLS
17) DISCON 11 PEND	DL_DISCON11_PENDING	The DLS user is waiting for an acknowledgement of a DL_DISCONNECT_REQ issued from the DL_DATAXFER state	DL_CODLS
18) DISCON 12 PEND	DL_DISCON12_PENDING	The DLS user is waiting for an acknowledgement of a DL_DISCONNECT_REQ issued from the DL_USER_RESET_PENDING state	DL_CODLS
19) DISCON 13 PEND	DL_DISCON13_PENDING	The DLS user is waiting for an acknowledgement of a DL_DISCONNECT_REQ issued from the DL_PROV_RESET_PENDING state	DL_CODLS
20) SUBS_BIND PEND	DL_SUBS_BIND_PND	The DLS user is waiting for an acknowledgement of a DL_SUBS_BIND_REQ	ALL
21) SUBS_UNBIND PEND	DL_SUBS_UNBIND_PND	The DLS user is waiting for an acknowledgement of a DL_SUBS_UNBIND_REQ	ALL

TABLE 2. DLPI States

B.2 Variables and Actions for State Transition Table

The following tables describe variables and actions used to describe the DLPI state transitions.

The variables are used to distinguish various uses of the same DLPI primitive. For example, a DL_CONNECT_RES causes a different state transition depending on the current number of outstanding connect indications. To distinguish these different connect response events, a variable is used to track the number of outstanding connect indications.

VARIABLE	DESCRIPTION
token	The token contained in a DL_CONNECT_RES that indicates on which stream the connection will be established. A value of zero indicates that the connection will be established on the stream where the DL_CONNECT_IND arrived. A non-zero value indicates the connection will be passed to another stream.
outcnt	Number of outstanding connect indications - those to which the DLS user has not responded. Actions in the state tables that manipulate this value may be disregarded when providing connectionless service.

TABLE 3. DPLI State Transition Table Variables

The actions represent steps the DLS provider must take during certain state transitions to maintain the interface state. When an action is indicated in the state transition table, the DLS provider should change the state as indicated and perform the specified action.

ACTION	DESCRIPTION
1	outcnt = outcnt + 1;
2	outcnt = outcnt - 1;
3	Pass connection to the stream indicated by the token in the DL_CONNECT_RES primitive

TABLE 4. DPLI State Transition Actions

B.3 DLPI User-Originated Events

The following table describes events initiated by the DLS user that correspond to the various request and response primitives of DLPI. The table presents the event name used in the state transition table, a brief description of the event (including the corresponding DLPI primitive), and an indication of whether the event is valid for connection-oriented data link service (DL_CODLS), connectionless data link service (DL_CLDLS), acknowledged connectionless data link service (DL_ACLDLS) or all.

FSM EVENT	DESCRIPTION	SERVICE TYPE
ATTACH_REQ	DL_ATTACH_REQ primitive	ALL
DETACH_REQ	DL_DETACH_REQ primitive	ALL
BIND_REQ	DL_BIND_REQ primitive	ALL
SUBS_BIND_REQ	DL_SUBS_BIND_REQ primitive	ALL
UNBIND_REQ	DL_UNBIND_REQ primitive	ALL
SUBS_UNBIND_REQ	DL_SUBS_UNBIND_REQ primitive	ALL
UNITDATA_REQ	DL_UNITDATA_REQ primitive	DL_CLDLS
UDQOS_REQ	DL_UDQOS_REQ primitive	DL_CLDLS
CONNECT_REQ	DL_CONNECT_REQ primitive	DL_CODLS
CONNECT_RES	DL_CONNECT_RES primitive	DL_CODLS
PASS_CONN	Received a passed connection from a DL_CONNECT_RES primitive	DL_CODLS
DISCON_REQ	DL_DISCONNECT_REQ primitive	DL_CODLS
DATA_REQ	DL_DATA_REQ primitive	DL_CODLS
RESET_REQ	DL_RESET_REQ primitive	DL_CODLS
RESET_RES	DL_RESET_RES primitive	DL_CODLS
DATA_ACK_REQ	DL_DATA_ACK_REQ primitive	DL_ACLDLS
REPLY_REQ	DL_REPLY_REQ primitive	DL_ACLDLS
REPLY_UPDATE_REQ	DL_REPLY_UPDATE_REQ primitive	DL_ACLDLS

TABLE 5. DLPI User-Originated Events

B.4 DLPI Provider-Originated Events

The following table describes the events initiated by the DLS provider that correspond to the various indication, confirmation, and acknowledgement primitives of DLPI. The table presents the event name used in the state transition table, a brief description of the event (including the corresponding DLPI primitive), and an indication of whether the event is valid for connection-oriented data link service (DL_CODLS), connectionless data link service (DL_CLDLS), acknowledged connectionless service (DL_ACDLS) or all.

FSM EVENT	DESCRIPTION	SERVICE TYPE
BIND_ACK	DL_BIND_ACK primitive	ALL
SUBS_BIND_ACK	DL_SUBS_BIND_ACK primitive	ALL
UNITDATA_IND	DL_UNITDATA_IND primitive	DL_CLDLS
UDERROR_IND	DL_UDERROR_IND primitive	DL_CLDLS
CONNECT_IND	DL_CONNECT_IND primitive	DL_CODLS
CONNECT_CON	DL_CONNECT_CON primitive	DL_CODLS
DISCON_IND1	DL_DISCONNECT_IND primitive when outcnt == 0	DL_CODLS
DISCON_IND2	DL_DISCONNECT_IND primitive when outcnt == 1	DL_CODLS
DISCON_IND3	DL_DISCONNECT_IND primitive when outcnt > 1	DL_CODLS
DATA_IND	DL_DATA_IND primitive	DL_CODLS
RESET_IND	DL_RESET_IND primitive	DL_CODLS
RESET_CON	DL_RESET_CON primitive	DL_CODLS
OK_ACK1	DL_OK_ACK primitive when outcnt == 0	ALL
OK_ACK2	DL_OK_ACK primitive when outcnt == 1 and token == 0	DL_CODLS
OK_ACK3	DL_OK_ACK primitive when outcnt == 1 and token != 0	DL_CODLS
OK_ACK4	DL_OK_ACK primitive when outcnt > 1 and token != 0	DL_CODLS
ERROR_ACK	DL_ERROR_ACK	ALL
DATA_ACK_IND	DL_DATA_ACK_IND	ACLDLS
DATA_ACK_STATUS_IND	DL_DATA_ACK_STATUS_IND	ACLDLS
REPLY_IND	DL_REPLY_IND	ACLDLS
REPLY_STATUS_IND	DL_REPLY_STATUS_IND	ACLDLS
REPLY_UPDATE_STATUS_IND	DL_REPLY_UPDATE_STATUS_IND	ACLDLS

TABLE 6. DLPI Provider-Originated Events

B.5 DLPI State Transition Table

Tables 7 - 10 describe the DLPI state transitions. Each column represents a state of DLPI (Table 2) and each row represents a DLPI event (Tables 5 and 6). The intersecting transition cell defines the resulting state transition (i.e. next state) and associated actions, if any, that must be executed by the DLS provider to maintain the interface state. Each cell may contain the following:

-	This transition cannot occur.
n	The current input results in a transition to state "n".
n [a]	The list of actions "a" should be executed following the specified state transition "n" (see table 4 for actions).

The DL_INFO_REQ, DL_INFO_ACK, DL_TOKEN_REQ, and DL_TOKEN_ACK primitives are excluded from the state transition table because they can be issued from many states and, when fully processed, do not cause a state transition to occur. However, the DLS user may not issue a DL_INFO_REQ or DL_TOKEN_REQ if any local acknowledgements are pending. In other words, these two primitives may not be issued until the DLS user receives the acknowledgement for any previously issued primitive that is expecting local positive acknowledgement. Thus, these primitives may not be issued from the DL_ATTACH_PENDING, DL_DETACH_PENDING, DL_BIND_PENDING, DL_SUBS_BIND_PND, DL_SUBS_UNBIND_PND, DL_UNBIND_PENDING, DL_UDQOS_PENDING, DL_CONN_RES_PENDING, DL_RESET_RES_PENDING, DL_DISCON8_PENDING, DL_DISCON9_PENDING, DL_DISCON11_PENDING, DL_DISCON12_PENDING, or DL_DISCON13_PENDING states. Failure to comply by this restriction may result in loss of primitives at the stream head if the DLS user is a user process. Once a DL_INFO_REQ or DL_TOKEN_REQ has been issued, the DLS provider must respond with the appropriate acknowledgement primitive.

The following rules apply to the maintenance of DLPI state:

- The DLS provider is responsible for keeping a record of the state of the interface as viewed by the DLS user, to be returned in the DL_INFO_ACK.
- The DLS provider may never generate a primitive that places the interface out of state (i.e. would correspond to a "-" cell entry in the state transition table below).
- If the DLS provider generates a STREAMS M_ERROR message upstream, it should free any further primitives processed by it's write side *put* or *service* procedure.
- The close of a stream is considered an abortive action by the DLS user, and may be executed from any state. The DLS provider must issue appropriate indications to the remote DLS user when a close occurs. For example, if the DLPI state is DL_DATAXFER, a DL_DISCONNECT_IND should be sent to the remote DLS user. The DLS provider should free any resources associated with that stream and reset the stream to its unopened condition.

The following points clarify the state transition table.

- If the DLS provider supports connection-mode service, the value of the *outcnt* state variable must be initialized to zero for each stream when that stream is first opened.
- The initial and final state for a *style 2* DLS provider is DL_UNATTACHED. However, because a *style 1* DLS provider implicitly attaches a PPA to a stream when it is opened, the initial and final DLPI state for a *style 1* provider is DL_UNBOUND. The DLS user should not issue DL_ATTACH_REQ or DL_DETACH_REQ primitives to a *style 1* DLS provider.
- A DLS provider may have multiple connect indications outstanding (i.e. the DLS user has not responded to them) at one time (see section 4.2.1, *Multi-threaded Connection Establishment*). As the

state transition table points out, the stream on which those indications are outstanding will remain in the DL_INCON_PENDING state until the DLS provider receives a response for all indications.

- The DLPI state associated with a given stream may be transferred to another stream only when the DL_CONNECT_RES primitive indicates this behavior. In this case, the responding stream (where the connection will be established) must be in the DL_IDLE state. This state transition is indicated by the PASS_CONN event in table 9.
- The labeling of the states DL_PROV_RESET_PENDING and DL_USER_RESET_PENDING indicate the party that started the local interaction, and does not necessarily indicate the originator of the reset procedure.
- A DL_DATA_REQ primitive received by the DLS provider in the state DL_PROV_RESET_PENDING (i.e. after a DL_RESET_IND has been passed to the DLS user) or the state DL_IDLE (i.e. after a data link connection has been released) should be discarded by the DLS provider.
- A DL_DATA_IND primitive received by the DLS user after the user has issued a DL_RESET_REQ should be discarded.

To ensure accurate processing of DLPI primitives, the DLS provider must adhere to the following rules concerning the receipt and generation of STREAMS M_FLUSH messages during various state transitions.

- The DLS provider must be ready to receive M_FLUSH messages from upstream and flush it's queues as specified in the message.
- The DLS provider must issue an M_FLUSH message upstream to flush both the read and write queues after receiving a successful DL_UNBIND_REQ primitive but before issuing the DL_OK_ACK.
- If an incoming disconnect occurs when the interface is in the DL_DATAXFER, DL_USER_RESET_PENDING, or DL_PROV_RESET_PENDING state, the DLS provider must send up an M_FLUSH message to flush both the read and write queues before sending up a DL_DISCONNECT_IND.
- If a DL_DISCONNECT_REQ is issued in the DL_DATAXFER, DL_USER_RESET_PENDING, or DL_PROV_RESET_PENDING states, the DLS provider must issue an M_FLUSH message upstream to flush both the read and write queues after receiving the successful DL_DISCONNECT_REQ but before issuing the DL_OK_ACK.
- If a reset occurs when the interface is in the DL_DATAXFER or DL_USER_RESET_PENDING state, the DLS provider must send up an M_FLUSH message to flush both the read and write queues before sending up a DL_RESET_IND or DL_RESET_CON.

The following table presents the allowed sequence of DLPI primitives for the common local management phase of communication.

STATES EVENTS	UNATT. 0	ATTACH PEND 1	DETACH PEND 2	UNBND 3	BND PND 4	UNBND PND 5	IDLE 6	SUBS_BND PND 20	SUBS UNBND PND 21
ATTACH_REQ	1	-	-	-	-	-	-	-	-
DETACH_REQ	-	-	-	2	-	-	-	-	-
BIND_REQ	-	-	-	4	-	-	-	-	-
BIND_ACK	-	-	-	-	6	-	-	-	-
SUBS_BIND_REQ	-	-	-	-	-	-	20	-	-
SUBS_BIND_ACK	-	-	-	-	-	-	-	6	-
UNBIND_REQ	-	-	-	-	-	-	5	-	-
OK_ACK1	-	3	0	-	-	3	-	-	6
ERROR_ACK	-	0	3	-	3	6	-	-	-
SUBS_UNBND_RQ	-	-	-	-	-	-	21	-	-

TABLE 7. DLPI State Transition Table - Local Management Phase

The following table presents the allowed sequence of DLPI primitives for the connectionless data transfer phase.

STATES EVENTS	IDLE 6	UDQOS PEND 7
UDQOS_REQ	7	-
OK_ACK1	-	6
ERROR_ACK	-	6
UNITDATA_REQ	6	-
UNITDATA_IND	6	-
UDERROR_IND	6	-

TABLE 8. DLPI State Transition Table - Connectionless-mode Data Transfer Phase

STATES EVENTS	IDLE 6	UDQOS PEND 7
UDQOS_REQ	7	-
OK_ACK1	-	6
ERROR_ACK	-	6
DATA_ACK_REQ	6	-
REPLY_REQ	6	-
REPLY_UPDATE_REQ	6	-
DATA_ACK_IND	6	-
REPLY_IND	6	-
DATA_ACK_STATUS_IND	6	-
REPLY_STATUS_IND	6	-
REPLY_UPDATE_STATUS_IND	6	-
ERROR_ACK	6	-

TABLE 9. DLPI State Transition Table - Acknowledged Connectionless-mode Data Transfer Phase

The following table presents the allowed sequence of DLPI primitives for the connection establishment phase of connection mode service.

STATES EVENTS	IDLE 6	OUTCON PEND 8	INCON PEND 9	CONN_RES PEND 10	DATA-XFER 11	DISCON 8 PEND 15	DISCON 9 PEND 16
CONNECT_REQ	8	-	-	-	-	-	-
CONNECT_RES	-	-	10	-	-	-	-
DISCON_REQ	-	15	16	-	-	-	-
PASS_CONN	11	-	-	-	-	-	-
CONNECT_IND	9 [1]	-	9 [1]	-	-	-	-
CONNECT_CON	-	11	-	-	-	-	-
DISCON_IND1 (outcnt == 0)	-	6	-	-	6	-	-
DISCON_IND2 (outcnt == 1)	-	-	6 [2]	-	-	-	-
DISCON_IND3 (outcnt > 1)	-	-	9 [2]	-	-	-	-
OK_ACK1 (outcnt == 0)	-	-	-	-	-	6	-
OK_ACK2 (outcnt == 1, token == 0)	-	-	-	11 [2]	-	-	6 [2]
OK_ACK3 (outcnt == 1, token != 0)	-	-	-	6 [2,3]	-	-	6 [2]
OK_ACK4 (outcnt > 1, token != 0)	-	-	-	9 [2,3]	-	-	9 [2]
ERROR_ACK	-	6	-	9	-	8	9

TABLE 10. DLPI State Transition Table - Connection Establishment Phase

The following table presents the allowed sequence of DLPI primitives for the connection mode data transfer phase.

STATES EVENTS	IDLE 6	DATA-XFER 11	USER RESET PEND 12	PROV RESET PEND 13	RESET_RES PEND 14	DISCON 11 PEND 17	DISCON 12 PEND 18	DISCON 13 PEND 19
DISCON_REQ	-	17	18	19	-	-	-	-
DATA_REQ	-	11	-	-	-	-	-	-
RESET_REQ	-	12	-	-	-	-	-	-
RESET_RES	-	-	-	14	-	-	-	-
DISCON_IND1 (outcnt == 0)	-	6	6	6	-	-	-	-
DATA_IND	-	11	-	-	-	-	-	-
RESET_IND	-	13	-	-	-	-	-	-
RESET_CON	-	-	11	-	-	-	-	-
OK_ACK1 (outcnt == 0)	-	-	-	-	11	6	6	6
ERROR_ACK	-	-	11	-	13	11	12	13

TABLE 11. DLPI State Transition Table - Connection-mode Data Transfer Phase

Appendix C — Precedence of DLPI Primitives

This appendix presents the precedence of DLPI primitives relative to one another. Two queues are used to describe DLPI precedence rules. One queue contains DLS user-originated primitives and corresponds to the STREAMS write queue of the DLS provider. The other queue contains DLS provider-originated primitives and corresponds to the STREAMS read queue of the DLS user. The DLS provider is responsible for determining precedence on its write queue and the DLS user is responsible for determining precedence on its read queue as indicated in the precedence tables below.

For each precedence table, the rows (labeled PRIM X) correspond to primitives that are on the given queue and the columns (labeled PRIM Y) correspond to primitives that are about to be placed on that queue. Each pair of primitives (PRIM X, PRIM Y) may be manipulated resulting in:

- Change of order, where the order of a pair of primitives is reversed if, and only if, the second primitive in the pair (PRIM Y) is of a type defined to be able to advance ahead of the first primitive in the pair (PRIM X).
- Deletion, where a primitive (PRIM X) may be deleted if, and only if, the primitive that follows it (PRIM Y) is defined to be destructive with respect to that primitive. Destructive primitives may always be added to the queue. Some primitives may cause both primitives in the pair to be destroyed.

The precedence rules define the allowed manipulations of a pair of DLPI primitives. Whether these actions are performed is the choice of the DLS provider for user-originated primitives and the choice of the DLS user for provider-originated primitives.

C.1 Write Queue Precedence

The following table presents the precedence rules for DLS user-originated primitives on the DLS provider's STREAMS write queue. It assumes that only non-local primitives (i.e. those that generate protocol data units to a peer DLS user) are queued by the DLS provider.

For connection establishment primitives, this table represents the possible pairs of DLPI primitives when connect indications/responses are single-threaded. For the multi-threading scenario, the following rules apply:

- A DL_CONNECT_RES primitive has no precedence over either a DL_CONNECT_RES or a DL_DISCONNECT_REQ primitive that is associated with another connection correlation number (*dl_correlation*), and should therefore be placed on the queue behind such primitives.
- Similarly, a DL_DISCONNECT_REQ primitive has no precedence over either a DL_CONNECT_RES or a DL_DISCONNECT_REQ primitive that is associated with another connection correlation number, and should therefore be placed on the queue behind such primitives. Notice, however, that a DL_DISCONNECT_REQ does have precedence over a DL_CONNECT_RES primitive that is associated with the same correlation number (this is indicated in the table below).

PRIM Y PRIM X (on queue)	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
P1 DL_INFO_REQ															
P2 DL_ATTACH_REQ															
P3 DL_DETACH_REQ															
P4 DL_BIND_REQ															
P5 DL_UNBIND_REQ															
P6 DL_UNITDATA_REQ						1									
P7 DL_UDQOS_REQ															
P8 DL_CONNECT_REQ											4				
P9 DL_CONNECT_RES											3	1	1		
P10 DL_TOKEN_REQ															
P11 DL_DISCONNECT_REQ								1							
P12 DL_DATA_REQ											5	1	3	3	
P13 DL_RESET_REQ											3				
P14 DL_RESET_RES											3	1	1		
P15 DL_SUBS_BIND_REQ															

TABLE 12. Write Queue Precedence

KEY:

Code	Interpretation
" "	Empty box indicates a scenario which cannot take place.
1	Y has no precedence over X and should be placed on queue behind X.
2	Y has precedence over X and may advance ahead of X.
3	Y has precedence over X and X must be removed.
4	Y has precedence over X and both X and Y must be removed.
5	Y may have precedence over X (DLS provider’s choice), and if so then X must be removed.

C.2 Read Queue Precedence

The following table presents the precedence rules for DLS provider-originated primitives on the DLS user's STREAMS read queue.

For connection establishment primitives, this table represents the possible pairs of DLPI primitives when connect indications/responses are single-threaded. For the multi-threading scenario, the following rules apply:

1. A DL_CONNECT_IND primitive has no precedence over either a DL_CONNECT_IND or a DL_DISCONNECT_IND primitive that is associated with another connection correlation number (*dl_correlation*), and should therefore be placed on the queue behind such primitives.
2. Similarly, a DL_DISCONNECT_IND primitive has no precedence over either a DL_CONNECT_IND or a DL_DISCONNECT_IND primitive that is associated with another connection correlation number, and should therefore be placed on the queue behind such primitives.
3. A DL_DISCONNECT_IND does have precedence over a DL_CONNECT_IND primitive that is associated with the same correlation number (this is indicated in the table below). If a DL_DISCONNECT_IND is about to be placed on the DLS user's read queue, the user should scan the read queue for a possible DL_CONNECT_IND primitive with a matching correlation number. If a match is found, both the DL_DISCONNECT_IND and matching DL_CONNECT_IND should be removed.

If the DLS user is a user-level process, it's read queue is the stream head read queue. Because a user process has no control over the placement of DLS primitives on the stream head read queue, a DLS user cannot straightforwardly initiate the actions specified in the following precedence table. Except for the connection establishment scenario, the DLS user can ignore the precedence rules defined in the table below. This is equivalent to saying the DLS user's read queue contains at most one primitive.

The only exception to this rule is the processing of connect indication/response primitives. A problem arises if a user issues a DL_CONNECT_RES primitive when a DL_DISCONNECT_IND is on the stream head read queue. The DLS provider will not be expecting the connect response because it has forwarded the disconnect indication to the DLS user and is in the DL_IDLE state. It will therefore generate an error upon seeing the DL_CONNECT_RES. To avoid this error, the DLS user should not respond to a DL_CONNECT_IND primitive if the stream head read queue is not empty. The assumption here is a non-empty queue may be holding a disconnect indication that is associated with the connect indication that is being processed.

When connect indications/responses are single-threaded, a non-empty read queue can only contain a DL_DISCONNECT_IND, which must be associated with the outstanding DL_CONNECT_IND. This DL_DISCONNECT_IND primitive indicates to the DLS user that the DL_CONNECT_IND is to be removed. The DLS user should not issue a response to the DL_CONNECT_IND if a DL_DISCONNECT_IND is received.

The multi-threaded scenario is slightly more complex, because multiple DL_CONNECT_IND and DL_DISCONNECT_IND primitives may be interspersed on the stream head read queue. In this scenario, the DLS user should retrieve all indications on the queue before responding to a given connect indication. If a queued primitive is a DL_CONNECT_IND, it should be stored by the user process for eventual response. If a queued primitive is a DL_DISCONNECT_IND, it should be matched (using the correlation number) against any stored connect indications. The matched connect indication should then be removed, just as is done in the single-threaded scenario.

PRIM Y PRIM X (on queue)	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
P1 DL_INFO_ACK			1	1	1	1		1	1	1	1			
P2 DL_BIND_ACK			1		1									
P3 DL_UNITDATA_IND	2		1	2								2	2	
P4 DL_UDERROR_IND	2		1	1								2	2	
P5 DL_CONNECT_IND	2						2	4						
P6 DL_CONNECT_CON	2						2	3	1	1				
P7 DL_TOKEN_ACK					1	1		1	1	1	1			
P8 DL_DISCONNECT_IND	2				1		2						2	
P9 DL_DATA_IND	2						2	5	1	3	3		2	
P10 DL_RESET_IND	2						2	3					2	
P11 DL_RESET_CON	2						2	3	1	1			2	
P12 DL_OK_ACK			1	1	1			1	1	1				
P13 DL_ERROR_ACK			1	1	1			1	1	1	1			
P14 DL_SUBS_BIND_ACK			1		1									

TABLE 13. Read Queue Precedence

KEY:

Code	Interpretation
" "	Empty box indicates a scenario which cannot take place.
1	Y has no precedence over X and should be placed on queue behind X.
2	Y has precedence over X and may advance ahead of X.
3	Y has precedence over X and X must be removed.
4	Y has precedence over X and both X and Y must be removed.
5	Y may have precedence over X (DLS provider's choice), and if so then X must be removed.

Appendix D — Glossary of DLPI Terms and Acronyms

The following acronyms apply to the Data Link Provider Interface:

DLPI	Data Link Provider Interface
DLS	Data Link Service
DLSAP	Data Link Service Access Point
DLSDU	Data Link Service Data Unit
ISO	International Organization for Standardization
OSI	Open Systems Interconnection
PPA	Physical Point of Attachment
QOS	Quality of Service

The following terms apply to the Data Link Provider Interface:

Called DLS user

The DLS user in connection mode that processes requests for connections from other DLS users.

Calling DLS user

The DLS user in connection mode that initiates the establishment of a data link connection.

Communication endpoint

The local communication channel between a DLS user and DLS provider.

Connection establishment

The phase in connection mode that enables two DLS users to create a data link connection between them.

Connectionless mode

A mode of transfer in which data is passed from one user to another in self-contained units with no logical relationship required among the units.

Connection management stream

A special stream that will receive all incoming connect indications destined for DLSAP addresses that are not bound to any other streams associated with a particular PPA.

Connection mode

A circuit-oriented mode of transfer in which data is passed from one user to another over an established connection in a sequenced manner.

Connection release

The phase in connection mode that terminates a previously established data link connection.

Data link service data unit

A grouping of DLS user data whose boundaries are preserved from one end of a data link connection to the other.

Data transfer

The phase in connection and connectionless modes that supports the transfer of data between two DLS users.

DLSAP

An point at a DLS user attaches itself to a DLS provider to access data link services.

DLSAP address
An identifier used to differentiate and locate specific DLS user access points to a DLS provider.

DLS provider
The data link layer protocol that provides the services of the Data Link Provider Interface.

DLS user
The user-level application or user-level or kernel-level protocol that accesses the services of the data link layer.

Local management
The phase in connection and connectionless modes in which a DLS user initializes a stream and binds a DLSAP to the stream. Primitives in this phase generate local operations only.

PPA
The point at which a system attaches itself to a physical communications medium.

PPA identifier
An identifier of a particular physical medium over which communication transpires.

Quality of service
Characteristics of transmission quality between two DLS users.

Appendix E — Guidelines for Protocol Independent DLS Users

DLPI enables a DLS user to be implemented in a protocol-independent manner such that the DLS user can operate over many DLS providers without changing the DLS user software. DLS user implementors must adhere to the following guidelines, however, to achieve this independence.

- The protocol-specific service limits returned in the DL_INFO_ACK primitive (e.g. *dl_max_sdu*) must not be exceeded. The DLS user should access these limits and adhere to them while interacting with the DLS provider.
- Protocol-specific DLSAP address and PPA identifier formats should be hidden from DLS user software. Hard-coded addresses and identifiers must be avoided. The DLS user should retrieve the necessary information from some other entity (such as a management entity or a higher layer protocol entity) and insert it without inspection into the appropriate primitives.
- The DLS user should not be written to a specific style of DLS provider (i.e. *style 1* vs. *style 2*). The DL_INFO_ACK returns sufficient information to identify which style of provider has been accessed, and the DLS user should perform (or not perform) a DL_ATTACH_REQ accordingly.
- The names of devices should not be hard-coded into user-level programs that access a DLS provider.
- The DLS user should access the *dl_service_mode* field of the DL_INFO_ACK primitive to determine whether connection or connectionless services are available on a given stream.

Appendix F — Required Information for DLS Provider-Specific Addenda

DLPI is a general interface to the services of any DLS provider. However, areas have been documented in this specification where DLS provider-specific information can be conveyed and interpreted. This appendix summarizes all provider-specific issues as an aid to developers of DLS provider implementations. As such, it forms a checklist of required information that should be documented in some manner as part of the provider implementation. The areas DLS provider-specific addendum documentation must address are:

- DLSAP Address Space
- PPA Access and Control
- Quality of Service
- DL_INFO_ACK Values
- Supported Services

For each area listed, a brief description of the provider-specific item(s) associated with it will be presented, including references to the appropriate section in this specification.

DLSAP Address Space (Sections 2.3.2 and 4.1.6)

The format of a DLSAP address is specific to each DLS provider, as is the management of that address space. There are no restriction on the format or style of a DLSAP address. As such, a specific implementation should document the format, size, and restrictions of a DLSAP address, as well as information on how the address space is managed. For example, DLPI enables a DLS user to choose a specific DLSAP address to be bound to a stream, but a given implementation may pre-associate addresses with streams based, for example, on the major/minor device number of the stream. In this case, the DLS user could only retrieve the address associated with a stream.

If the DLS provider enables a user to select the DLSAP address for a stream, the implementation must document the contents of the *dl_sap* field in the DL_BIND_REQ. This field must contain sufficient information to enable the DLS provider to determine the chosen DLSAP address. This may be the full DLSAP address (if it is not larger than sizeof(ulong)), or some distinguishable part of that address. For example, an implementation of a DLS provider conforming to the ISO 8802/2 address space might allow the DSAP or SSAP portion of the DLSAP address to be specified here, where the MAC address portion remains constant over all DLSAP addresses managed by that provider.

Another aspect of address management is whether the provider supports the ability to dynamically allocate DLSAPs other than the requested DLSAP in a DL_BIND_REQ.

Restrictions on DLSAPs might cover the range of supported DLSAP values, services provided by a DLSAP, connection management, and multiplexing. An example of connection management restrictions is the number of connections allowed per DLSAP. Examples of multiplexing restrictions include the number of DLSAPs per PPA, and requirements that certain DLSAPs are attached to specific PPAs.

Subsequent DLSAP Addresses (Section 4.1.9)

The IEEE 802.2 link layer standard allows two ways of specifying a DLSAP value:

- Using an IEEE reserved DLSAP which corresponds to a well-defined protocol.
- Using a privately defined DLSAP.

Previously, subnetworks used privately defined DLSAP values. As these subnetworks move into the OSI world, they may exist in environments with other vendors machines. This presents a problem because there are only 64 privately definable DLSAPS and any other vendor may choose to use these same DLSAP values.

IEEE 802.1 has defined a third way of assigning DLSAP values that will allow for unique private protocol demultiplexing. The DL_SUBS_BIND_REQ may be used to support this method.

The Subsequent binding of DLSAPs can be peer or hierarchical. When the User requests peer addressing, the DL_SUBS_BIND_REQ will specify a DLSAP that may be used in lieu of the DLSAP that was bound in the DL_BIND_REQ. This will allow for a choice to be made between a number of DLSAPs on a stream when determining traffic based on DLSAP values. An example of this would be to various ether_type values as DLSAPs. The DL_BIND_REQ, for example, could be issued with ether_type value of IP, and a subsequent bind could be issued with ether type value of ARP. The Provider may now multiplex off of the ether_type field and allow for either IP or ARP traffic to be sent up this stream.

When the DLS User requests hierarchical binding, the DL_SUBS_BIND_REQ will specify a DLSAP that will be used in addition to the DLSAP bound using a DL_BIND_REQ. This will allow additional information to be specified, that will be used in a header or used for demultiplexing. An example of this would be to use hierarchical bind to specify the OUI (organizationally unique identifier) to be used by SNAP.

If a DLS Provider supports peer subsequent bind operations, the first SAP that is bound is used as the source SAP when there is ambiguity.

PPA Access and Control (Sections 2.3.1 and 4.1.1)

A physical point of attachment (PPA) is referenced in DLPI by a PPA identifier, which is of type 'ulong'. The format of this identifier is provider-specific. The DLS provider addendum documentation should describe the format and generation of PPA identifiers for all physical media it is expected to control. It should also describe how a PPA is controlled, the capabilities of the PPA, the number of PPAs supported, and the administrative interface.

Multiplexing capabilities of a PPA should also be described in the DLS provider addendum documentation. This conveys information on the number of DLSAPs that may be supported per PPA, and the number of PPAs supported.

Another item that should be described is the manner in which a PPA is initialized. Section 4.1.1, *PPA Initialization/De-initialization*, presents the alternative methods supported by DLPI for initializing a PPA. The interactions of auto-initialization or pre-initialization with the Attach and Bind services should be discussed, and the following items should be addressed.

- Is auto-initialization, pre-initialization, or both supported for a PPA?
- Can the method of initialization be restricted on a PPA basis?

Quality of Service (Section 5)

Support of QOS parameter negotiation and selection is a provider-specific issue that must be described for each implementation. The DLS provider addendum documentation should describe which, if any, QOS parameters are supported by the provider. For parameters that are negotiated end-to-end, the addendum should describe whether the provider supports end-to-end negotiation, or whether these parameters are negotiated in a local manner only. Finally, default QOS parameter values should be documented.

DL_INFO_ACK Values (Section 4.1.3)

The DL_INFO_ACK primitive specifies information on a DLS provider's restrictions and capabilities. The DLS provider addendum documentation should describe the values for all fields in the DL_INFO_ACK, and how they are determined (static, tunable, dynamic). At a minimum, the addendum must describe the provider style and the service modes supported by the DLS provider.

Supported Services (Section 3)

The overall services that a specific DLS provider supports should be described. These include whether a provider supports connection-mode service, connectionless-mode service (acknowledged or unacknowledged), or both, and how a DLS user selects the appropriate mode. For example, the mode may be mapped directly to a specific major/minor device, and the user selects an appropriate mode by opening the corresponding special file. Alternatively, a DLS provider that supports both modes may enable a DLS user to select the service mode on the DL_BIND_REQ.

The file name(s) used to access a particular DLS provider and/or specific service modes of that provider must also be documented.

Appendix G — DLPI Header File

This appendix contains a listing of the DLPI header file needed by implementations of both DLS user and DLS provider software.

```
#ifndef _SYS_DLPI_H
#define _SYS_DLPI_H


/*
 * dlpi.h header for Data Link Provider Interface
 */

/*
 * This header file has encoded the values so an existing driver
 * or user which was written with the Logical Link Interface(LLI)
 * can migrate to the DLPI interface in a binary compatible manner.
 * Any fields which require a specific format or value are flagged
 * with a comment containing the message LLI compatibility.
 */

/*
 *      DLPI revision definition history
 */
#define DL_CURRENT_VERSION      0x02    /* current version of dlpi */
#define DL_VERSION_2            0x02    /* version of dlpi March 12,1991 */

/*
 * Primitives for Local Management Services
 */
#define DL_INFO_REQ             0x00    /* Information Req, LLI compatibility */
#define DL_INFO_ACK             0x03    /* Information Ack, LLI compatibility */
#define DL_ATTACH_REQ           0x0b    /* Attach a PPA */
#define DL_DETACH_REQ           0x0c    /* Detach a PPA */
#define DL_BIND_REQ             0x01    /* Bind dlsap address, LLI compatibility */
#define DL_BIND_ACK             0x04    /* Dlsap address bound, LLI compatibility */
#define DL_UNBIND_REQ           0x02    /* Unbind dlsap address, LLI compatibility */
#define DL_OK_ACK               0x06    /* Success acknowledgment, LLI compatibility */
#define DL_ERROR_ACK            0x05    /* Error acknowledgment, LLI compatibility */
#define DL_SUBS_BIND_REQ        0x1b    /* Bind Subsequent DLSAP address */
#define DL_SUBS_BIND_ACK        0x1c    /* Subsequent DLSAP address bound */
#define DL_SUBS_UNBIND_REQ      0x15    /* Subsequent unbind */
#define DL_ENABMULTI_REQ        0x1d    /* Enable multicast addresses */
#define DL_DISABMULTI_REQ       0x1e    /* Disable multicast addresses */
#define DL_PROMISCON_REQ        0x1f    /* Turn on promiscuous mode */
#define DL_PROMISCOFF_REQ       0x20    /* Turn off promiscuous mode */

/*
 * Primitives used for Connectionless Service
 */
#define DL_UNITDATA_REQ         0x07    /* datagram send request, LLI compatibility */
#define DL_UNITDATA_IND         0x08    /* datagram receive indication, LLI compatibility */
#define DL_UDERROR_IND          0x09    /* datagram error indication, LLI compatibility */
#define DL_UDQOS_REQ            0x0a    /* set QOS for subsequent datagram transmissions */

/*
 * Primitives used for Connection-Oriented Service
 */
#define DL_CONNECT_REQ          0x0d    /* Connect request */
#define DL_CONNECT_IND          0x0e    /* Incoming connect indication */
#define DL_CONNECT_RES          0x0f    /* Accept previous connect indication */
#define DL_CONNECT_CON          0x10    /* Connection established */

#define DL_TOKEN_REQ            0x11    /* Passoff token request */
```

```
#define DL_TOKEN_ACK            0x12    /* Passoff token ack */

#define DL_DISCONNECT_REQ       0x13    /* Disconnect request */
#define DL_DISCONNECT_IND       0x14    /* Disconnect indication */

#define DL_RESET_REQ            0x17    /* Reset service request */
#define DL_RESET_IND            0x18    /* Incoming reset indication */
#define DL_RESET_RES            0x19    /* Complete reset processing */
#define DL_RESET_CON            0x1a    /* Reset processing complete */

/*
 *  Primitives used for Acknowledged Connectionless Service
 */

#define DL_DATA_ACK_REQ         0x21    /* data unit transmission request */
#define DL_DATA_ACK_IND         0x22    /* Arrival of a command PDU */
#define DL_DATA_ACK_STATUS_IND  0x23    /* Status indication of DATA_ACK_REQ*/
#define DL_REPLY_REQ            0x24    /* Request a DLSDU from the remote */
#define DL_REPLY_IND            0x25    /* Arrival of a command PDU */
#define DL_REPLY_STATUS_IND     0x26    /* Status indication of REPLY_REQ */
#define DL_REPLY_UPDATE_REQ     0x27    /* Hold a DLSDU for transmission */
#define DL_REPLY_UPDATE_STATUS_IND      0x28 /* Status of REPLY_UPDATE req */

/*
 * Primitives used for XID and TEST operations
 */

#define DL_XID_REQ      0x29            /* Request to send an XID PDU */
#define DL_XID_IND      0x2a            /* Arrival of an XID PDU */
#define DL_XID_RES      0x2b            /* request to send a response XID PDU*/
#define DL_XID_CON      0x2c            /* Arrival of a response XID PDU */
#define DL_TEST_REQ     0x2d            /* TEST command request */
#define DL_TEST_IND     0x2e            /* TEST response indication */
#define DL_TEST_RES     0x2f            /* TEST response */
#define DL_TEST_CON     0x30            /* TEST Confirmation */

/*
 * Primitives to get and set the physical address, and to get
 * Statistics
 */

#define DL_PHYS_ADDR_REQ        0x31    /* Request to get physical addr */
#define DL_PHYS_ADDR_ACK        0x32    /* Return physical addr */
#define DL_SET_PHYS_ADDR_REQ    0x33    /* set physical addr */
#define DL_GET_STATISTICS_REQ   0x34    /* Request to get statistics */
#define DL_GET_STATISTICS_ACK   0x35    /* Return statistics */

/*
 * DLPI interface states
 */
#define DL_UNATTACHED           0x04    /* PPA not attached */
#define DL_ATTACH_PENDING       0x05    /* Waiting ack of DL_ATTACH_REQ */
#define DL_DETACH_PENDING       0x06    /* Waiting ack of DL_DETACH_REQ */
#define DL_UNBOUND              0x00    /* PPA attached, LLI compatibility */
#define DL_BIND_PENDING         0x01    /* Waiting ack of DL_BIND_REQ, LLI compatibility */
#define DL_UNBIND_PENDING       0x02    /* Waiting ack of DL_UNBIND_REQ, LLI compatibility */
#define DL_IDLE                 0x03    /* dlsap bound, awaiting use, LLI compatibility */
#define DL_UDQOS_PENDING        0x07    /* Waiting ack of DL_UDQOS_REQ */
#define DL_OUTCON_PENDING       0x08    /* outgoing connection, awaiting DL_CONN_CON */
#define DL_INCON_PENDING        0x09    /* incoming connection, awaiting DL_CONN_RES */
#define DL_CONN_RES_PENDING     0x0a    /* Waiting ack of DL_CONNECT_RES */
#define DL_DATAXFER             0x0b    /* connection-oriented data transfer */
#define DL_USER_RESET_PENDING   0x0c    /* user initiated reset, awaiting DL_RESET_CON */
#define DL_PROV_RESET_PENDING   0x0d    /* provider initiated reset, awaiting DL_RESET_RES */
#define DL_RESET_RES_PENDING    0x0e    /* Waiting ack of DL_RESET_RES */
#define DL_DISCON8_PENDING      0x0f    /* Waiting ack of DL_DISC_REQ when in DL_OUTCON_PENDING */
```

```
#define DL_DISCON9_PENDING      0x10    /* Waiting ack of DL_DISC_REQ when in DL_INCON_PENDING */
#define DL_DISCON11_PENDING     0x11    /* Waiting ack of DL_DISC_REQ when in DL_DATAXFER */
#define DL_DISCON12_PENDING     0x12    /* Waiting ack of DL_DISC_REQ when in DL_USER_RESET_PENDING */
#define DL_DISCON13_PENDING     0x13    /* Waiting ack of DL_DISC_REQ when in DL_DL_PROV_RESET_PENDING */
#define DL_SUBS_BIND_PND        0x14    /* Waiting ack of DL_SUBS_BIND_REQ */
#define DL_SUBS_UNBIND_PND      0x15    /* Waiting ack of DL_SUBS_UNBIND_REQ */


/*
 * DL_ERROR_ACK error return values
 *
 */
#define DL_ACCESS       0x02    /* Improper permissions for request, LLI compatibility */
#define DL_BADADDR      0x01    /* DLSAP address in improper format or invalid */
#define DL_BADCORR      0x05    /* Sequence number not from outstanding DL_CONN_IND */
#define DL_BADDATA      0x06    /* User data exceeded provider limit */
#define DL_BADPPA       0x08    /* Specified PPA was invalid */
#define DL_BADPRIM      0x09    /* Primitive received is not known by DLS provider */
#define DL_BADQOSPARAM  0x0a    /* QOS parameters contained invalid values */
#define DL_BADQOSTYPE   0x0b    /* QOS structure type is unknown or unsupported */
#define DL_BADSAP       0x00    /* Bad LSAP selector, LLI compatibility */
#define DL_BADTOKEN     0x0c    /* Token used not associated with an active stream */
#define DL_BOUND        0x0d    /* Attempted second bind with dl_max_conind or  */
                                /*      dl_conn_mgmt > 0 on same DLSAP or PPA */
#define DL_INITFAILED   0x0e    /* Physical Link initialization failed */
#define DL_NOADDR       0x0f    /* Provider couldn't allocate alternate address */
#define DL_NOTINIT      0x10    /* Physical Link not initialized */
#define DL_OUTSTATE     0x03    /* Primitive issued in improper state, LLI compatibility */
#define DL_SYSERR       0x04    /* UNIX system error occurred, LLI compatibility */
#define DL_UNSUPPORTED  0x07    /* Requested service not supplied by provider */
#define DL_UNDELIVERABLE 0x11   /* Previous data unit could not be delivered */
#define DL_NOTSUPPORTED  0x12   /* Primitive is known but not supported by DLS provider */
#define DL_TOOMANY      0x13    /* limit exceeded       */
#define DL_NOTENAB      0x14    /* Promiscuous mode not enabled */
#define DL_BUSY         0x15    /* Other streams for a particular PPA in the
                                   post-attached state */

#define DL_NOAUTO       0x16    /* Automatic handling of XID & TEST responses
                                   not supported */
#define DL_NOXIDAUTO    0x17    /* Automatic handling of XID not supported */
#define DL_NOTESTAUTO   0x18    /* Automatic handling of TEST not supported */
#define DL_XIDAUTO      0x19    /* Automatic handling of XID response */
#define DL_TESTAUTO     0x1a    /* AUtomatic handling of TEST response*/
#define DL_PENDING      0x1b    /* pending outstanding connect indications */

/*
 * NOTE: The range of error codes, 0x80 - 0xff is reserved for
 *       implementation specific error codes. This reserved range of error
 *       codes will be defined by the DLS Provider.
 */



/*
 * DLPI media types supported
 */
#define DL_CSMACD       0x0     /* IEEE 802.3 CSMA/CD network, LLI Compatibility */
#define DL_TPB          0x1     /* IEEE 802.4 Token Passing Bus, LLI Compatibility */
#define DL_TPR          0x2     /* IEEE 802.5 Token Passing Ring, LLI Compatibility */
#define DL_METRO        0x3     /* IEEE 802.6 Metro Net, LLI Compatibility */
#define DL_ETHER        0x4     /* Ethernet Bus, LLI Compatibility */
#define DL_HDLC         0x05    /* ISO HDLC protocol support, bit synchronous */
#define DL_CHAR         0x06    /* Character Synchronous protocol support, eg BISYNC */
#define DL_CTCA         0x07    /* IBM Channel-to-Channel Adapter */
#define DL_FDDI         0x08    /* Fiber Distributed data interface */
#define DL_OTHER        0x09    /* Any other medium not listed above */
```

```
/*
 * DLPI provider service supported.
 * These must be allowed to be bitwise-OR for dl_service_mode in
 * DL_INFO_ACK.
 */
#define DL_CODLS        0x01    /* support connection-oriented service */
#define DL_CLDLS        0x02    /* support connectionless data link service */
#define DL_ACLDLS       0x04    /* support acknowledged connectionless service*/


/*
 * DLPI provider style.
 * The DLPI provider style which determines whether a provider
 * requires a DL_ATTACH_REQ to inform the provider which PPA
 * user messages should be sent/received on.
 */
#define DL_STYLE1       0x0500  /* PPA is implicitly bound by open(2) */
#define DL_STYLE2       0x0501  /* PPA must be explicitly bound via DL_ATTACH_REQ */


/*
 * DLPI Originator for Disconnect and Resets
 */
#define DL_PROVIDER     0x0700
#define DL_USER         0x0701

/*
 * DLPI Disconnect Reasons
 */
#define DL_CONREJ_DEST_UNKNOWN                  0x0800
#define DL_CONREJ_DEST_UNREACH_PERMANENT        0x0801
#define DL_CONREJ_DEST_UNREACH_TRANSIENT        0x0802
#define DL_CONREJ_QOS_UNAVAIL_PERMANENT         0x0803
#define DL_CONREJ_QOS_UNAVAIL_TRANSIENT         0x0804
#define DL_CONREJ_PERMANENT_COND                0x0805
#define DL_CONREJ_TRANSIENT_COND                0x0806
#define DL_DISC_ABNORMAL_CONDITION              0x0807
#define DL_DISC_NORMAL_CONDITION                0x0808
#define DL_DISC_PERMANENT_CONDITION             0x0809
#define DL_DISC_TRANSIENT_CONDITION             0x080a
#define DL_DISC_UNSPECIFIED                     0x080b

/*
 * DLPI Reset Reasons
 */
#define DL_RESET_FLOW_CONTROL   0x0900
#define DL_RESET_LINK_ERROR     0x0901
#define DL_RESET_RESYNCH        0x0902

/*
 * DLPI status values for acknowledged connectionless data transfer
 */
#define DL_CMD_MASK     0x0f    /* mask for command portion of status */
#define DL_CMD_OK       0x00    /* Command Accepted */
#define DL_CMD_RS       0x01    /* Unimplemented or inactivated service */
#define DL_CMD_UE       0x05    /* Data Link User interface error */
#define DL_CMD_PE       0x06    /* Protocol error */
#define DL_CMD_IP       0x07    /* Permanent implementation dependent error*/
#define DL_CMD_UN       0x09    /* Resources temporarily unavailable */
#define DL_CMD_IT       0x0f    /* Temporary implementation dependent error */
#define DL_RSP_MASK     0xf0    /* mask for response portion of status */
#define DL_RSP_OK       0x00    /* Response DLSDU present */
#define DL_RSP_RS       0x10    /* Unimplemented or inactivated service */
#define DL_RSP_NE       0x30    /* Response DLSDU never submitted */
#define DL_RSP_NR       0x40    /* Response DLSDU not requested */
#define DL_RSP_UE       0x50    /* Data Link User interface error */
```

```
#define DL_RSP_IP       0x70    /* Permanent implementation dependent error */
#define DL_RSP_UN       0x90    /* Resources temporarily unavailable */
#define DL_RSP_IT       0xf0    /* Temporary implementation dependent error */

/*
 * Service Class values for acknowledged connectionless data transfer
 */
#define DL_RQST_RSP     0x01    /* Use acknowledge capability in MAC sublayer*/
#define DL_RQST_NORSP   0x02    /* No acknowledgement service requested */

/*
 * DLPI address type definition
 */
#define DL_FACT_PHYS_ADDR       0x01    /* factory physical address */
#define DL_CURR_PHYS_ADDR       0x02    /* current physical address */

/*
 * DLPI flag definitions
 */
#define DL_POLL_FINAL   0x01            /* if set,indicates poll/final bit set*/

/*
 *      XID and TEST responses supported by the provider
 */
#define DL_AUTO_XID     0x01            /* provider will respond to XID */
#define DL_AUTO_TEST    0x02            /* provider will respond to TEST */

/*
 * Subsequent bind type
 */
#define DL_PEER_BIND    0x01            /* subsequent bind on a peer addr */
#define DL_HIERARCHICAL_BIND    0x02    /* subs_bind on a hierarchical addr*/

/*
 * DLPI promiscuous mode definitions
 */
#define DL_PROMISC_PHYS         0x01    /* promiscuous mode at phys level */
#define DL_PROMISC_SAP          0x02    /* promiscous mode at sap level */
#define DL_PROMISC_MULTI        0x03    /* promiscuous mode for multicast */

/*
 * DLPI Quality Of Service definition for use in QOS structure definitions.
 * The QOS structures are used in connection establishment, DL_INFO_ACK,
 * and setting connectionless QOS values.
 */

/*
 * Throughput
 *
 * This parameter is specified for both directions.
 */
typedef struct {
                long    dl_target_value;        /* desired bits/second desired */
                long    dl_accept_value;        /* min. acceptable bits/second */
} dl_through_t;

/*
 * transit delay specification
 *
 * This parameter is specified for both directions.
 * expressed in milliseconds assuming a DLSDU size of 128 octets.
 * The scaling of the value to the current DLSDU size is provider dependent.
 */
typedef struct {
                long    dl_target_value;        /* desired value of service */
                long    dl_accept_value;        /* min. acceptable value of service */
```

```
} dl_transdelay_t;

/*
 * priority specification
 * priority range is 0-100, with 0 being highest value.
 */
typedef struct {
                long    dl_min;
                long    dl_max;
} dl_priority_t;


/*
 * protection specification
 *
 */
#define DL_NONE                 0x0B01  /* no protection supplied */
#define DL_MONITOR              0x0B02  /* protection against passive monitoring */
#define DL_MAXIMUM              0x0B03  /* protection against modification, replay, */
                                        /* addition, or deletion */

typedef struct {
                long    dl_min;
                long    dl_max;
} dl_protect_t;


/*
 * Resilience specification
 * probabilities are scaled by a factor of 10,000 with a time interval
 * of 10,000 seconds.
 */
typedef struct {
                long    dl_disc_prob;   /* probability of provider init DISC */
                long    dl_reset_prob;  /* probability of provider init RESET */
} dl_resilience_t;


/*
 * QOS type definition to be used for negotiation with the
 * remote end of a connection, or a connectionless unitdata request.
 * There are two type definitions to handle the negotiation
 * process at connection establishment. The typedef dl_qos_range_t
 * is used to present a range for parameters. This is used
 * in the DL_CONNECT_REQ and DL_CONNECT_IND messages. The typedef
 * dl_qos_sel_t is used to select a specific value for the QOS
 * parameters. This is used in the DL_CONNECT_RES, DL_CONNECT_CON,
 * and DL_INFO_ACK messages to define the selected QOS parameters
 * for a connection.
 *
 * NOTE
 *      A DataLink provider which has unknown values for any of the fields
 *      will use a value of DL_UNKNOWN for all values in the fields.
 *
 * NOTE
 *      A QOS parameter value of DL_QOS_DONT_CARE informs the DLS
 *      provider the user requesting this value doesn't care
 *      what the QOS parameter is set to. This value becomes the
 *      least possible value in the range of QOS parameters.
 *      The order of the QOS parameter range is then:
 *
 *              DL_QOS_DONT_CARE < 0 < MAXIMUM QOS VALUE
 */
#define DL_UNKNOWN              -1
#define DL_QOS_DONT_CARE        -2
```

```
/*
 * Every QOS structure has the first 4 bytes containing a type
 * field, denoting the definition of the rest of the structure.
 * This is used in the same manner has the dl_primitive variable
 * is in messages.
 *
 * The following list is the defined QOS structure type values and structures.
 */
#define DL_QOS_CO_RANGE1        0x0101  /* QOS range struct. for Connection modeservice */
#define DL_QOS_CO_SEL1          0x0102  /* QOS selection structure */
#define DL_QOS_CL_RANGE1        0x0103  /* QOS range struct. for connectionless*/
#define DL_QOS_CL_SEL1          0x0104  /* QOS selection for connectionless mode*/

typedef struct {
                ulong           dl_qos_type;
                dl_through_t    dl_rcv_throughput;  /* desired and acceptable*/
                dl_transdelay_t dl_rcv_trans_delay; /* desired and acceptable*/
                dl_through_t    dl_xmt_throughput;
                dl_transdelay_t dl_xmt_trans_delay;
                dl_priority_t   dl_priority;        /* min and max values */
                dl_protect_t    dl_protection;      /* min and max values */
                long            dl_residual_error;
                dl_resilience_t dl_resilience;
}       dl_qos_co_range1_t;

typedef struct {
                ulong           dl_qos_type;
                long            dl_rcv_throughput;
                long            dl_rcv_trans_delay;
                long            dl_xmt_throughput;
                long            dl_xmt_trans_delay;
                long            dl_priority;
                long            dl_protection;
                long            dl_residual_error;
                dl_resilience_t dl_resilience;
}       dl_qos_co_sel1_t;

typedef struct {
                ulong           dl_qos_type;
                dl_transdelay_t dl_trans_delay;
                dl_priority_t   dl_priority;
                dl_protect_t    dl_protection;
                long            dl_residual_error;
}       dl_qos_cl_range1_t;

typedef struct {
                ulong           dl_qos_type;
                long            dl_trans_delay;
                long            dl_priority;
                long            dl_protection;
                long            dl_residual_error;
}       dl_qos_cl_sel1_t;

/*
 * DLPI interface primitive definitions.
 *
 * Each primitive is sent as a stream message.  It is possible that
 * the messages may be viewed as a sequence of bytes that have the
 * following form without any padding. The structure definition
 * of the following messages may have to change depending on the
 * underlying hardware architecture and crossing of a hardware
 * boundary with a different hardware architecture.
 *
 * Fields in the primitives having a name of the form
 * dl_reserved cannot be used and have the value of
 * binary zero, no bits turned on.
```

```
 *
 * Each message has the name defined followed by the
 * stream message type (M_PROTO, M_PCPROTO, M_DATA)
 */

/*
 *      LOCAL MANAGEMENT SERVICE PRIMITIVES
 */

/*
 * DL_INFO_REQ, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;                   /* set to DL_INFO_REQ */
} dl_info_req_t;

/*
 * DL_INFO_ACK, M_PCPROTO type
 */
typedef struct {
        ulong           dl_primitive;           /* set to DL_INFO_ACK */
        ulong           dl_max_sdu;             /* Max bytes in a DLSDU */
        ulong           dl_min_sdu;             /* Min bytes in a DLSDU */
        ulong           dl_addr_length;         /* length of DLSAP address */
        ulong           dl_mac_type;            /* type of medium supported*/
        ulong           dl_reserved;            /* value set to zero */
        ulong           dl_current_state;       /* state of DLPI interface */
        long            dl_sap_length;          /*current length of SAP part of
                                                        dlsap address */
        ulong           dl_service_mode;        /* CO, CL or ACL */
        ulong           dl_qos_length;          /* length of qos values */
        ulong           dl_qos_offset;          /* offset from beg. of block*/
        ulong           dl_qos_range_length;    /* available range of qos */
        ulong           dl_qos_range_offset;    /* offset from beg. of block*/
        ulong           dl_provider_style;      /* style1 or style2 */
        ulong           dl_addr_offset;         /* offset of the dlsap addr */
        ulong           dl_version;             /* version number */
        ulong           dl_brdcst_addr_length;  /* length of broadcast addr */
        ulong           dl_brdcst_addr_offset;  /* offset from beg. of block*/
        ulong           dl_growth;              /* set to zero */
} dl_info_ack_t;

/*
 * DL_ATTACH_REQ, M_PROTO type
 */
typedef struct {
        ulong           dl_primitive;           /* set to DL_ATTACH_REQ*/
        ulong           dl_ppa;                 /* id of the PPA */
} dl_attach_req_t;

/*
 * DL_DETACH_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;                   /* set to DL_DETACH_REQ */
} dl_detach_req_t;

/*
 * DL_BIND_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* set to DL_BIND_REQ */
        ulong   dl_sap;                 /* info to identify dlsap addr*/
        ulong   dl_max_conind;          /* max # of outstanding con_ind*/
        ushort  dl_service_mode;        /* CO, CL or ACL */
        ushort  dl_conn_mgmt;           /* if non-zero, is con-mgmt stream*/
```

```
        ulong   dl_xidtest_flg;         /* if set to 1 indicates automatic
                                           initiation of test and xid frames */
} dl_bind_req_t;

/*
 * DL_BIND_ACK, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_BIND_ACK */
        ulong   dl_sap;                 /* DLSAP addr info */
        ulong   dl_addr_length;         /* length of complete DLSAP addr */
        ulong   dl_addr_offset;         /* offset from beginning of M_PCPROTO*/
        ulong   dl_max_conind;          /* allowed max. # of con-ind */
        ulong   dl_xidtest_flg;         /* responses supported by provider*/
} dl_bind_ack_t;

/*
 * DL_SUBS_BIND_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_SUBS_BIND_REQ */
        ulong   dl_subs_sap_offset;     /* offset of subs_sap */
        ulong   dl_subs_sap_length;     /* length of subs_sap */
        ulong   dl_subs_bind_class;     /* peer or hierarchical */
} dl_subs_bind_req_t;

/*
 * DL_SUBS_BIND_ACK, M_PCPROTO type
 */
typedef struct {
        ulong dl_primitive;             /* DL_SUBS_BIND_ACK */
        ulong dl_subs_sap_offset;       /* offset of subs_sap */
        ulong dl_subs_sap_length;       /* length of subs_sap */
} dl_subs_bind_ack_t;

/*
 * DL_UNBIND_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_UNBIND_REQ */
} dl_unbind_req_t;

/*
 * DL_SUBS_UNBIND_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_SUBS_UNBIND_REQ */
        ulong   dl_subs_sap_offset;     /* offset of subs_sap */
        ulong   dl_subs_sap_length;     /* length of subs_sap */
} dl_subs_unbind_req_t;

/*
 * DL_OK_ACK, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_OK_ACK */
        ulong   dl_correct_primitive;   /* primitive being acknowledged */
} dl_ok_ack_t;

/*
 * DL_ERROR_ACK, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_ERROR_ACK */
        ulong   dl_error_primitive;     /* primitive in error */
        ulong   dl_errno;               /* DLPI error code */
```

```
        ulong   dl_unix_errno;          /* UNIX system error code */
} dl_error_ack_t;

/*
 * DL_ENABMULTI_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_ENABMULTI_REQ */
        ulong   dl_addr_length;         /* length of multicast address */
        ulong   dl_addr_offset;         /* offset from beg. of M_PROTO block*/
} dl_enabmulti_req_t;

/*
 * DL_DISABMULTI_REQ, M_PROTO type
 */

typedef struct {
        ulong   dl_primitive;           /* DL_DISABMULTI_REQ */
        ulong   dl_addr_length;         /* length of multicast address */
        ulong   dl_addr_offset;         /* offset from beg. of M_PROTO block*/
} dl_disabmulti_req_t;

/*
 * DL_PROMISCON_REQ, M_PROTO type
 */

typedef struct {
        ulong   dl_primitive;           /* DL_PROMISCON_REQ */
        ulong   dl_level;               /* physical,SAP level or ALL multicast*/
} dl_promiscon_req_t;

/*
 * DL_PROMISCOFF_REQ, M_PROTO type
 */

typedef struct {
        ulong   dl_primitive;           /* DL_PROMISCOFF_REQ */
        ulong   dl_level;               /* Physical,SAP level or ALL multicast*/
} dl_promiscoff_req_t;

/*
 *      Primitives to get and set the Physical address
 */

/*
 * DL_PHYS_ADDR_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_PHYS_ADDR_REQ */
        ulong   dl_addr_type;           /* factory or current physical addr */
} dl_phys_addr_req_t;

/*
 * DL_PHYS_ADDR_ACK, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_PHYS_ADDR_ACK */
        ulong   dl_addr_length;         /* length of the physical addr */
        ulong   dl_addr_offset;         /* offset from beg. of block */
} dl_phys_addr_ack_t;

/*
 * DL_SET_PHYS_ADDR_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_SET_PHYS_ADDR_REQ */
```

```
        ulong   dl_addr_length;         /* length of physical addr */
        ulong   dl_addr_offset;         /* offset from beg. of block */
} dl_set_phys_addr_req_t;

/*
 *      Primitives to get statistics
 */

/*
 * DL_GET_STATISTICS_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_GET_STATISTICS_REQ */
} dl_get_statistics_req_t;

/*
 * DL_GET_STATISTICS_ACK, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_GET_STATISTICS_ACK */
        ulong   dl_stat_length;         /* length of statistics structure*/
        ulong   dl_stat_offset;         /* offset from beg. of block */
} dl_get_statistics_ack_t;

/*
 *      CONNECTION-ORIENTED SERVICE PRIMITIVES
 */

/*
 * DL_CONNECT_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_CONNECT_REQ */
        ulong   dl_dest_addr_length;    /* len. of dlsap addr*/
        ulong   dl_dest_addr_offset;    /* offset */
        ulong   dl_qos_length;          /* len. of QOS parm val*/
        ulong   dl_qos_offset;          /* offset */
        ulong   dl_growth;              /* set to zero */
} dl_connect_req_t;

/*
 * DL_CONNECT_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_CONNECT_IND */
        ulong   dl_correlation;         /* provider's correlation token*/
        ulong   dl_called_addr_length;  /* length of called address */
        ulong   dl_called_addr_offset;  /* offset from beginning of block */
        ulong   dl_calling_addr_length; /* length of calling address */
        ulong   dl_calling_addr_offset; /* offset from beginning of block */
        ulong   dl_qos_length;          /* length of qos structure */
        ulong   dl_qos_offset;          /* offset from beginning of block */
        ulong   dl_growth;              /* set to zero */
} dl_connect_ind_t;

/*
 * DL_CONNECT_RES, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;   /* DL_CONNECT_RES */
        ulong   dl_correlation; /* provider's correlation token */
        ulong   dl_resp_token;  /* token associated with responding stream */
        ulong   dl_qos_length;  /* length of qos structure
        ulong   dl_qos_offset;  /* offset from beginning of block */
        ulong   dl_growth;      /* set to zero */
} dl_connect_res_t;
```

```
/*
 * DL_CONNECT_CON, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_CONNECT_CON*/
        ulong   dl_resp_addr_length;    /* length of responder’s address */
        ulong   dl_resp_addr_offset;    /* offset from beginning of block*/
        ulong   dl_qos_length;          /* length of qos structure */
        ulong   dl_qos_offset;          /* offset from beginning of block*/
        ulong   dl_growth;              /* set to zero */
} dl_connect_con_t;

/*
 * DL_TOKEN_REQ, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_TOKEN_REQ */
} dl_token_req_t;

/*
 * DL_TOKEN_ACK, M_PCPROTO type
 */
typedef struct {
        ulong   dl_primitive;   /* DL_TOKEN_ACK */
        ulong   dl_token;       /* Connection response token associated
                                           with the stream */
}dl_token_ack_t;

/*
 * DL_DISCONNECT_REQ, M_PROTO type
 */
typedef struct {
        ulong           dl_primitive;   /* DL_DISCONNECT_REQ */
        ulong           dl_reason;      /*normal, abnormal, perm. or transient*/
        ulong           dl_correlation; /* association with connect_ind */
} dl_disconnect_req_t;

/*
 * DL_DISCONNECT_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_DISCONNECT_IND */
        ulong   dl_originator;          /* USER or PROVIDER */
        ulong   dl_reason;              /* permanent or transient */
        ulong   dl_correlation;         /* association with connect_ind */
} dl_disconnect_ind_t;

/*
 * DL_RESET_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_RESET_REQ */
} dl_reset_req_t;

/*
 * DL_RESET_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_RESET_IND */
        ulong   dl_originator;          /* Provider or User */
        ulong   dl_reason;              /* flow control, link error or resynch*/
} dl_reset_ind_t;

/*
 * DL_RESET_RES, M_PROTO type
 */
```

```
typedef struct {
        ulong   dl_primitive;           /* DL_RESET_RES */
} dl_reset_res_t;

/*
 * DL_RESET_CON, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_RESET_CON */
} dl_reset_con_t;


/*
 *      CONNECTIONLESS SERVICE PRIMITIVES
 */

/*
 * DL_UNITDATA_REQ, M_PROTO type, with M_DATA block(s)
 */
typedef struct {
        ulong   dl_primitive;           /* DL_UNITDATA_REQ */
        ulong   dl_dest_addr_length;    /* DLSAP length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
        dl_priority_t   dl_priority;    /* priority value */
} dl_unitdata_req_t;

/*
 * DL_UNITDATA_IND, M_PROTO type, with M_DATA block(s)
 */
typedef struct {
        ulong   dl_primitive;           /* DL_UNITDATA_IND */
        ulong   dl_dest_addr_length;    /* DLSAP length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
        ulong   dl_src_addr_length;     /* DLSAP addr length of sending user*/
        ulong   dl_src_addr_offset;     /* offset from beg. of block */
        ulong   dl_group_address;       /* set to one if multicast/broadcast*/
} dl_unitdata_ind_t;

/*
 * DL_UDERROR_IND, M_PROTO type
 *      (or M_PCPROTO type if LLI-based provider)
 */
typedef struct {
        ulong   dl_primitive;           /* DL_UDERROR_IND */
        ulong   dl_dest_addr_length;    /* Destination DLSAP */
        ulong   dl_dest_addr_offset;    /* Offset from beg. of block */
        ulong   dl_unix_errno;          /* unix system error code*/
        ulong   dl_errno;               /* DLPI error code */
} dl_uderror_ind_t;

/*
 * DL_UDQOS_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_UDQOS_REQ */
        ulong   dl_qos_length;          /* length in bytes of requested qos*/
        ulong   dl_qos_offset;          /* offset from beg. of block */
} dl_udqos_req_t;

/*
 *      Primitives to handle XID and TEST operations
 */

/*
 * DL_TEST_REQ, M_PROTO type
 */
```

```
typedef struct {
        ulong   dl_primitive;           /* DL_TEST_REQ */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* DLSAP length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
} dl_test_req_t;

/*
 * DL_TEST_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_TEST_IND */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* dlsap length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
        ulong   dl_src_addr_length;     /* dlsap length of source user */
        ulong   dl_src_addr_offset;     /* offset from beg. of block */
} dl_test_ind_t;

/*
 *      DL_TEST_RES, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_TEST_RES */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* DLSAP length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
} dl_test_res_t;

/*
 *      DL_TEST_CON, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_TEST_CON */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* dlsap length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
        ulong   dl_src_addr_length;     /* dlsap length of source user */
        ulong   dl_src_addr_offset;     /* offset from beg. of block */
} dl_test_con_t;

/*
 * DL_XID_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_XID_REQ */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* dlsap length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
} dl_xid_req_t;

/*
 * DL_XID_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_XID_IND */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* dlsap length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
        ulong   dl_src_addr_length;     /* dlsap length of source user */
        ulong   dl_src_addr_offset;     /* offset from beg. of block */
} dl_xid_ind_t;

/*
 *      DL_XID_RES, M_PROTO type
 */
```

```
typedef struct {
        ulong   dl_primitive;           /* DL_XID_RES */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* DLSAP length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
} dl_xid_res_t;

/*
 *      DL_XID_CON, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_XID_CON */
        ulong   dl_flag;                /* poll/final */
        ulong   dl_dest_addr_length;    /* dlsap length of dest. user */
        ulong   dl_dest_addr_offset;    /* offset from beg. of block */
        ulong   dl_src_addr_length;     /* dlsap length of source user */
        ulong   dl_src_addr_offset;     /* offset from beg. of block */
} dl_xid_con_t;

/*
 *      ACKNOWLEDGED CONNECTIONLESS SERVICE PRIMITIVES
 */

/*
 * DL_DATA_ACK_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_DATA_ACK_REQ */
        ulong   dl_correlation;         /* User's correlation token */
        ulong   dl_dest_addr_length;    /* length of destination addr */
        ulong   dl_dest_addr_offset;    /* offset from beginning of block */
        ulong   dl_src_addr_length;     /* length of source address */
        ulong   dl_src_addr_offset;     /* offset from beginning of block */
        ulong   dl_priority;            /* priority */
        ulong   dl_service_class;       /* DL_RQST_RSP or DL_RQST_NORSP */
} dl_data_ack_req_t;

/*
 * DL_DATA_ACK_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_DATA_ACK_IND */
        ulong   dl_dest_addr_length;    /* length of destination addr */
        ulong   dl_dest_addr_offset;    /* offset from beginning of block */
        ulong   dl_src_addr_length;     /* length of source address */
        ulong   dl_src_addr_offset;     /* offset from beginning of block */
        ulong   dl_priority;            /* priority for data unit transm. */
        ulong   dl_service_class;       /* DL_RQST_RSP or DL_RQST_NORSP */
} dl_data_ack_ind_t;

/*
 * DL_DATA_ACK_STATUS_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_DATA_ACK_STATUS_IND */
        ulong   dl_correlation;         /* User's correlation token */
        ulong   dl_status;              /* success or failure of previous req*/
} dl_data_ack_status_ind_t;

/*
 * DL_REPLY_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_REPLY_REQ */
        ulong   dl_correlation;         /* User's correlation token */
        ulong   dl_dest_addr_length;    /* length of destination address */
```

```
        ulong   dl_dest_addr_offset;    /* offset from beginning of block */
        ulong   dl_src_addr_length;     /* source address length */
        ulong   dl_src_addr_offset;     /* offset from beginning of block */
        ulong   dl_priority;            /* priority for data unit transmission*/
        ulong   dl_service_class;
} dl_reply_req_t;

/*
 * DL_REPLY_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_REPLY_IND */
        ulong   dl_dest_addr_length;    /* length of destination address */
        ulong   dl_dest_addr_offset;    /* offset from beginning of block*/
        ulong   dl_src_addr_length;     /* length of source address */
        ulong   dl_src_addr_offset;     /* offset from beginning of block */
        ulong   dl_priority;            /* priority for data unit transmission*/
        ulong   dl_service_class;       /* DL_RQST_RSP or DL_RQST_NORSP */
} dl_reply_ind_t;

/*
 * DL_REPLY_STATUS_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_REPLY_STATUS_IND */
        ulong   dl_correlation;         /* User’s correlation token */
        ulong   dl_status;              /* success or failure of previous req*/
} dl_reply_status_ind_t;

/*
 * DL_REPLY_UPDATE_REQ, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_REPLY_UPDATE_REQ */
        ulong   dl_correlation;         /* user’s correlation token */
        ulong   dl_src_addr_length;     /* length of source address */
        ulong   dl_src_addr_offset;     /* offset from beginning of block */
} dl_reply_update_req_t;

/*
 * DL_REPLY_UPDATE_STATUS_IND, M_PROTO type
 */
typedef struct {
        ulong   dl_primitive;           /* DL_REPLY_UPDATE_STATUS_IND */
        ulong   dl_correlation;         /* User’s correlation token */
        ulong   dl_status;              /* success or failure of previous req*/
} dl_reply_update_status_ind_t;

union DL_primitives {
        ulong                   dl_primitive;
        dl_info_req_t           info_req;
        dl_info_ack_t           info_ack;
        dl_attach_req_t         attach_req;
        dl_detach_req_t         detach_req;
        dl_bind_req_t           bind_req;
        dl_bind_ack_t           bind_ack;
        dl_unbind_req_t         unbind_req;
        dl_subs_bind_req_t      subs_bind_req;
        dl_subs_bind_ack_t      subs_bind_ack;
        dl_subs_unbind_req_t    subs_unbind_req;
        dl_ok_ack_t             ok_ack;
        dl_error_ack_t          error_ack;
        dl_connect_req_t        connect_req;
        dl_connect_ind_t        connect_ind;
        dl_connect_res_t        connect_res;
        dl_connect_con_t        connect_con;
```

```
        dl_token_req_t          token_req;
        dl_token_ack_t          token_ack;
        dl_disconnect_req_t     disconnect_req;
        dl_disconnect_ind_t     disconnect_ind;
        dl_reset_req_t          reset_req;
        dl_reset_ind_t          reset_ind;
        dl_reset_res_t          reset_res;
        dl_reset_con_t          reset_con;
        dl_unitdata_req_t       unitdata_req;
        dl_unitdata_ind_t       unitdata_ind;
        dl_uderror_ind_t        uderror_ind;
        dl_udqos_req_t          udqos_req;
        dl_enabmulti_req_t      enabmulti_req;
        dl_disabmulti_req_t     disabmulti_req;
        dl_promiscon_req_t      promiscon_req;
        dl_promiscoff_req_t     promiscoff_req;
        dl_phys_addr_req_t      physaddr_req;
        dl_phys_addr_ack_t      physaddr_ack;
        dl_set_phys_addr_req_t  set_physaddr_req;
        dl_get_statistics_req_t get_statistics_req;
        dl_get_statistics_ack_t get_statistics_ack;
        dl_test_req_t           test_req;
        dl_test_ind_t           test_ind;
        dl_test_res_t           test_res;
        dl_test_con_t           test_con;
        dl_xid_req_t            xid_req;
        dl_xid_ind_t            xid_ind;
        dl_xid_res_t            xid_res;
        dl_xid_con_t            xid_con;
        dl_data_ack_req_t       data_ack_req;
        dl_data_ack_ind_t       data_ack_ind;
        dl_data_ack_status_ind_t        data_ack_status_ind;
        dl_reply_req_t          reply_req;
        dl_reply_ind_t          reply_ind;
        dl_reply_status_ind_t   reply_status_ind;
        dl_reply_update_req_t   reply_update_req;
        dl_reply_update_status_ind_t    reply_update_status_ind;
};

#define DL_INFO_REQ_SIZE        sizeof(dl_info_req_t)
#define DL_INFO_ACK_SIZE        sizeof(dl_info_ack_t)
#define DL_ATTACH_REQ_SIZE      sizeof(dl_attach_req_t)
#define DL_DETACH_REQ_SIZE      sizeof(dl_detach_req_t)
#define DL_BIND_REQ_SIZE        sizeof(dl_bind_req_t)
#define DL_BIND_ACK_SIZE        sizeof(dl_bind_ack_t)
#define DL_UNBIND_REQ_SIZE      sizeof(dl_unbind_req_t)
#define DL_SUBS_BIND_REQ_SIZE   sizeof(dl_subs_bind_req_t)
#define DL_SUBS_BIND_ACK_SIZE   sizeof(dl_subs_bind_ack_t)
#define DL_SUBS_UNBIND_REQ_SIZE sizeof(dl_subs_unbind_req_t)
#define DL_OK_ACK_SIZE          sizeof(dl_ok_ack_t)
#define DL_ERROR_ACK_SIZE       sizeof(dl_error_ack_t)
#define DL_CONNECT_REQ_SIZE     sizeof(dl_connect_req_t)
#define DL_CONNECT_IND_SIZE     sizeof(dl_connect_ind_t)
#define DL_CONNECT_RES_SIZE     sizeof(dl_connect_res_t)
#define DL_CONNECT_CON_SIZE     sizeof(dl_connect_con_t)
#define DL_TOKEN_REQ_SIZE       sizeof(dl_token_req_t)
#define DL_TOKEN_ACK_SIZE       sizeof(dl_token_ack_t)
#define DL_DISCONNECT_REQ_SIZE  sizeof(dl_disconnect_req_t)
#define DL_DISCONNECT_IND_SIZE  sizeof(dl_disconnect_ind_t)
#define DL_RESET_REQ_SIZE       sizeof(dl_reset_req_t)
#define DL_RESET_IND_SIZE       sizeof(dl_reset_ind_t)
#define DL_RESET_RES_SIZE       sizeof(dl_reset_res_t)
#define DL_RESET_CON_SIZE       sizeof(dl_reset_con_t)
#define DL_UNITDATA_REQ_SIZE    sizeof(dl_unitdata_req_t)
#define DL_UNITDATA_IND_SIZE    sizeof(dl_unitdata_ind_t)
#define DL_UDERROR_IND_SIZE     sizeof(dl_uderror_ind_t)
```

```
#define DL_UDQOS_REQ_SIZE       sizeof(dl_udqos_req_t)
#define DL_ENABMULTI_REQ_SIZE   sizeof(dl_enabmulti_req_t)
#define DL_DISABMULTI_REQ_SIZE  sizeof(dl_disabmulti_req_t)
#define DL_PROMISCON_REQ_SIZE   sizeof(dl_promiscon_req_t)
#define DL_PROMISCOFF_REQ_SIZE  sizeof(dl_promiscoff_req_t)
#define DL_PHYS_ADDR_REQ_SIZE   sizeof(dl_phys_addr_req_t)
#define DL_PHYS_ADDR_ACK_SIZE   sizeof(dl_phys_addr_ack_t)
#define DL_SET_PHYS_ADDR_REQ_SIZE       sizeof(dl_set_phys_addr_req_t)
#define DL_GET_STATISTICS_REQ_SIZE      sizeof(dl_get_statistics_req_t)
#define DL_GET_STATISTICS_ACK_SIZE      sizeof(dl_get_statistics_ack_t)
#define DL_XID_REQ_SIZE         sizeof(dl_xid_req_t)
#define DL_XID_IND_SIZE         sizeof(dl_xid_ind_t)
#define DL_XID_RES_SIZE         sizeof(dl_xid_res_t)
#define DL_XID_CON_SIZE         sizeof(dl_xid_con_t)
#define DL_TEST_REQ_SIZE        sizeof(dl_test_req_t)
#define DL_TEST_IND_SIZE        sizeof(dl_test_ind_t)
#define DL_TEST_RES_SIZE        sizeof(dl_test_res_t)
#define DL_TEST_CON_SIZE        sizeof(dl_test_con_t)
#define DL_DATA_ACK_REQ_SIZE    sizeof(dl_data_ack_req_t)
#define DL_DATA_ACK_IND_SIZE    sizeof(dl_data_ack_ind_t)
#define DL_DATA_ACK_STATUS_IND_SIZE     sizeof(dl_data_ack_status_ind_t)
#define DL_REPLY_REQ_SIZE       sizeof(dl_reply_req_t)
#define DL_REPLY_IND_SIZE       sizeof(dl_reply_ind_t)
#define DL_REPLY_STATUS_IND_SIZE        sizeof(dl_reply_status_ind_t)
#define DL_REPLY_UPDATE_REQ_SIZE        sizeof(dl_reply_update_req_t)
#define DL_REPLY_UPDATE_STATUS_IND_SIZE sizeof(dl_reply_update_status_ind_t)

#endif /* _SYS_DLPI_H */
```

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Table of Contents

List of Figures

List of Tables