DLPI

Application Program Interface Guide

April 2003

Protocols: LAPB, MLP, QLLC, X.25, HDLC/SDLC,
LAPD, and Frame Relay

This manual was written and produced by Senior Technical Writer Debra J. Schweiger using Microsoft Word 97SR-2 and FrameMaker 6.0 on a Windows Millenium platform with the help of subject matter specialists Dave Healy and Dave Grothe.

This manual was printed in the U.S.A.

FOR FURTHER INFORMATION

If you want more information about GCOM products, contact us at:

GCOM, Inc.
1800 Woodfield Dr.
Savoy, IL 61874
(217) 351-4241
FAX: (217) 351-4240
e-mail: support@gcom.com
homepage: http://www.gcom.com

CONTENTS

Table of Contents

Figures

Tables

PREFACE

About This Guide

Purpose of This Guide

This guide is written for C programmers who intend to transfer data between local and remote peers in a UNIX STREAMS environment using a data link layer protocol. The data and other messages are passed to the streams-based Data Link Provider Interface (DLPI) by making calls to routines contained in the GCOM's DLPI Application Program Interface (API) Library.

Knowledge Requirements

You should be familiar with the OSI Reference Model terminology, OSI Data Link Services and the implementation of UNIX STREAMS that your application is using. You must also be proficient with the C programming language and have specific knowledge of the data link layer protocol that your application is using to transfer data.

GCOM implements a subset of the DLPI standard that is fully described in Univel's *STREAMS Modules and Drivers Manual,* universal part number 10000203. Contact Univel (a division of Novell) at:

Univel
2180 Fortune Drive
San Jose, CA 95131 (U.S.A.)
(408) 473-8788

The C programming language is described in Kernighan and Ritchie's *The C Programming Language.*

For an understanding of the data link layer protocols, GCOM recommends reading Uyless Black's book, entitled *Data Link Protocols,* © 1993 by PTR Prentice-Hall, Inc. (ISBN 0-13-204918-X).

Organization of This Guide

Table 1 shows the organization of this manual and tells you where to find specific information.

Table 1 Location of Important Information

For information about:	*Look at:*
Product description and related files	Section 1
Architecture of the Data Link Layer	Section 2
Understanding the service reference model	Section 3
Local Management Services	Section 4
Connectionless Services	Section 5
LAPB/LAPD and LLC-II Connection-Oriented Services	Section 6
HDLC/SDLC Connection-Oriented Services	Section 7
Understanding a sample DLPI API test program and linking header files	Section 8
Understanding the DLPI API header file, **dlpiapi.h**	Section 9
DLPI API Library routine reference	Appendix A

Conventions Used In This Guide

This section discusses conventions used throughout this guide.

Special Notices

A special format indicates notes, cautions and warnings. The purpose of these notices is defined as follows:

Note: *Notes call attention to important features or instructions.*

Caution: Cautions contain directions that you must follow to avoid immediate system damage or loss of data.

Warning! Warnings contain directions that you must follow for your personal safety. Follow these instructions carefully.

Text Conventions

The use of italics, boldface and other text conventions are explained as follows:

Terminology	The following terms appear in **boldface**: directories and file names. An example is the **hstpar.h** include file. Boldface names within angle brackets refer to the global copy of the file. For instance, **<intsx25.h>** refers to **/rsys/include/intsx25.h**. The following terms appear in *italics*: variables (parameters), fields, structures, glossary terms, routines (functions, programs, utilities and applications), flags, commands and scripts. Examples include the *count* variable, *Command Type* field, *rteparam* structure, *target* term, *rsys_read()* routine, *avail* flag, *Add Route* command and *gcomunld* script.
"Enter" vs. "Type"	When the word "enter" is used in this guide, it means type something and then press the Return key. Do not press Return when an instruction simply says "type."
Screen Display	This typeface is used to represent displays that appear on a terminal screen. Commands entered at the prompt use the same typeface only in boldface. For example: C:> **cd gcom** % **cd gcom** # **cd gcom** Each of these instructs you to enter "cd gcom" at the system prompt.

Naming Conventions for DLPI Routines

The general purpose of most routines can be inferred from the prefix and suffix naming conventions in Table 2.

Table 2 Naming Conventions for DLPI Routines

Prefix or Suffix?	*String*	*Description*
Prefix	dlpi_	DLPI API Library C routine
Suffix	_req	Request routines
Suffix	_res	Response routines

Product Overview

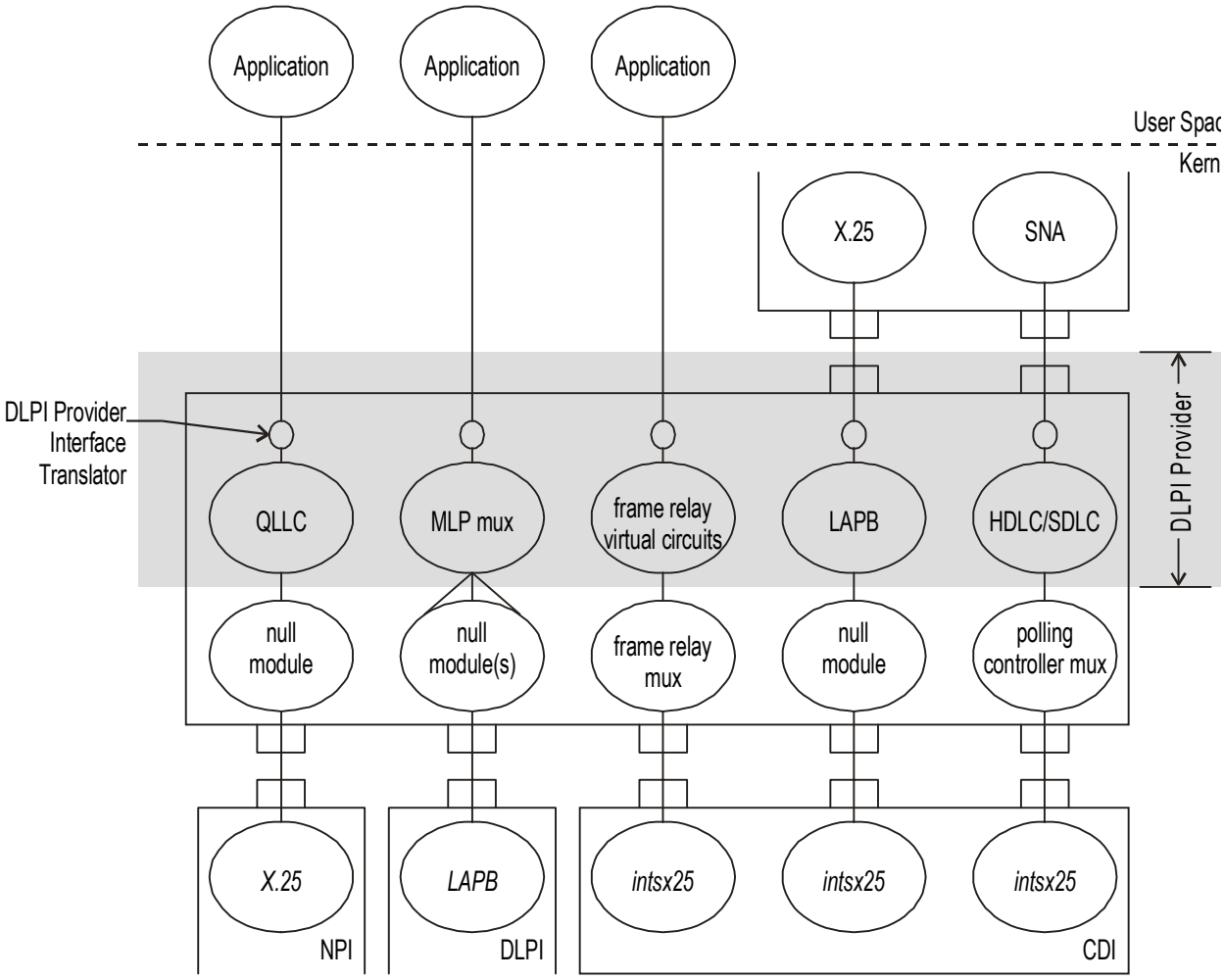


Figure 1 DLPI provider

Product Description

The Data Link Provider Interface (DLPI) enables a Data Link Service (DLS) user to access and use any of a variety of conforming DLS providers without special knowledge of the provider's protocol. The GCOM DLPI Application Program Interface (API) translates DLPI protocol messages to your application by way of subroutine calls to the GCOM DLPI API Library.

The GCOM DLPI API Library is intended to support the data link layer protocols shown in Figure 1:

- LAPB
- HDLC/SDLC
- ISDN LAPD
- QLLC
- the MLP multiplexor
- frame relay
- LLC-II (not pictured)

These protocols connect to your application by using the UNIX STREAMS implementation of DLPI API.

Using the DLPI API Library

In order to utilize the GCOM DLPI API library it is necessary to link it into your program ahead of the "libgcom" library in order to link to the routines that perform the remote functions. A sample command line link for this is as follows:

```
cc -o foo foo.o /usr/lib/gcom/dlpiapi.a /usr/lib/gcom/libgcom.a
```

Two important files that pertain to the API library are described as follows:

/usr/lib/gcom/dlpiapi.a. This file is the library of DLPI/SDLC interface routines that is linked in with your application program.

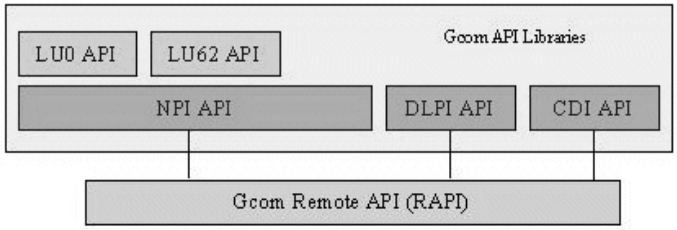
/usr/include/gcom/dlpiapi.h. This header file should be included in your application program. It contains defines and prototype declarations useful to you application program. This header file is compatible with both old-style C language and ANSI C. To use the ANSI style function prototype declarations, you should define the compile-time symbol PROTOTYPE prior to including the **gcom/dlpiapi.h** file.

GCOM Remote API

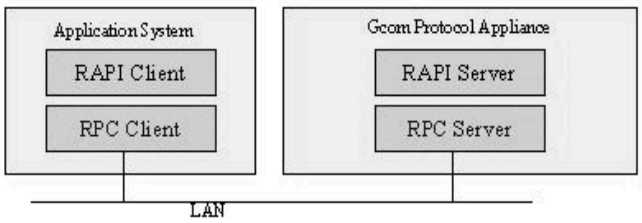
GCOM'S Remote API (RAPI) is a library of functions that allows the standard GCOM APIs to operate on protocol stacks that are configured and running on a remote machine. It is especially useful in situations in which the application code resides on a server system and the protocol processing is performed on a GCOM Protocol appliance attached to the server via a LAN connection.

Architecture

The illustration, below, shows how the GCOM RAPI relates to all GCOM APIs. In the suite of GCOM API libraries, the NPI API interfaces to GCOM's NPI driver for X.25, SNA and Bisync protocols. The GCOM DLPI interfaces to GCOM'S DLPI driver for link layer protocols such as LAPB, LAPD, HDLVC and Frame Relay. The GCOM CDI API library interfaces to GCOM's synchronous protocol drivers directly for raw frame access.



Client Server Model



The Remote API is intended for use in a client/server environment. The user's application program, linked with the GCOM RAPI library, runs on the client system. The server system is typically a GCOM Protocol Appliance. It contains the communication hardware, protocol software and the Remote API server.

Running the RAPI Server

The GCOM Remote API server is named `Gcom_rapisvr`. It is usually unnecessary to run this program with any arguments. By default the program runs in the background. It can be run from the command line or from a shell script.

It is common to run `Gcom_rapisvr` under root from an "rc" script. However, if permissions are set appropriately on the files that are to be accessed remotely, it is perfectly possible to run `Gcom_rapisvr` from a non-root user id.

Note: *Additional information on GCOM RAPI arguments, authentication, and other API routines can be found by accessing the GCOM RAPI white paper on the www.gcom.com web site.*

Using the RAPI Library

In order to utilize the GCOM RAPI library it is necessary to link it into your program ahead of the "libgcom" library in order to link to the routines that perform the remote functions. A sample command line link for this is as follows:

```
cc -o foo foo.o /usr/lib/gcom/dlpiapi.a /usr/lib/gcom/rapi.a
/usr/lib/gcom/libgcom.a
```

Note: *If RAPI library is omitted, then all file operations will be executed on the same machine on which the application program is running.*

In the application program, be sure to use the correct API routine to open data streams on a remote system. The open routing of each of these routines is passed a parameter which is a pointer to a string which names the remote host. Passing a NULL pointer, or a pointer to an empty string, indicates that the file is to be opened on the local machine.

When opening or closing DLPI protocol data streams, use the functions:

Open routine: *dlpi_open*
Close routine: *dlpi_close*

Apart from using the specially provided open and close functions, there are no other programming interface considerations for making an application utilize remote protocol services.

Architecture of the Data Link Layer

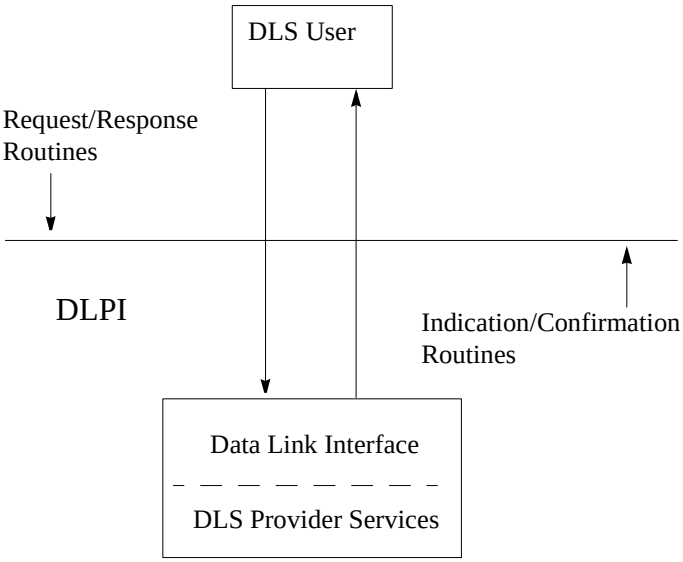


Figure 2 DLPI architecture

The *data link layer* (layer two in the OSI Reference Model) is responsible for the transmission and error-free delivery of bits of information over a physical communication medium. The data link layer can be used in both a connection-oriented and connectionless environment.

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

Model of the Service Interface

Each layer of the OSI Reference Model has two standards:

- One that defines the services provided by the layer
- One that defines the protocol through which layer services are provided

Figure 2 shows an abstract view of the DLPI architecture.

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, called the *Data Link Service (DLS) user*. The data link layer entity is the provider of those services, called the *DLS provider.* This interface consists of a set of routines that provide access to the data link layer services plus the rules for accessing the interface. A data link interface service routine 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 DLPI API Library service routines that make up these interfaces use streams message primitives that are transferred between the user and provider of the service. DLPI is one such kernel-level interface, so it is targeted for streams protocol modules that either use or provide data link services. In addition, your application program can access a streams-based data link provider directly by using the *putmsg(2)* and *getmsg(2)* UNIX system calls.

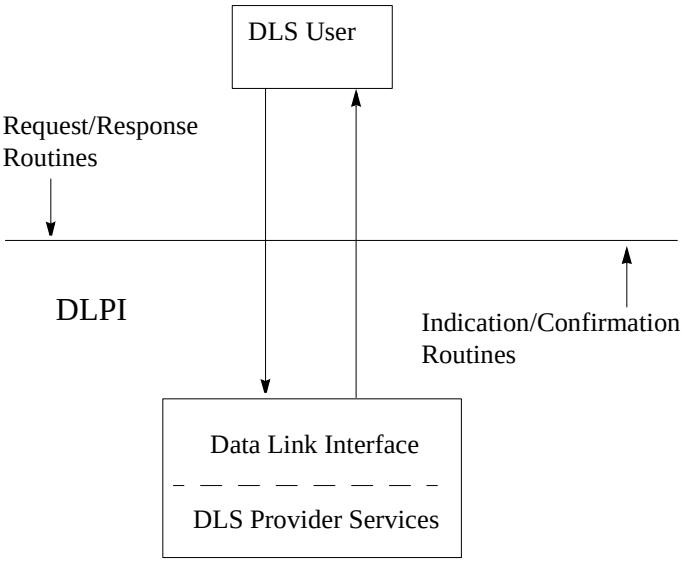


Figure 3 DLPI architecture *(repeated)*

Referring to Figure 3, 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 mechanism between a DLS user and the DLS provider. After the stream is created, the DLS user and DLS provider communicate by using the routines presented in Appendix A on page 125.

DLPI is intended to free data link users from specific knowledge of the services provided by the data link provider. Specifically, the definition of DLPI hopes to allow a DLS user to be implemented independent of a specific communication medium. Any data link provider (supporting any communications medium) that conforms to the DLPI specification can 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.

Modes of Communication

The GCOM implementation of the data link provider interface supports two modes of communication: connection-oriented and connectionless.

Connection-Oriented Service

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

Local Management Phase

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

Connection Establishment Phase

This phase enables two peer DLS users to establish a data link connection between them to exchange data. Typically, one user (the calling DLS user) initiates the connection establishment procedures, while another user (the called DLS user) waits for the incoming connect request. The called DLS user is identified by an address associated with its stream, as will be discussed in “DLPI Addressing” on page 33.

Note: *GCOM’s implementation of DLPI allows both peers to initiate the connection.*

A called DLS user can 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 can be established per stream. Thus, the stream is the communication endpoint for a data link connection.

Data Transfer Phase

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

Connection Release Phase

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.

Connectionless Service

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

DLPI Addressing

Each DLPI user must establish an identity to communicate with other data link users. Setting up this path involves two steps. First, the DLS user must 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. Figure 4 illustrates the components of this identification approach, which are explained in the text that follows it.

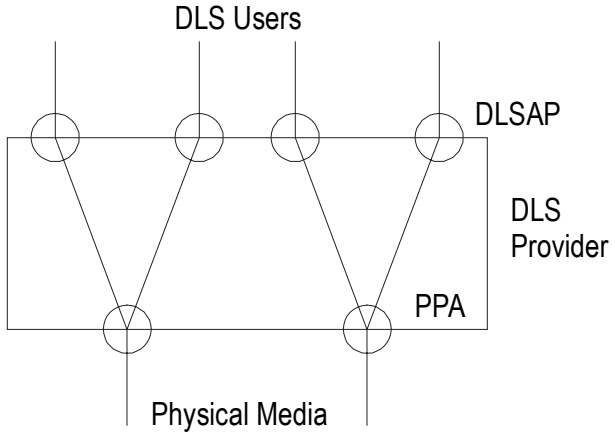


Figure 4 Data Link addressing components

Physical Attachment Identification

The *Physical Point of Attachment* (PPA in Figure 4) 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 occurs.

Two styles of DLS provider are defined by DLPI, distinguished by the way they enable a DLS user to choose a particular PPA: style 1 and style 2.

Defined: DL_STYLE1

The DL_STYLE1 provider assigns a PPA based on the major/minor device that the DLS user opened. One possible implementation of a style 1 driver would reserve a major device for each PPA that 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.

Defined: DL_STYLE2

If the number of PPAs that a DLS provider will support is large, a style 2 provider implementation is more suitable. The DL_STYLE2 provider requires a DLS user to explicitly identify the desired PPA using the *dlpi_attach_ppa()* routine. For a style 2 driver, the *dlpi_open()* creates a stream between the DLS user and DLS provider, and the *dlpi_attach_ppa()* routine then associates a particular PPA with that stream.

The DLS user utilizes the supported GCOM DLPI API Library routines *dlpi_attach_ppa()* and *dlpi_bind_dlsap()* to define a set of enabled physical and *service access point (SAP)* address components on a per-stream basis. It is invalid for a DLS provider to ever send an upstream 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.

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). The *dlpi_bind_dlsap()* routine enables a DLS user to either choose a specific DLSAP by specifying its DLSAP address.

The Service Reference Model

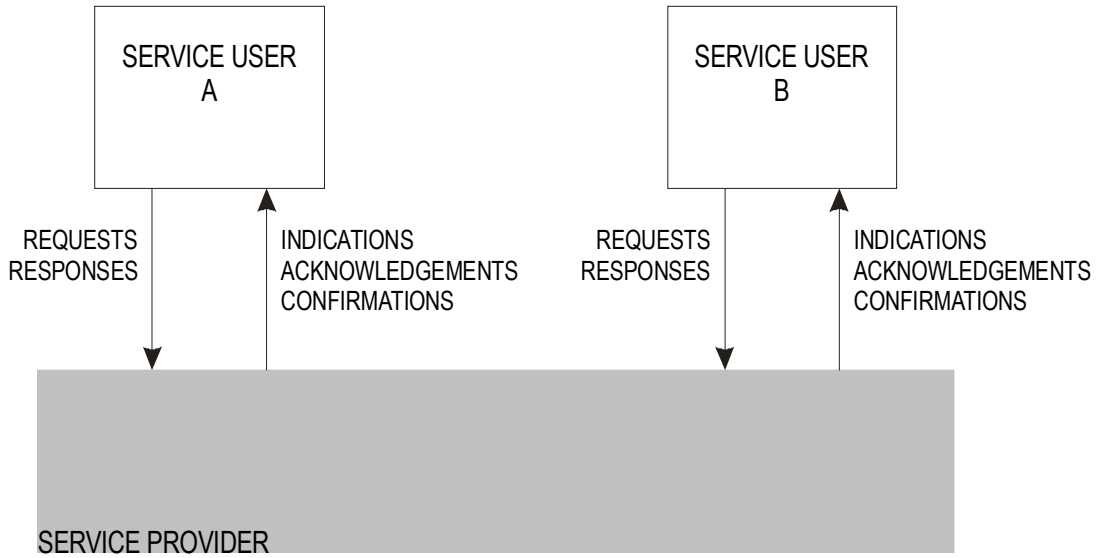


Figure 5 Reference model

Reference Model Terminology

A useful set of abstractions for discussing communications systems is embodied in a reference model such as the ones established by ISO, the CCITT and other standards bodies. A similar model (referred to hereafter simply as the Reference Model) is used in this manual, but its terms do not conform precisely to those of the standards documents of the above mentioned organizations.

A SERVICE is a set of capabilities provided by a SERVICE PROVIDER.

In the Reference Model, a service is defined as a set of capabilities, such as circuit establishment, error detection and/or data transfer. A service provider is an abstract entity that conceptually includes all the software, hardware, transmission media and so on required to provide a particular service.

A SERVICE USER uses the SERVICES of a SERVICE PROVIDER.

A service user is an entity that uses the capabilities of a service provider. An entity can be a service user with respect to a particular service provider, while at the same time itself being (part of) a service provider for other entities.

Example: The network layer.

Layer three (network layer) in the 7-layer ISO protocol stack is an excellent example. It is a service user with respect to layer two (data link layer), and a service provider to layer four (transport layer).

Figure 5 shows two service users (called A and B) connected to a single service provider. The service provided consists of whatever capabilities are required to achieve data transfer between the two service users.

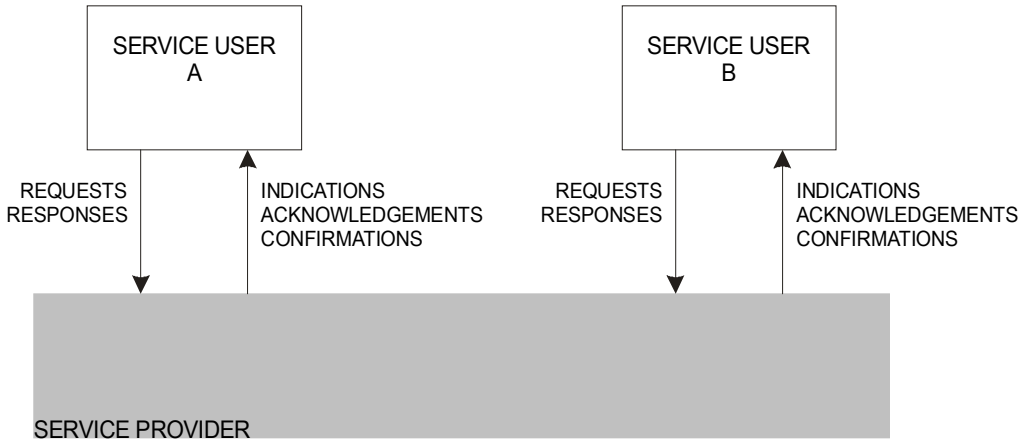


Figure 6 Reference model *(repeated)*

Reference Model Primitives

The arrows in Figure 2 indicate the sending and receiving entities of the following primitives, which are used to categorize communications between service providers and service users:

request	Issued by a service user to a service provider to initiate an operation.
indication	Issued by a service provider to a service user to initiate an operation or to indicate that an operation has been invoked by a peer service user.
response	Issued by a service user to a service provider to respond (positively or negatively) to a previous indication.
confirmation	Issued by a service provider to a service user to confirm the successful completion or failure of an operation that involved a response from a peer service user.
acknowledgement	Issued by a service provider to a service user to acknowledge the local successful completion or failure of an operation started as a result of an earlier request.

LAPD examples

The specific types of primitives within each of these categories depends upon the particular service provider. For example, a service provider can support several requests to manage a connection such as a LAPD open request, attach request and bind request, as well as a data request to initiate the transmission of data. A category can also be empty. For example, no confirmations are supported for the LAPD API.

Table 1 Standard DLS services and DLPI API library routines

Modes	*Service*	*DLPI API Library Routine(s)*
Local Management (for both connectionless and connection-oriented)	Information Reporting	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_info_req(), dlpi_get_info()*
	Attach/Detach	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_attach_req(), dlpi_attach_ppa(), dlpi_send_detach_req(), dlpi_detach_ppa()*
	Bind/Unbind	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_bind_req(), dlpi_bind_dlsap(), dlpi_send_unbind_req(), dlpi_unbind_dlsap()*
Connectionless	Data Transfer	*dlpi_send_uic(), dlpi_rcv(), dlpi_read_data()*
Connection-Oriented	Connection Establishment	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_connect_req(), dlpi_send_connect_res(), dlpi_connect(), dlpi_connect_req(), dlpi_listen()*
	Normal Data Transfer	*dlpi_read_data(), dlpi_write_data(), dlpi_rcv(),*
	U-Frames	*dlpi_rcv(), dlpi_send_xid_req(), dlpi_send_xid_res(), dlpi_read_data(), dlpi_send_test_req(), dlpi_send_uic()*
	Transferring TEST and XID U-frames	*dlpi_rcv(), dlpi_send_xid_req(), dlpi_send_xid_res(), dlpi_read_data(), dlpi_send_test_req()*
	Connection Rejections	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_connect_req(), dlpi_send_disconnect_req(), dlpi_connect(), dlpi_connect_req(), dlpi_listen(), dlpi_send_connect_res()*
	Connection Release	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_disconnect_req(), dlpi_disconnect_req()*
	Connection Reset	*dlpi_rcv(), dlpi_complete_req(), dlpi_send_reset_req(), dlpi_send_reset_res(), dlpi_reset_req(), dlpi_reset_res(), dlpi_send_conn_req()*

DLPI Specification Services Overview

The various features of the Data Link Provider Interface (DLPI) interface are defined in terms of the services provided by the Data Link Service (DLS) provider and the individual primitives that can flow between the DLS user and the DLS provider.

The data link provider interface supports two modes of service:

- Connection-oriented
- Connectionless

Connection-oriented mode requires connection setup/release and guarantees reliable, flow-controlled data delivery with all frames in their original sequence and with no missing or duplicate frames or bit errors within the frames.

Connectionless mode does not require connection setups, but cannot guarantee delivery of data or external flow control.

Standard DLPI Services

Table 2 relates the various phases of connectionless and connection-oriented services to the DLS services and associated GCOM-supplied DLPI API Library routines. The routines are described in detail in Appendix A, page 125.

Both connection-oriented and connectionless service modes require the local management functions shown in Table 1. They both also support U-frames (XIDs, TESTs and unnumbered information U-frames).

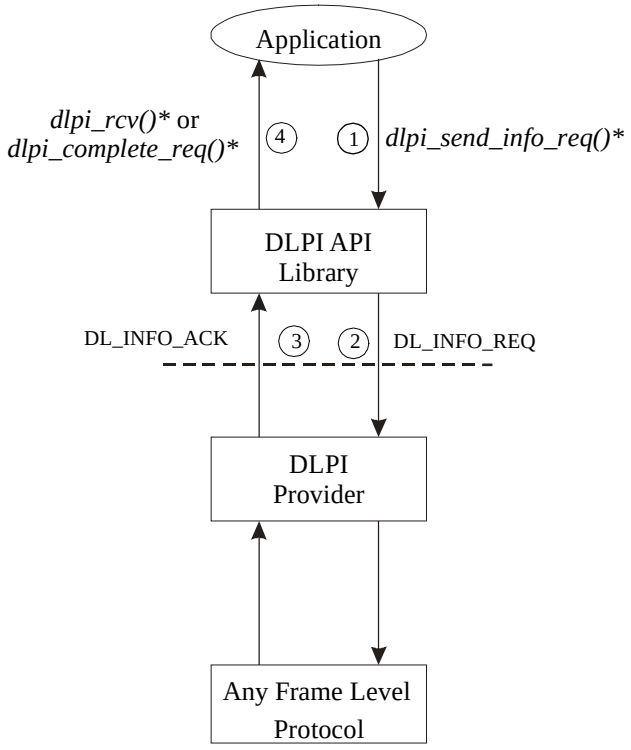
Table 2 GCOM extensions to DLPI as implemented in the DLPI API library

Modes	*Service*	*DLPI API Library Routine(s)*
Local Management (applies to both connectionless and connection-oriented)	Initialization	*dlpi_init(), dlpi_init_FILE()*
	Open/Close	*dlpi_open(), dlpi_open/close*
Configuration	DLPI Configuration	*dlpi_configure_dlsaps()*
Connectionless	Data Transfer	*dlpi_get_a_msg(), dlpi_put_data(), dlpi_set_unnum_frame_handler()*
Connection-oriented	Data Transfer	*dlpi_get_a_msg(), dlpi_set_unnum_frame_handler()*
Troubleshooting	Troubleshooting	*dlpi_printf(), dlpi_decode_ctl(), dlpi_set_signal_handling()*
Miscellaneous	Miscellaneous	*dlpi_get_style(), dlpi_send_test_res()*

GCOM Extensions to the DLPI Services

Beyond the standard DLPI provider services, GCOM has implemented a number of extensions that you might find useful while writing your application, as listed in Table 3. The DLPI API Library routines are described in detail in Appendix A, page 125.

Local Management Services



* *dlpi_get_info()* can be substituted for events 1 and 4

Figure 7 Information reporting for all frame level protocols

This section describes the local management services provided by the link-layer DLPI API Library for all connectionless and connection-oriented frame level protocols. These services, which fall outside the scope of standards specifications, define the method for initializing a stream that is connected to a Data Link Service (DLS) provider. DLS provider information reporting services are also supported by the local management facilities. These services are provided by the link-layer DLPI API Library.

Information Reporting Local Service

This service provides information about the DLPI stream to the DLS user. The *dlpi_send_info_req()* routine requests the DLS provider to return operating information about the stream. The DLS provider returns the requested information to one of several DLPI API Library routines in a DL_INFO_ACK message.

Open/Close Local Services

The DLPI specification does not define an open or close local management service. However, both are necessary to start and finish a data transfer session in both connectionless and connection-oriented environments.

Note: *You must call* dlpi_init() *before opening a session.*

Open Service

It is necessary to open a session before attaching the PPA, binding the DLSAP and (in connection-oriented mode) connecting to a circuit. Therefore, GCOM supplies the *dlpi_open()* routine, shown in Figure 8, which simply asks DLPI to open a session. After the *open()* system call is accepted by the DLPI Provider, a file descriptor is returned.

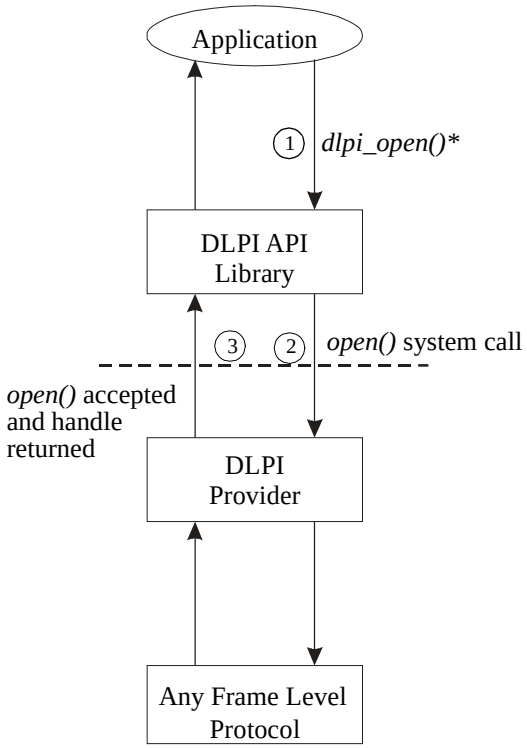


Figure 8 Open services for all frame level protocols

Close Service

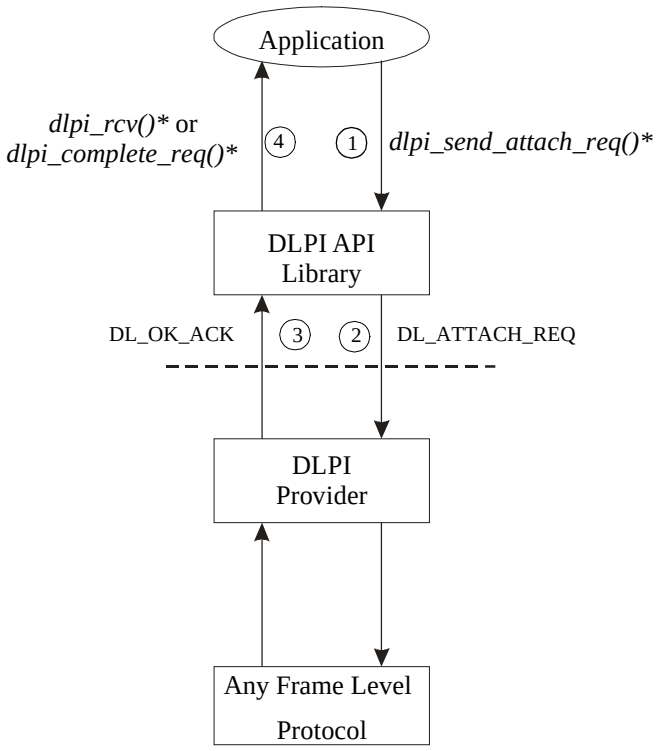
The last thing your application must do before a session is complete is close the session. This involves unbinding, detaching and closing. GCOM recommends simply using the *dlpi_close* routine. Your application would seldom need to explicitly detach and unbind a session. However, the DLPI API Library supplies such routines if you need to use them.

Attach/Detach Local Services

Attach

The attach service assigns a Physical Point of Attachment (PPA) to a stream. This service is required for style 2 DLS providers (explained in “DLPI Addressing” on page 33) to specify the physical medium over which communication occurs. The DLS provider indicates success with a DL_OK_ACK and failure with a DL_ERROR_ACK. An attach request is only valid when the stream is detached (DL_UNATTACHED).

The normal sequence of events is illustrated in Figure 9.



* *dlpi_attach_ppa()* can be substituted for events 1 and 4

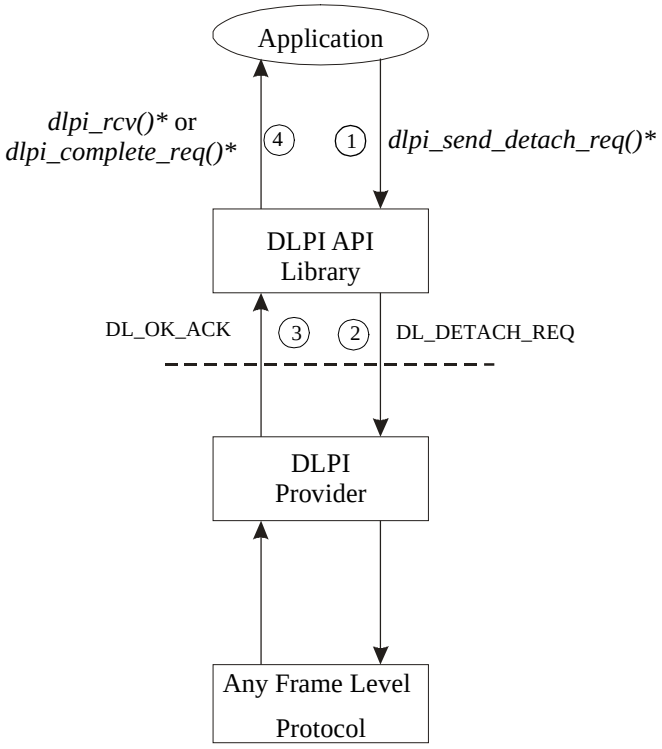
Figure 9 Attaching a stream to a physical line for all frame level protocols

Detach

A Physical Point of Attachment (PPA) can be disassociated with a stream using the *dlpi_send_detach_req()* routine. A detach request is only valid when the stream is attached to the PPA but not bound (DL_UNBOUND).

Note: *GCOM suggests unbinding and detaching using the dlpi_*close() *command.*

The normal sequence of events is illustrated in Figure 10.



* *dlpi_detach_ppa()* can be substituted for events 1 and 4

Figure 10 Detaching a stream from a physical line for all frame level protocols

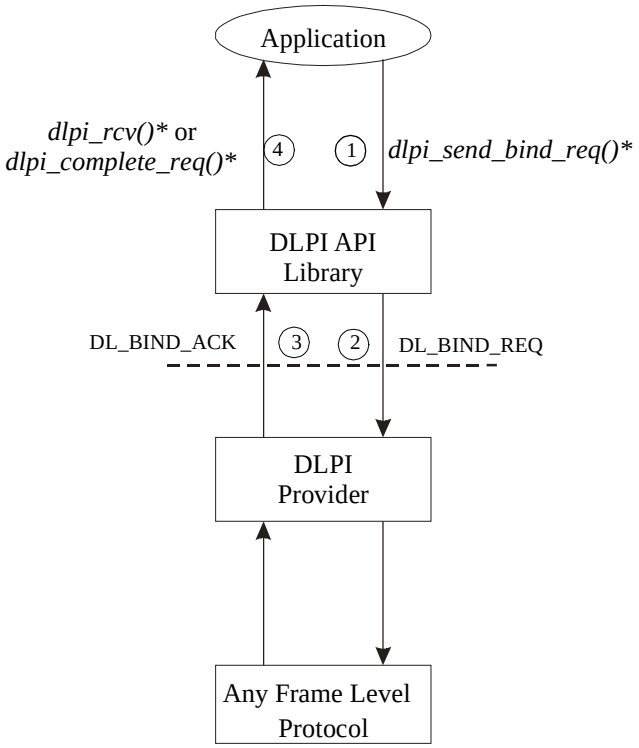
Bind/Unbind Services

The bind service associates a Data Link Service Access Point (DLSAP) with a stream.

Bind

The *dlpi_bind_dlsap()* or *dlpi_send_bind_req()* routine 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 data transfer and connection establishment requests. The DLS provider indicates success with a DL_BIND_ACK and failure with a DL_ERROR_ACK. A bind request is valid only when the stream is attached to a PPA but not bound to a DLSAP (DL_UNBOUND).

The normal sequence of events is illustrated in Figure 11.



* *dlpi_bind_dlsap()* can be substituted for events 1 and 4

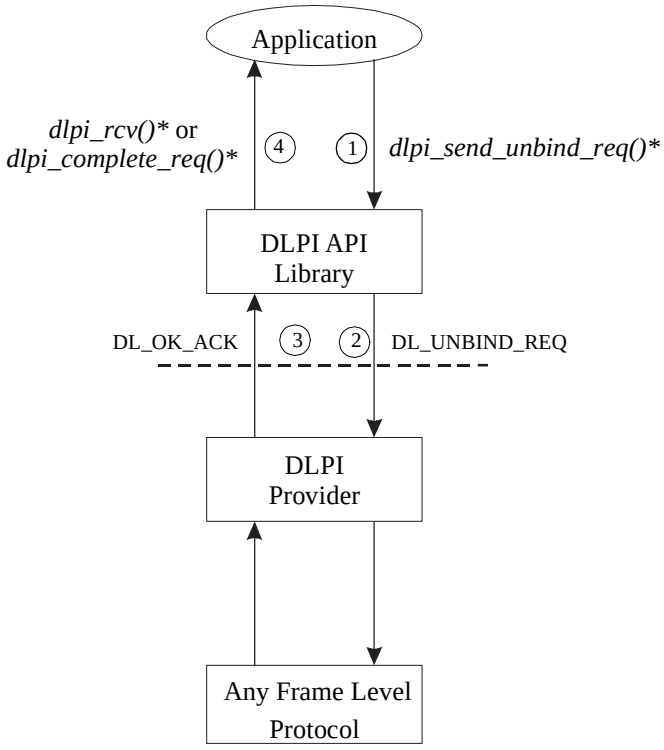
Figure 11 Binding a stream to a DLSAP all frame level protocols

Unbind

The *dlpi_unbind_dlsap()* or *dlpi_send_unbind_req()* routine requests the DLS provider to unbind all DLSAPs from a stream. The DLS provider indicates success with DL_OK_ACK or failure with DL_ERROR_ACK. An unbind request is valid only when the stream is bound to a DLSAP but not in a connected state (DL_IDLE).

Note: *GCOM suggests unbinding and detaching using the dlpi_close() command.*

The normal sequence of events is illustrated in Figure 12.



* *dlpi_unbind_dlsap()* can be substituted for events 1 and 4

Figure 12 Unbinding a stream from a DLSAP for all frame level protocols

SECTION 2

Connectionless Services

Understanding Connectionless Data Transfer

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

What? *Connectionless data transfer* implies that there is no connection. Data are simply shipped through the circuit, without the guaranteed expectation that it will arrive correctly on the other end. There is nothing that guarantees the safe delivery of data by all parts of the transport mechanism (such as the wire or the network) or that the data will be delivered in its original sequence without duplicated frames.[1] It is up to the client to detect and correct lost data. However, checksums will detect most bit-errors over synchronous lines.

Furthermore, connectionless data transfer has no DLS Provider-to-DLS Provider flow-control. That is, there is internal flow-control that prevents the system from being flooded with data, but there is no peer-to-peer flow-control.

Why? GCOM supports connectionless data transfer to:

- Communicate directly with a driver. That is, obtain direct access to a synchronous line (or port)
- Communicate over a frame relay circuit
- Use the U-frame mechanism of LAPB/LAPD, LLC-II and HDLC/SDLC (assuming you never ask for a connection)

Note: *Conversely, connection-oriented data transfer is associated with LAPB/LAPD, LLC-II and HDLC/SDLC running in connection-oriented mode.*

How? For successful connectionless data transfer to occur over DLPI, your application must achieve the following three phases:

- Begin the session by issuing an open, attach and bind
- Exchange data across the line
- End the session by issuing an unbind, detach and close

[1] Although frame relay guarantees frame delivery without duplication, complex WAN routing might cause a frame to be duplicated anyway. Therefore, you should consider coding your application to check for such duplication.

Beginning a Session—Open, Attach and Bind

In connectionless data transfer mode, your application first calls *dlpi_init()* and then proceeds to open a session, attach a PPA and bind the DLSAP.

Exchanging Data in Connectionless Mode

As mentioned previously, the connectionless data transfer service provides for the exchange of user data (DLSDUs) in either direction or in both directions simultaneously (full-duplex) without ever establishing a data link connection. Data transfer is not acknowledged, and there is no end-to-end flow control provided. As such, the connectionless data transfer service cannot guarantee reliable delivery of data.

Figure 13, below, shows how data are transferred in a connectionless mode environment. Data are transferred in the form of bits for frame relay and unnumbered information U-frames for all other supported protocols. TESTs and XIDs can also be transferred in a connectionless mode as explained starting on page 59.

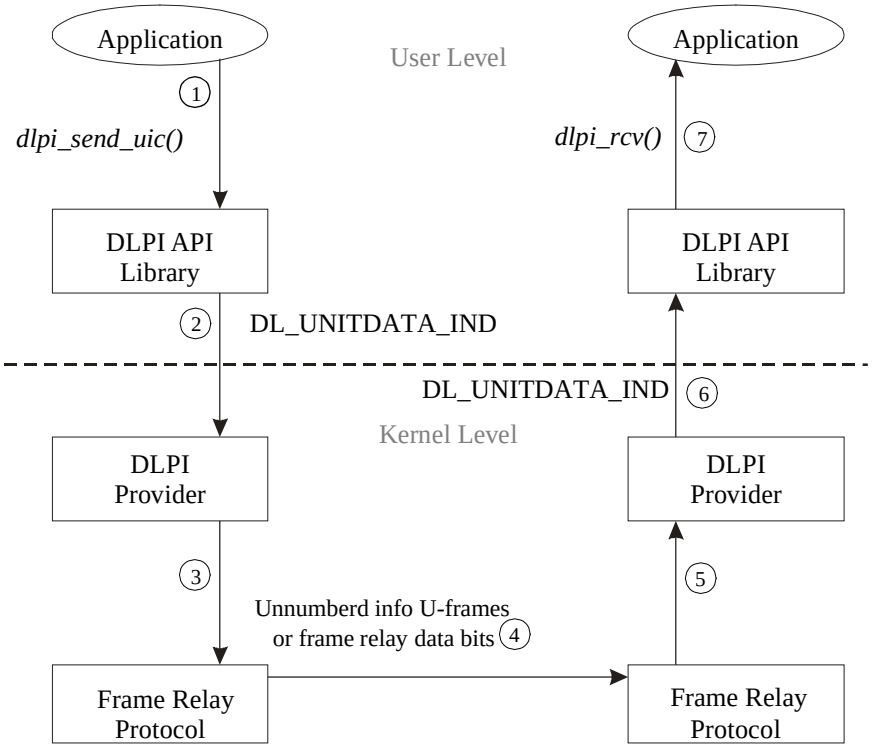


Figure 13 Connectionless data transfer for frame relay, LAPB/LAPD, LLC-II and HDLC/SDLC

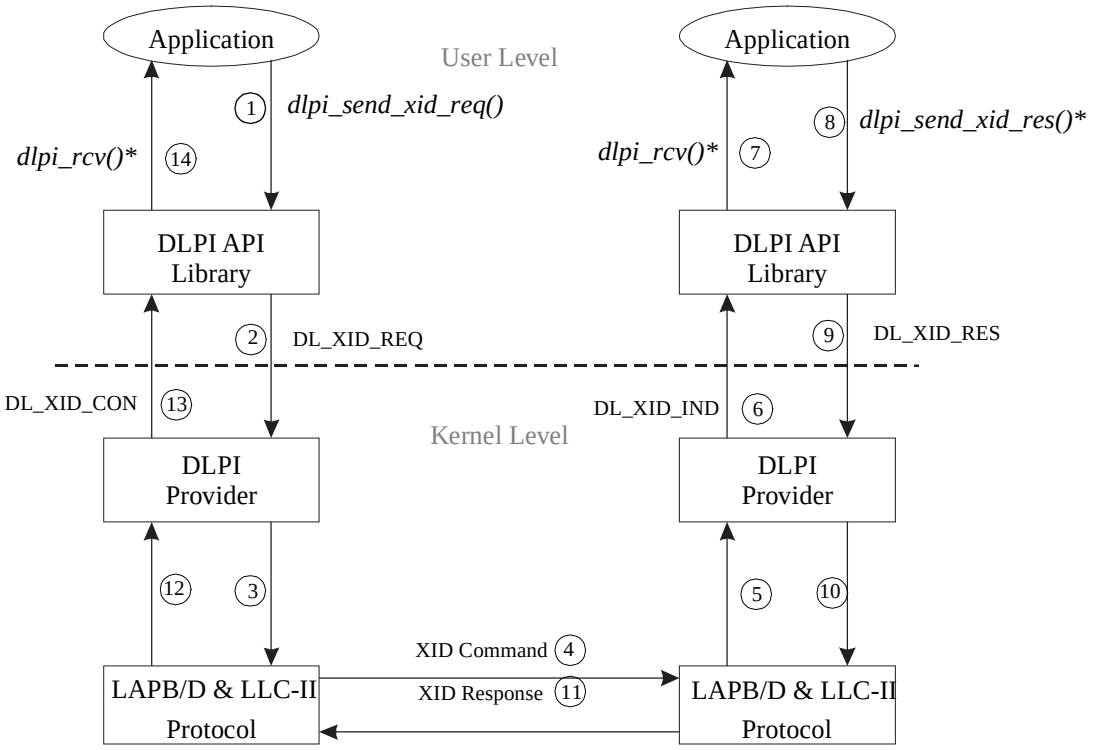
Transferring TEST and XID U-Frames

TESTs and XIDs are U-frame types defined by the HDLC/SDLC, LAPB/LAPD and LLC-II protocols. As such, these U-frames can be transferred once a stream has been attached, bound or while a connection exists.

Note: *Frame relay does not support TESTs and XIDs.*

XID Service

The local DLS user requests that an XID command response be sent to the remote DLS user. The feature that allows the DLS user to request automatic handling of the XID response at bind time is not supported at this time.

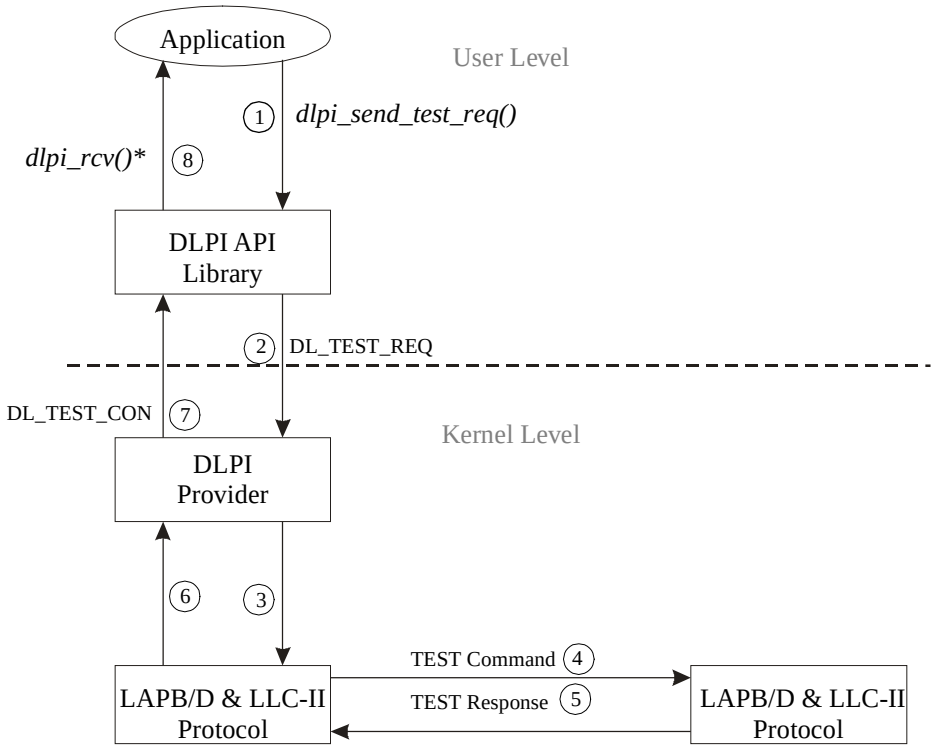


* *dlpi_read_data()* can also substitute for events 7 and 14 if you are using the unnumbered frame handler routine.

Figure 14 XID service for connectionless mode LAPB/LAPD, LLC-II and HDLC/SDLC

TEST Service

The local DLS user requests that TEST command response be sent to the remote DLS user. According to the DLPI specification, the optional feature that allows the DLS user to request automatic handling of the TEST response at bind time is handled by the DLPI Provider. GCOM's implementation makes this a required feature that is handled by the LAPB/LAPD, LLC-II and HDLC/SDLC protocols as shown in Figure 15.



* *dlpi_read_data()* can also substitute for events 7 and 14 if you are using the unnumbered frame handler routine.

Figure 15 TEST service for connectionless mode LAPB/LAPD, LLC-II and HDLC/SDLC

Closing a Connectionless Session

To unbind, detach and close, use the *dlpi_close* command, which is documented in your UNIX system administrator's manual. Your application would seldom need to explicitly detach and unbind a session. However, the DLPI API Library supplies such routines if you want to use them.

SECTION 3

LAPB/LAPD and LLC-II Connection-Oriented Services

The connection-mode services enable a Data Link Service (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.

Note: *For information about HDLC/SDLC connection-oriented services, refer to Section 4, page 83.*

Understanding Connection-Oriented Data Transfer

Why? *Connection-oriented data transfer* normally implies three phases: the connection is set up, data are transferred and the connection is torn down. A connection offers the advantage of reliable data delivery across the network in its original sequence with no missing or duplicate frames/packets and no bit-errors. It is also flow-controlled. That is, the connection itself has a flow-control mechanism at the protocol level, normally implemented using sequence numbers, acknowledgements and windows within the definition of a frame level connection.

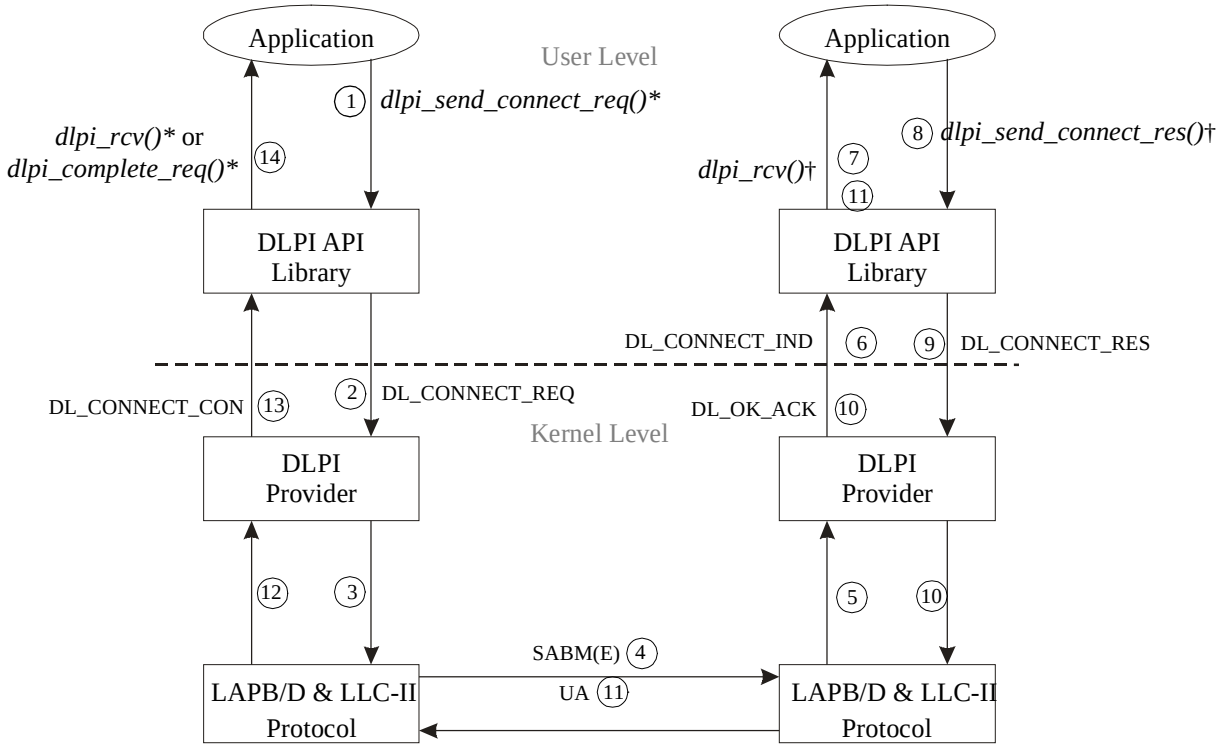
How? For successful connection-oriented data transfer to occur over DLPI, your application must achieve the following three phases:

- Setup the connection
- Exchange data
- End the session

Normal Connection Establishment for LAPB/LAPD and LLC-II

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

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 or using DL_DISCONNECT_REQ. DL_CONNECT_CON informs the calling DLS user that a requested connection has been established. Figure 16, below, illustrates the normal sequence of connection messages.



* *dlpi_connect()* performing open, attach and bind can substitute for events 1 and 14. *dlpi_connect_req()* can also substitute for events 1 and 14.

† *dlpi_listen()* performing open, attach and bind can substitute for events 7, 8 and 11.

Figure 16 Successful connection establishment for LAPB/LAPD and LLC-II

Normal Data Transfer for LAPB/LAPD and LLC-II

The connection-oriented data transfer service provides for the exchange of user data in either direction or in both directions simultaneously (full-duplex) between DLS users. Data are 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.

Each call to *dlpi_write_data()* in Figure 17, below, conveys a DLSDU from the local DLS user to the DLS provider. Similarly, each call to *dlpi_read_data()* conveys a DLSDU from the DLS provider to the remote DLS user.

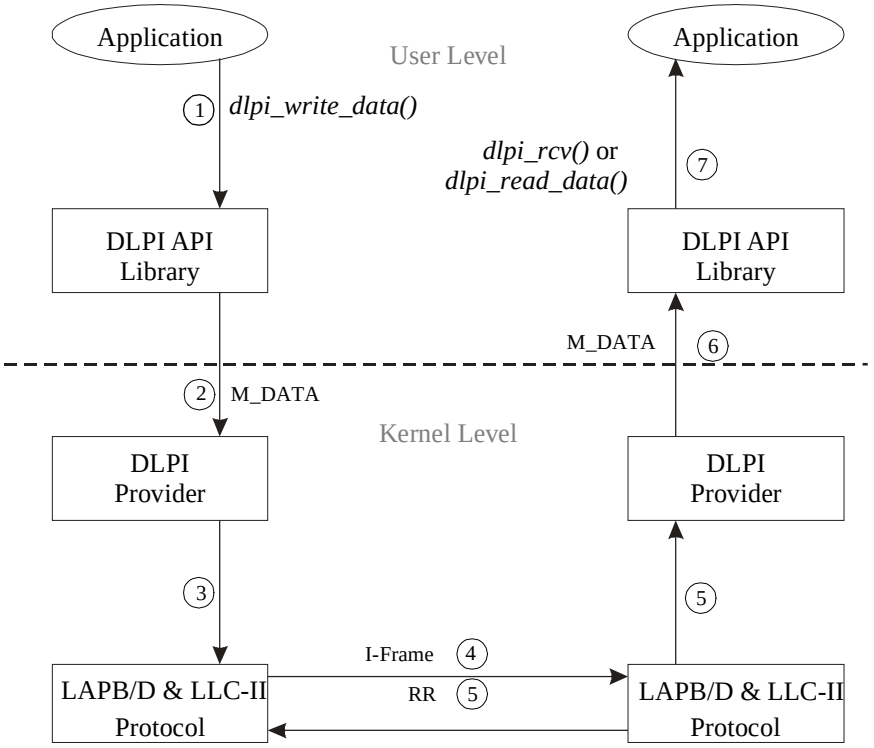


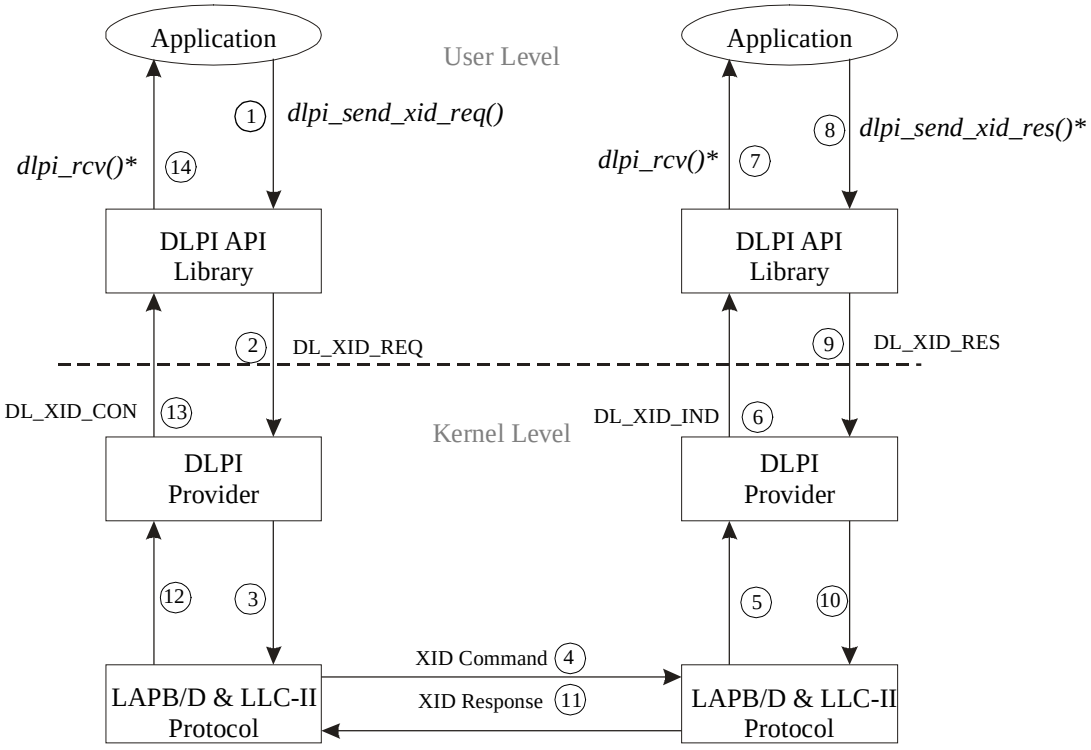
Figure 17 Normal data transfer for LAPB/LAPD and LLC-II

U-Frame Services for LAPB/LAPD and LLC-II

The GCOM DLPI API Library routines support U-frame service for connection-oriented protocols.

XID Service

The local DLS user requests that an XID command response be sent to the remote DLS user. The feature that allows the DLS user to request automatic handling of the XID response at bind time is not supported at this time.

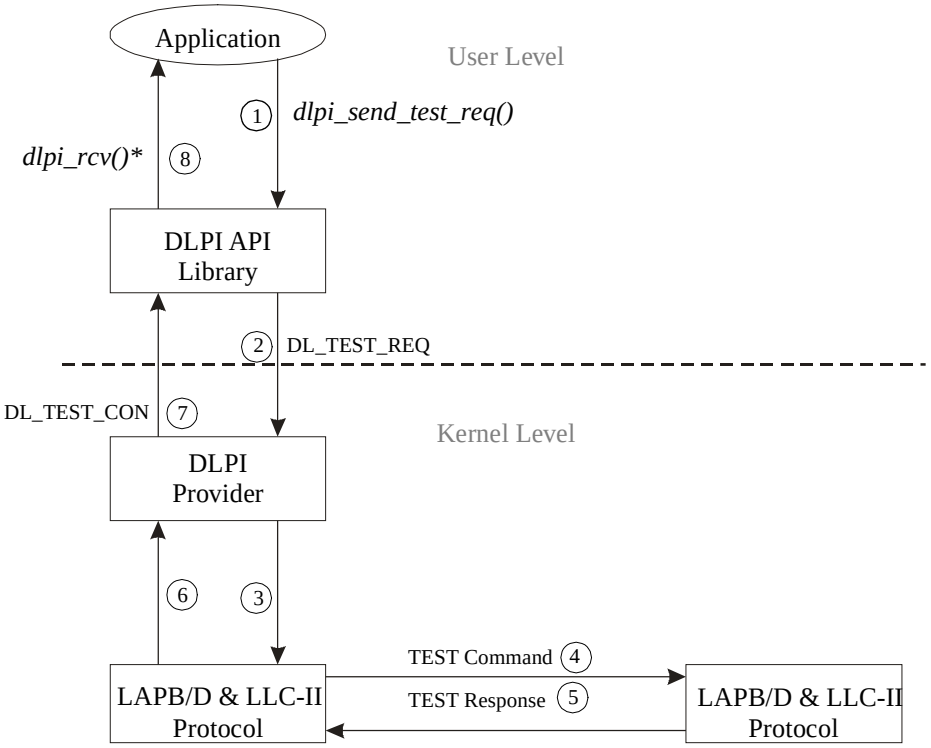


* *dlpi_read_data()* can also substitute for events 7 and 14 if you are using the unnumbered frame handler routine.

Figure 18 XID service for connection-oriented LAPB/LAPD and LLC-II

TEST Service

The local DLS user requests that TEST command response be sent to the remote DLS user. According to the DLPI specification, the optional feature that allows the DLS user to request automatic handling of the TEST response at bind time is handled by the DLPI Provider. GCOM's implementation makes this a required feature that is handled by the LAPB/LAPD and LLC-II protocols in Figure 19.



* *dlpi_read_data()* can also substitute for events 7 and 14 if you are using the unnumbered frame handler routine.

Figure 19 TEST service for connection-oriented LAPB/LAPD and LLC-II

Connection-Oriented Unnumbered Information U-Frame Data Transfer Service

Data are 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. The amount of user data that can be transferred in a single DLSDU is limited.

Each call to *dlpi_send_uic()* in Figure 20, below, conveys a DLSDU from the local DLS user to the DLS provider. Similarly, each call to *dlpi_read_data()* conveys a DLSDU from the DLS provider to the remote DLS user.

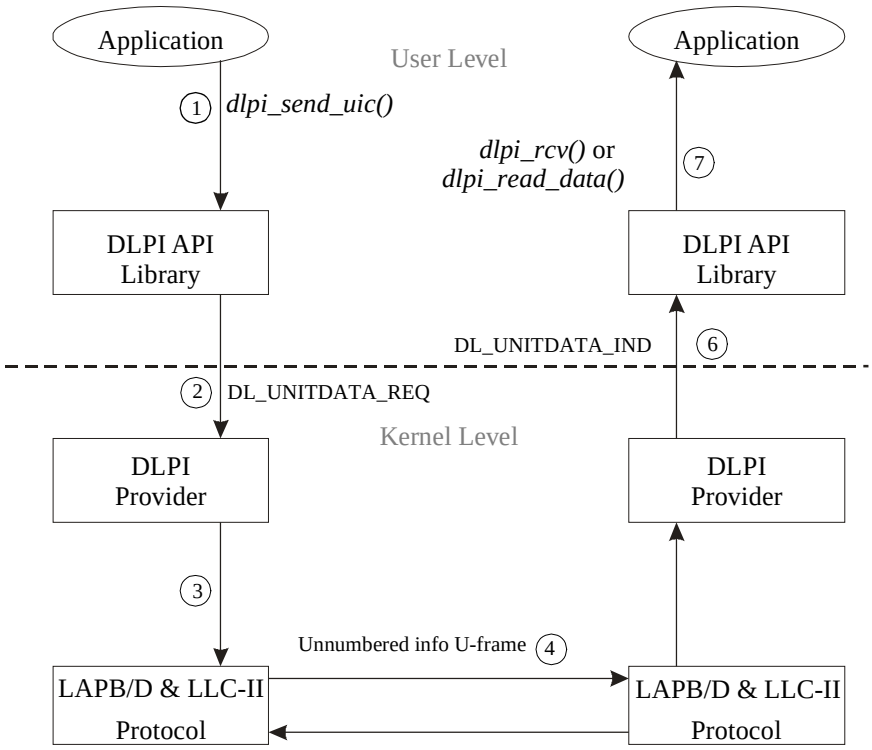


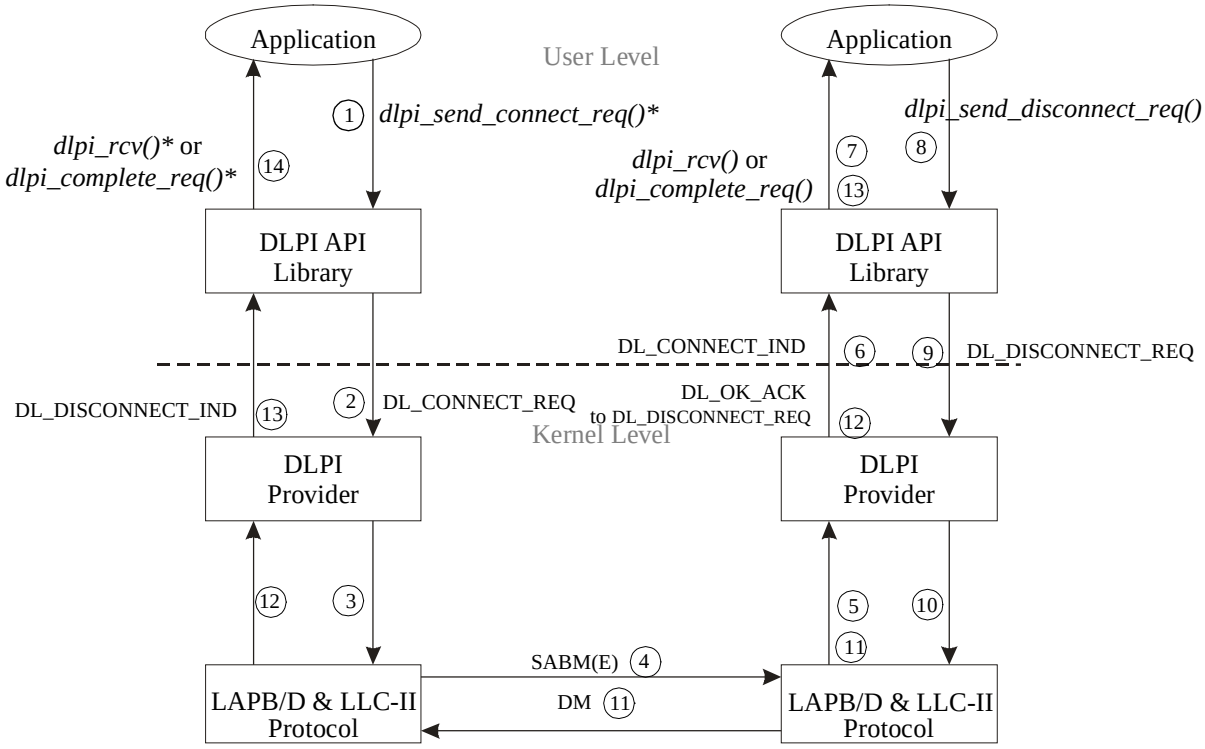
Figure 20 Unnumbered Information U-Frame Data Transfer Service for LAPB/LAPD and LLC-II

Connection Establishment Rejections for LAPB/LAPD and LLC-II

In certain situations, the connection establishment request cannot be completed. The following subsections describe instances where a DL_DISCONNECT_IND DLPI Provider primitive is flowing during the connection establishment phase. That is, a local DLS user issued a *dlpi_send_connect_req(), dlpi_connect()* or *dlpi_connect_req(),* but the peer rejected the connection request.

Called DLS User Connection Rejection

In Figure 21, below, the DLS user chooses to reject the connect request by issuing a DL_DISCONNECT_REQ primitive instead of a DL_CONNECT_RES.

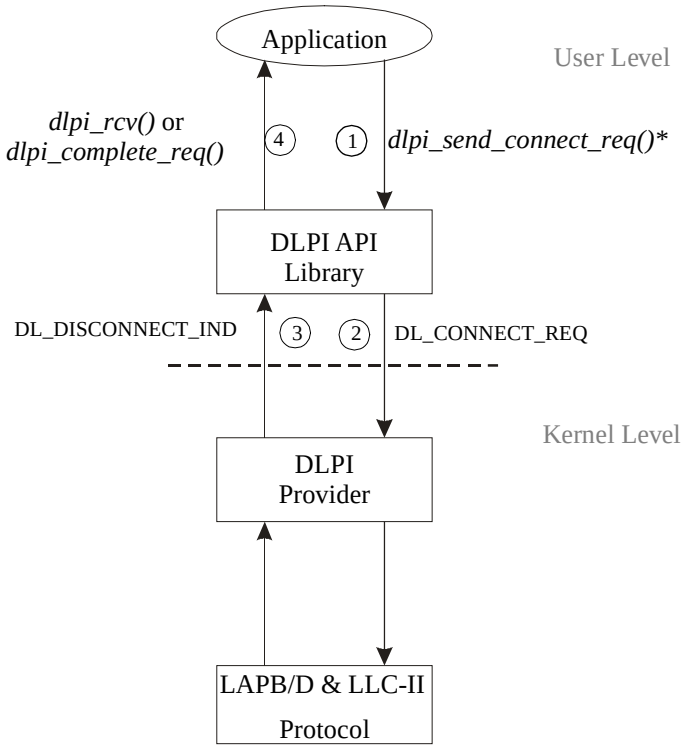


* *dlpi_connect()* performing open, attach and bind can substitute for events 1 and 14. *dlpi_connect_req()* can also substitute for events 1 and 14.

Figure 21 Called DLS user connection rejection for LAPB/LAPD and LLC-II

DLS Provider Connection Rejection

In Figure 22, below, the DLS provider rejects a connect request for lack of resources or other reasons. The DLS provider sends DL_DISCONNECT_IND in response to the connect request.



* *dlpi_connect()* performing open, attach and bind can substitute for event 1. *dlpi_connect_req()* can also substitute for event 1.

Figure 22 DLS provider connection rejection for LAPB/LAPD and LLC-II

Connection Retraction Services for LAPB/LAPD and LLC-II

The next two figures show scenarios where the calling DLS user chooses to abort a previous connection attempt. That is, the DLS user issues a disconnect request after a connect request. The resulting sequence of events depends on the relative timing of the DLPI primitives involved.

User Retracts Connection Request

Figure 23, below, shows a scenario where the retraction occurs before the local DLS provider can send a SABM(E) to the remote DLS provider.

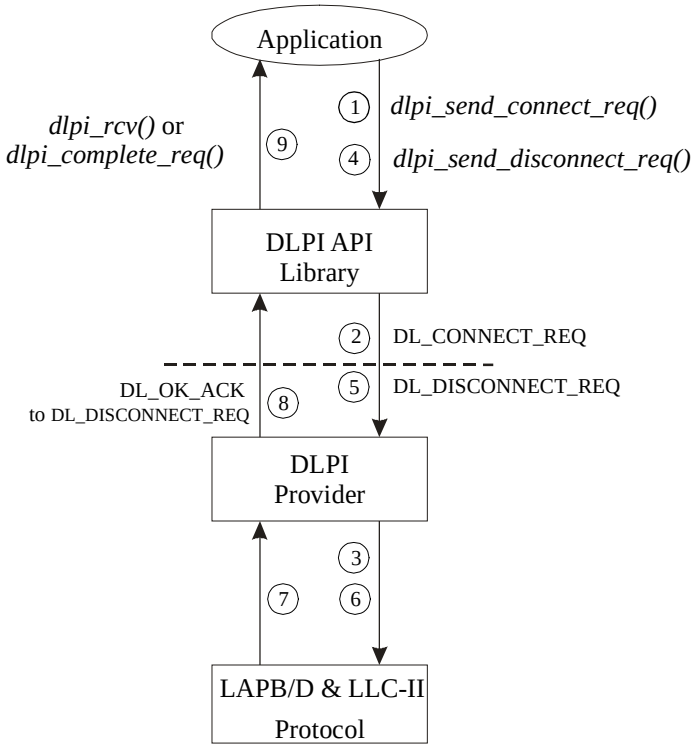
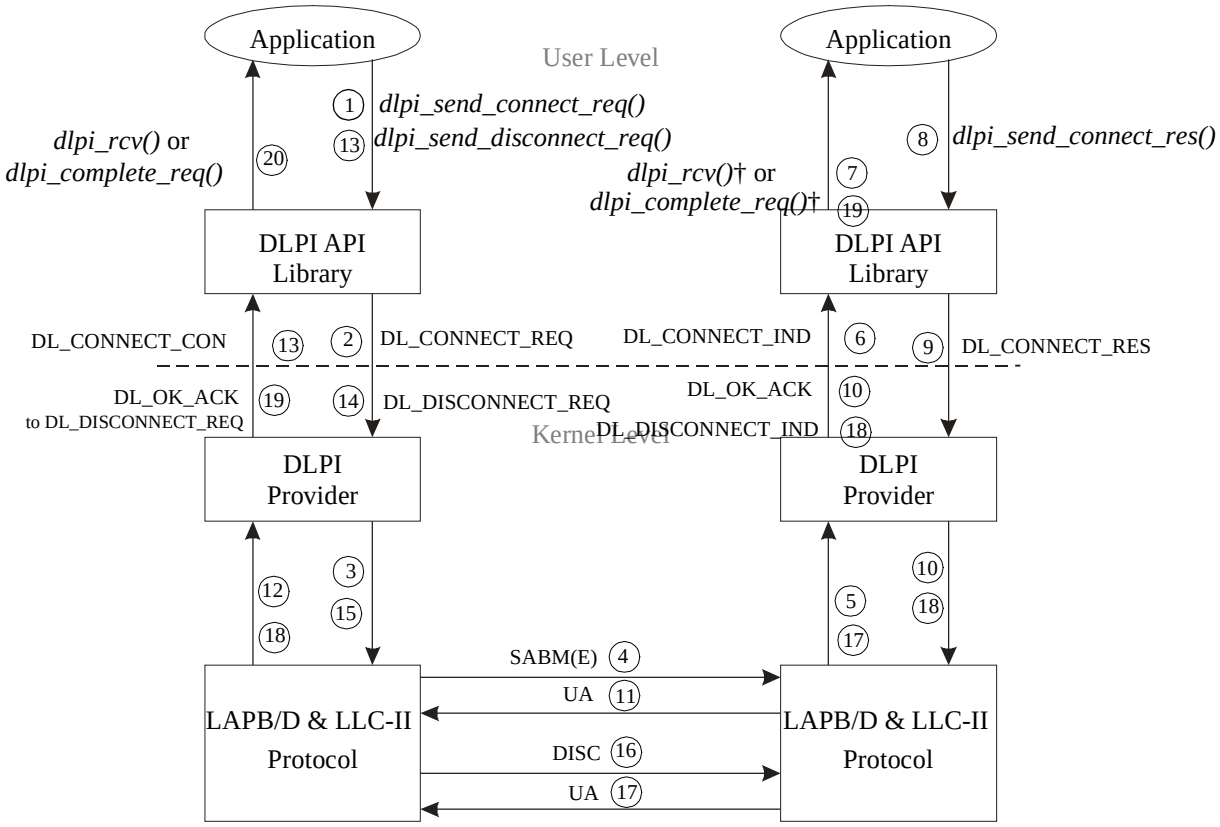


Figure 23 User retracts connection request for LAPB/LAPD and LLC-II

DL_DISCONNECT_IND Arrives After DL_CONNECT_RES is Sent

Figure 24, below, shows a scenario where the calling DLS user chooses to abort a previous connection attempt. That is, the DLS user issues a disconnect request after a connect request. The resulting sequence of events depends on the relative timing of the DLPI primitives involved.



† *dlpi_listen()* performing open, attach and bind can substitute for events 7 and 19.

Figure 24 DL_DISCONNECT_IND arrives after DL_CONNECT_RES is sent for LAPB/LAPD and LLC-II

The following network events in Figure 24 are defined as follows:

event 12 Connect sequence ends here

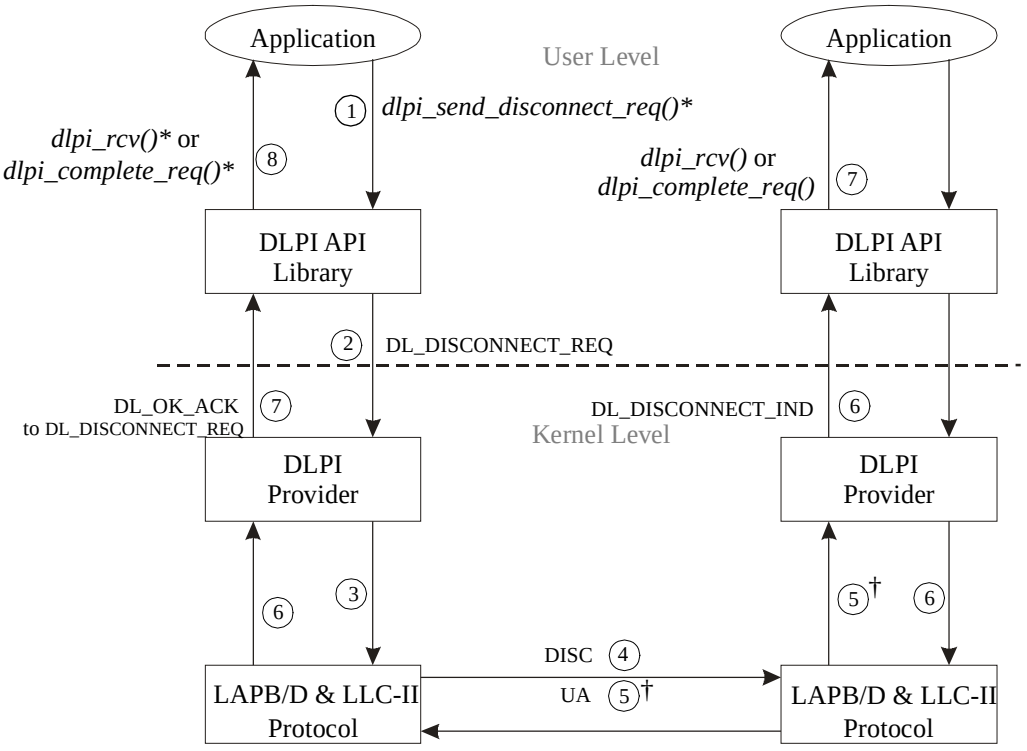
event 13 Disconnect starts here

Connection Release Services for LAPB/LAPD and LLC-II

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 that has not been delivered to the DLS user will be discarded. A DL_DISCONNECT_REQ primitive requests that a connection be released and DL_DISCONNECT_IND informs the DLS user that a connection has been release.

DLS User-Invoked Connection Release

Normally, one DLS user requests disconnection and the DLS provider issues an indication of the ensuing release to the other DLS user, as shown in Figure 25, below.



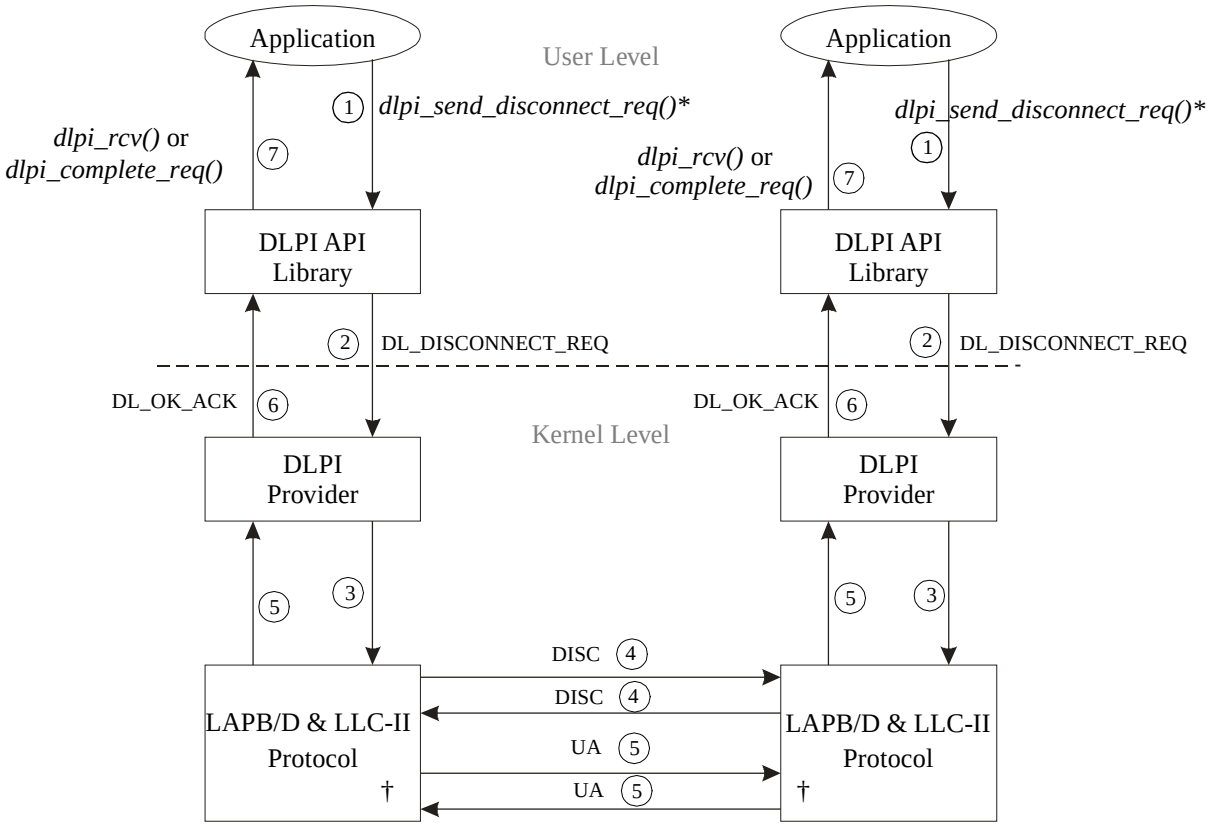
* *dlpi_disconnect_req()* can also substitute for events 1 and 8.

† The time sequence runs uncoupled starting at event 5.

Figure 25 DLS user-invoked connection release for LAPB/LAPD and LLC-II

Simultaneous DLS User-Invoked Connection Release

Figure 26, below, illustrates that when two DLS users independently invoke the connection release service, neither one receives a DL_DISCONNECT_IND primitive.



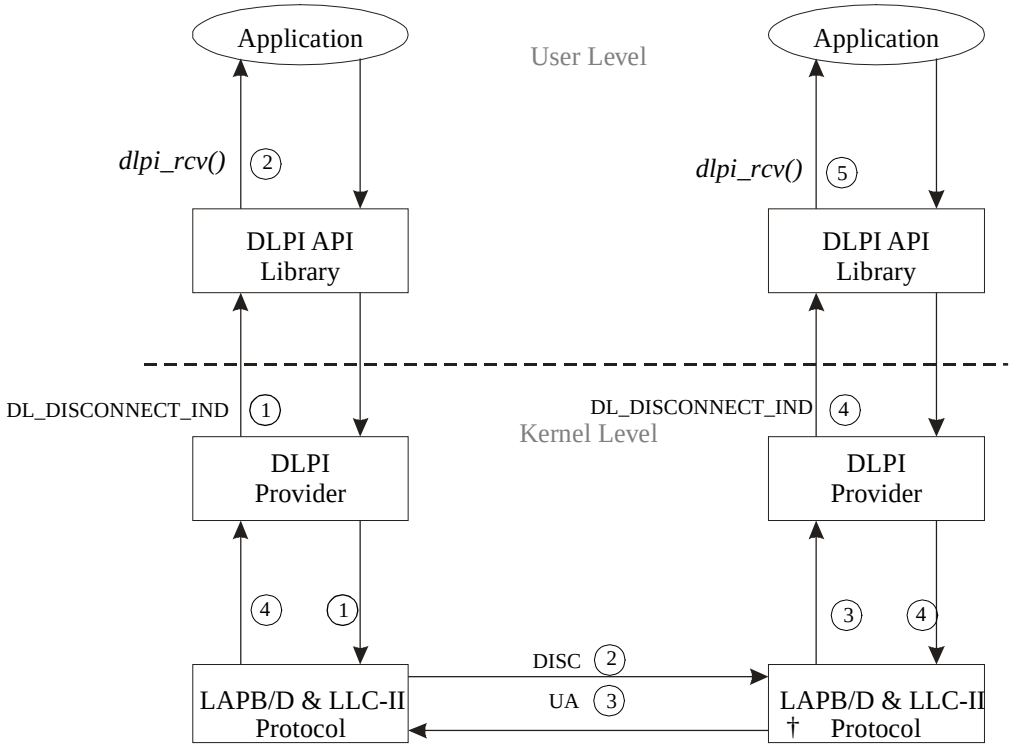
* *dlpi_disconnect_req()* can also substitute for events 1 and 7.

† Rendezvous. Uncoupled after this point.

Figure 26 Simultaneous DLS user-invoked connection release for LAPB/LAPD and LLC-II

DLS Provider-Invoked Connection Release

Figure 27, below, illustrates that when a DLS provider initiates the connection release service, each DLS user receives a DL_DISCONNECT_IND primitive.

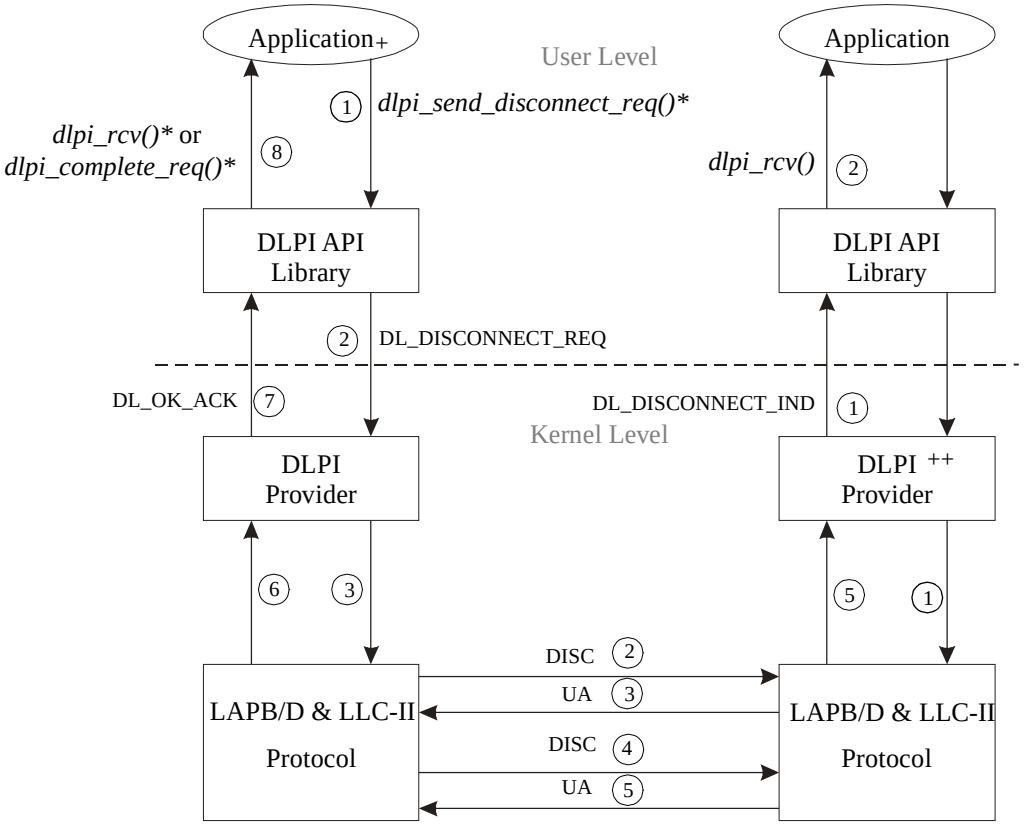


† Events are uncoupled after this point.

Figure 27 DLS provider-invoked connection release for LAPB/LAPD and LLC-II

Simultaneous DLS User- and DLS Provider-Invoked Connection Release

Figure 28, below, shows that when the remote DLS provider and the local DLS user simultaneously invoke the connection release service, the remote DLS user receives a DL_DISCONNECT_IND primitive.



* *dlpi_disconnect_req()* can also substitute for events 1 and 7.

Figure 28 Simultaneous DLS user- (+) and DLS provider- (++) invoked connection release for LAPB/LAPD and LLC-II

Connection Reset Services for LAPB/LAPD and LLC-II

The *reset service* can 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 that is unrecoverable within the data link service. The invocation of the reset service unblocks the flow of Data Link Service Data Units (DLSDUs) if the data link connection is congested. DLSDUs can be discarded by the DLS provider. The DLS 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.

Interaction between DLS user and DLS provider

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

- A reset request is invoked by the DLS user, followed by a reset confirmation from the DLS provider
- A reset indication from the DLS provider, followed by a reset response from the DLS user and an DL_OK_ACK returned to the DLS user

Primitives involved in the connection reset service

The DL_RESET_REQ acts as a synchronization mark in the streams 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 that originally issued the reset.

Resynchronizing properties of the reset service

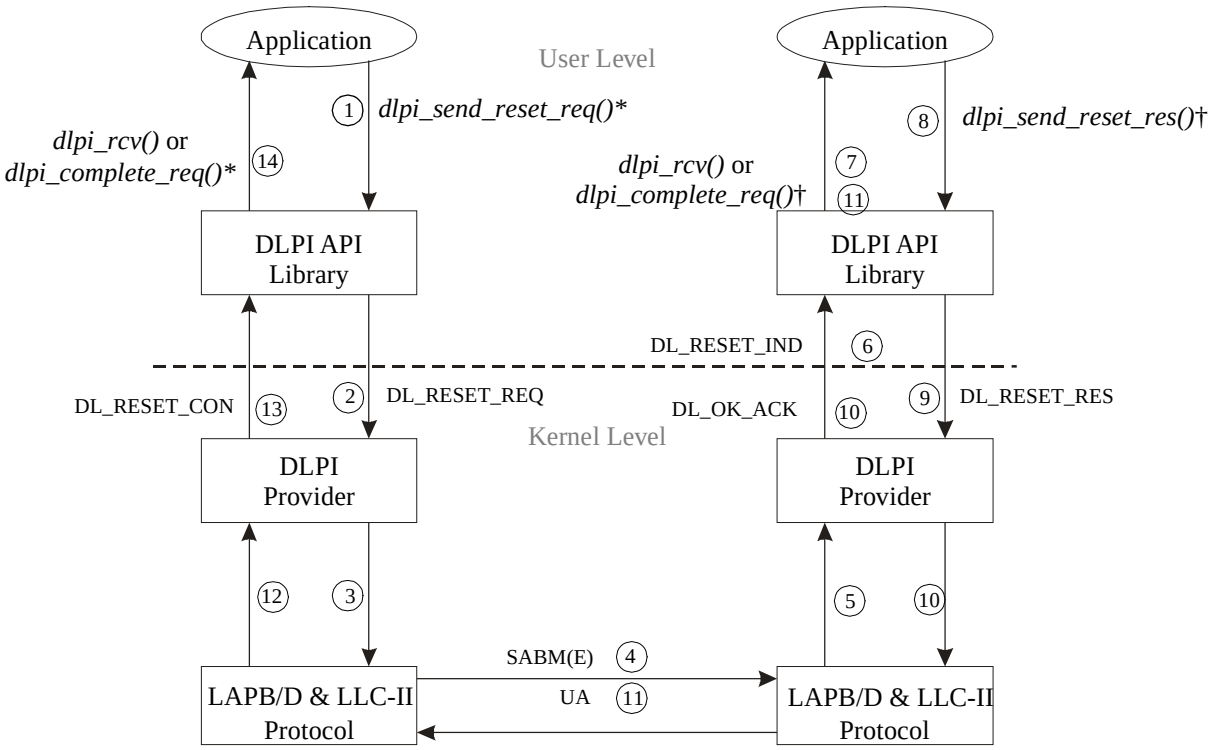
These are the resynchronizing properties of the reset service:

- 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 discards 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 the 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 upon the origin of the reset, which may be the DLS provider or either DLS user.

DLS User-Invoked Connection Reset

Figure 29, below, illustrates the message flow for a reset invoked by one DLS user.



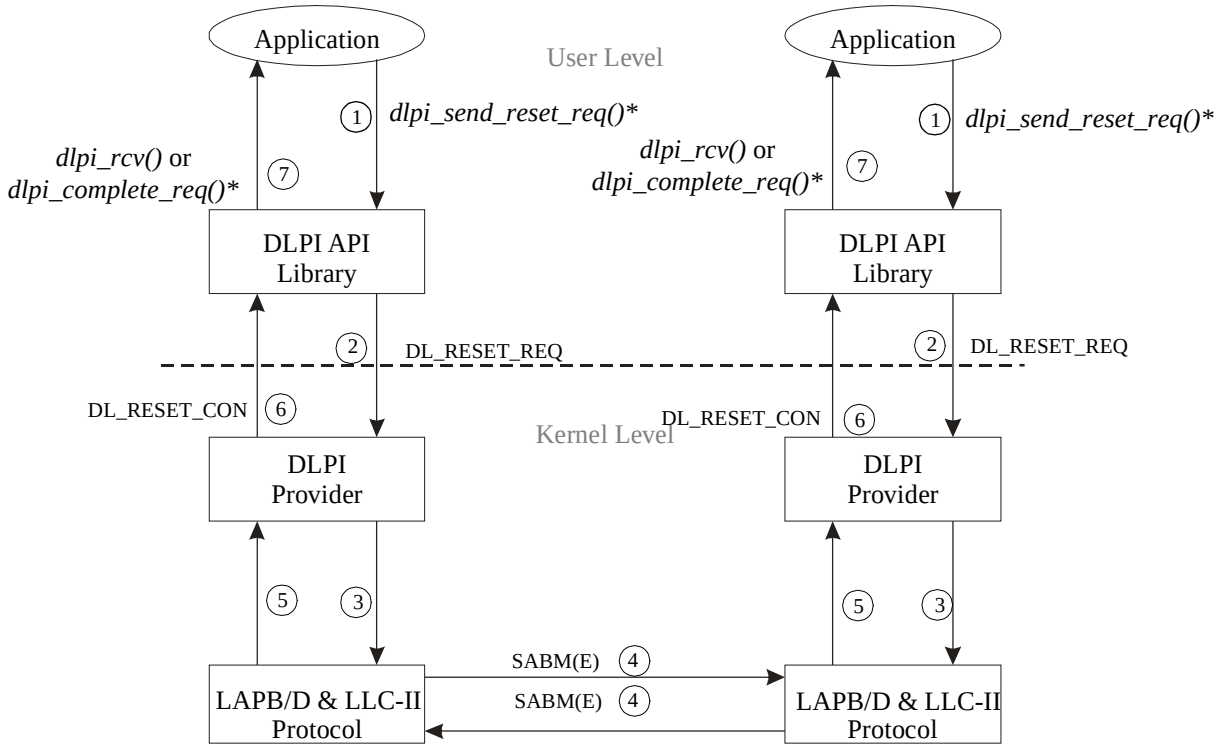
* *dlpi_reset_req()* can also substitute for events 1 and 14.

† *dlpi_reset_res()* can also substitute for events 8 and 11.

Figure 29 DLS user-invoked connection reset for LAPB/LAPD and LLC-II

Simultaneous DLS User-Invoked Connection Reset

Figure 30, below, illustrates the message flow for a reset invoked by both DLS users simultaneously.

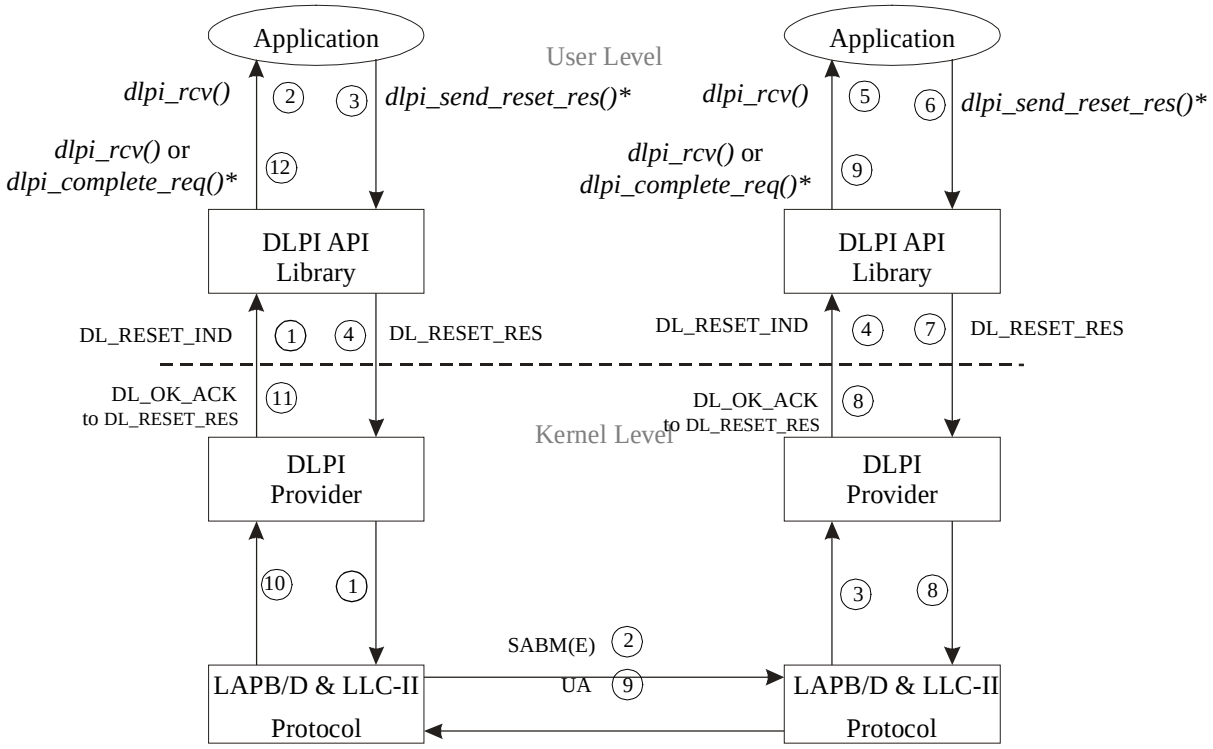


* *dlpi_reset_req()* can also substitute for events 1 and 7.

Figure 30 Simultaneous DLS user-invoked connection reset for LAPB/LAPD and LLC-II

DLS Provider-Invoked Connection Reset

Figure 31, below, illustrates the message flow for a reset invoked by the DLS provider.



* *dlpi_reset_res()* can also substitute for event pairs 3, 12 and 6, 9.

Figure 31 DLS provider-invoked connection reset for LAPB/LAPD and LLC-II

SECTION 4

HDLC/SDLC Connection-Oriented Services

The connection-mode services enable a Data Link Service (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.

Note: *For information about LAPB/LAPD and LLC-II connection-oriented services, refer to Section 3, page 63.*

Understanding Connection-Oriented Data Transfer

Why? *Connection-oriented data transfer* normally implies three phases: the connection is set up, data are transferred and the connection is torn down. A connection offers the advantage of reliable data delivery across the network in its original sequence with no missing or duplicate frames/packets and no bit-errors. It is also flow-controlled. That is, the connection itself has a flow-control mechanism at the protocol level, normally implemented using sequence numbers, acknowledgements and windows within the definition of a frame level connection.

How? For successful connection-oriented data transfer to occur over DLPI, your application must achieve the following three phases:

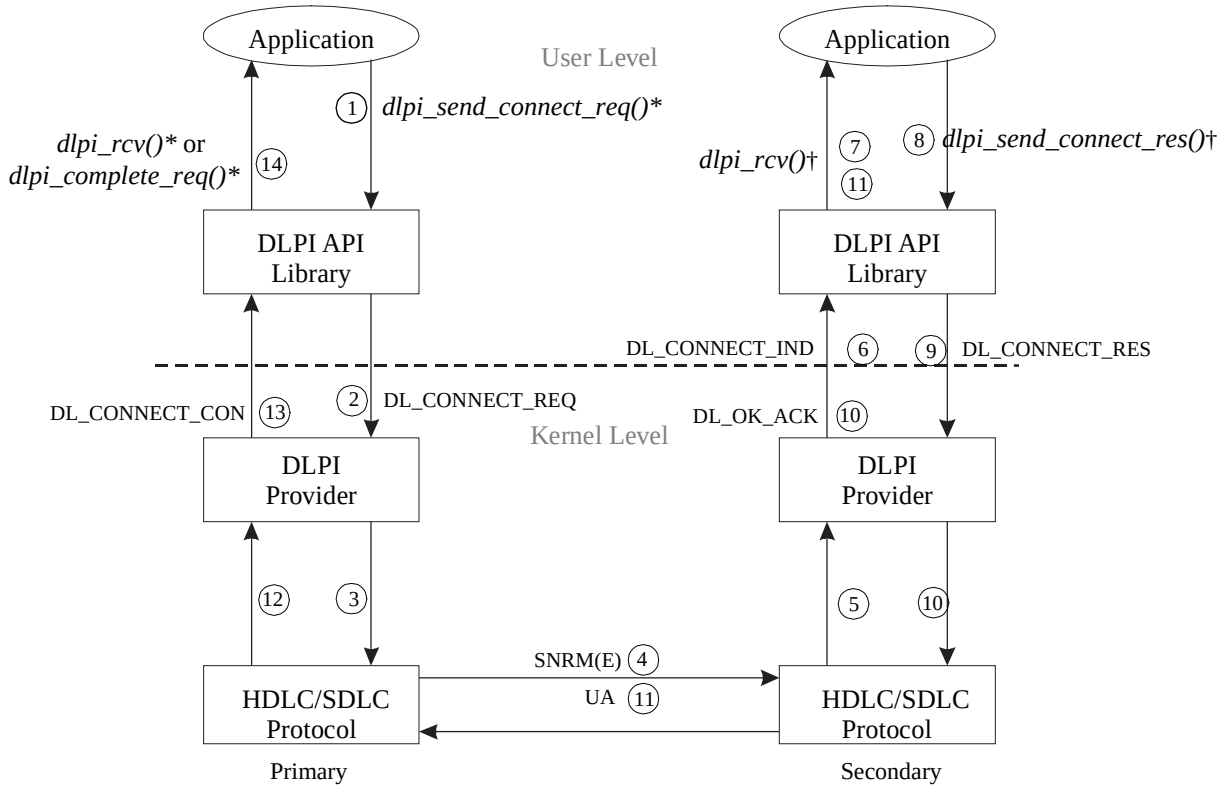
- Setup the connection
- Exchange data
- End the session

Normal Connection Establishment for HDLC/SDLC

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

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 or using DL_DISCONNECT_REQ. DL_CONNECT_CON informs the calling DLS user that a requested connection has been established.

Figure 32, below, illustrates the normal sequence of connection messages.



* *dlpi_connect()* performing open, attach and bind can substitute for events 1 and 14. *dlpi_connect_req()* can also substitute for events 1 and 14.

† *dlpi_listen()* performing open, attach and bind can substitute for events 7, 8 and 11.

Figure 32 Successful connection establishment for HDLC/SDLC

Normal Data Transfer for HDLC/SDLC

The connection-oriented data transfer service provides for the exchange of user data in either direction or in both directions simultaneously (full-duplex) between DLS users. Data are 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.

Each call to *dlpi_write_data()* in Figure 33 conveys a DLSDU from the local DLS user to the DLS provider. Similarly, each call to *dlpi_read_data()* conveys a DLSDU from the DLS provider to the remote DLS user.

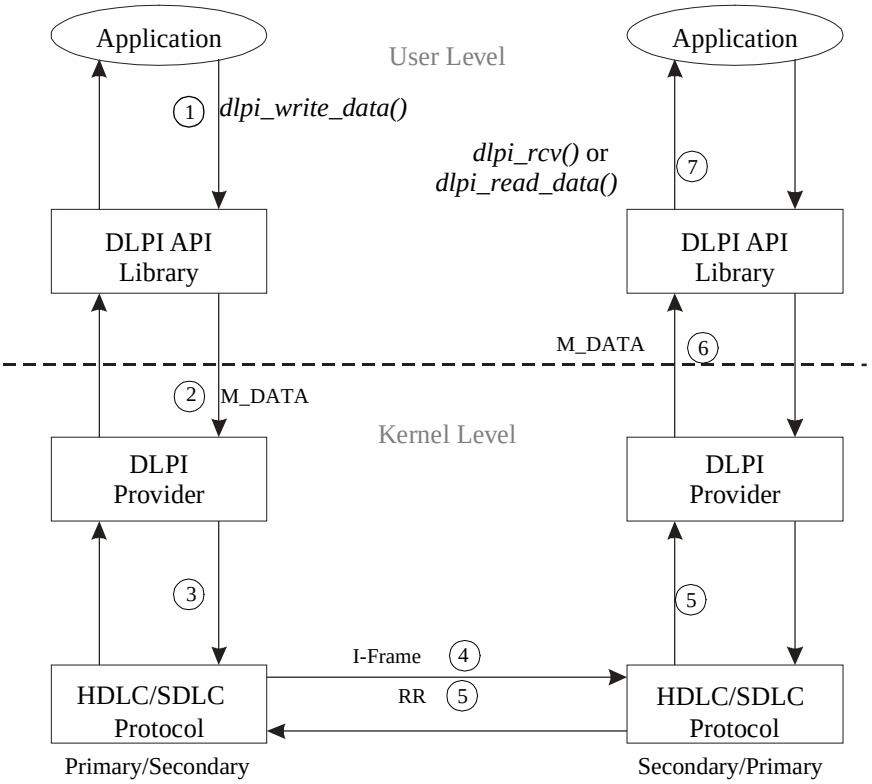


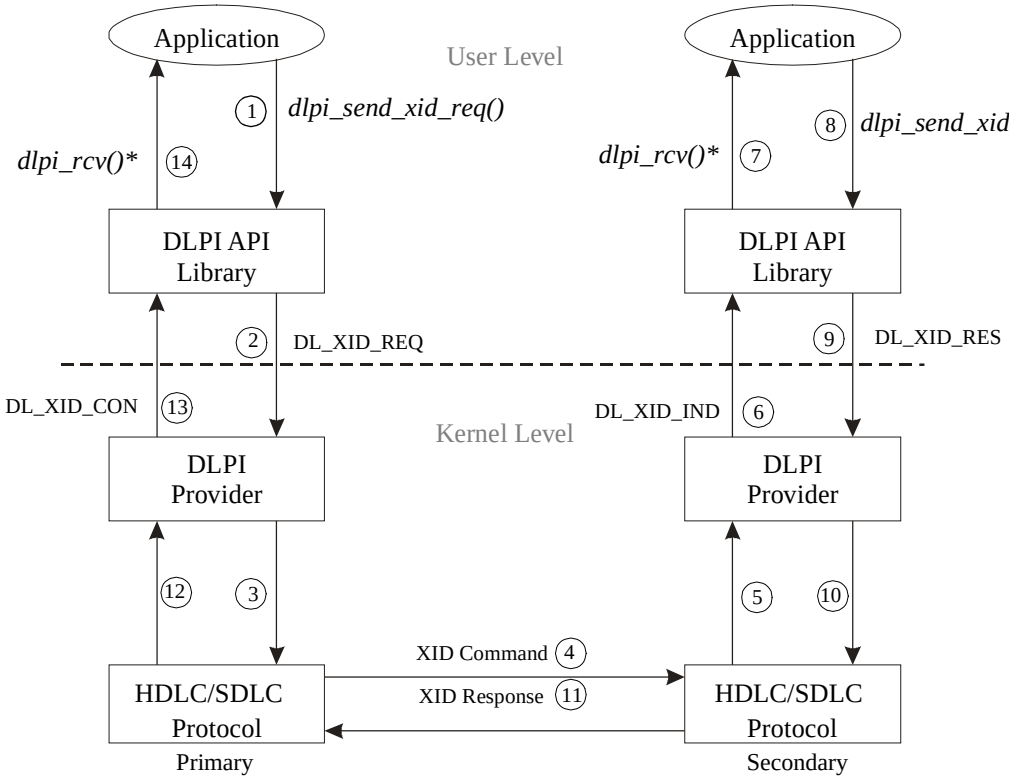
Figure 33 Normal data transfer for HDLC/SDLC

U-Frame Service for HDLC/SDLC

The GCOM DLPI API Library routines support U-frame service for XID and TEST commands and responses.

XID Service

The local DLS user requests that an XID command response be sent to the remote DLS user. The feature that allows the DLS user to request automatic handling of the XID response at bind time is not supported.

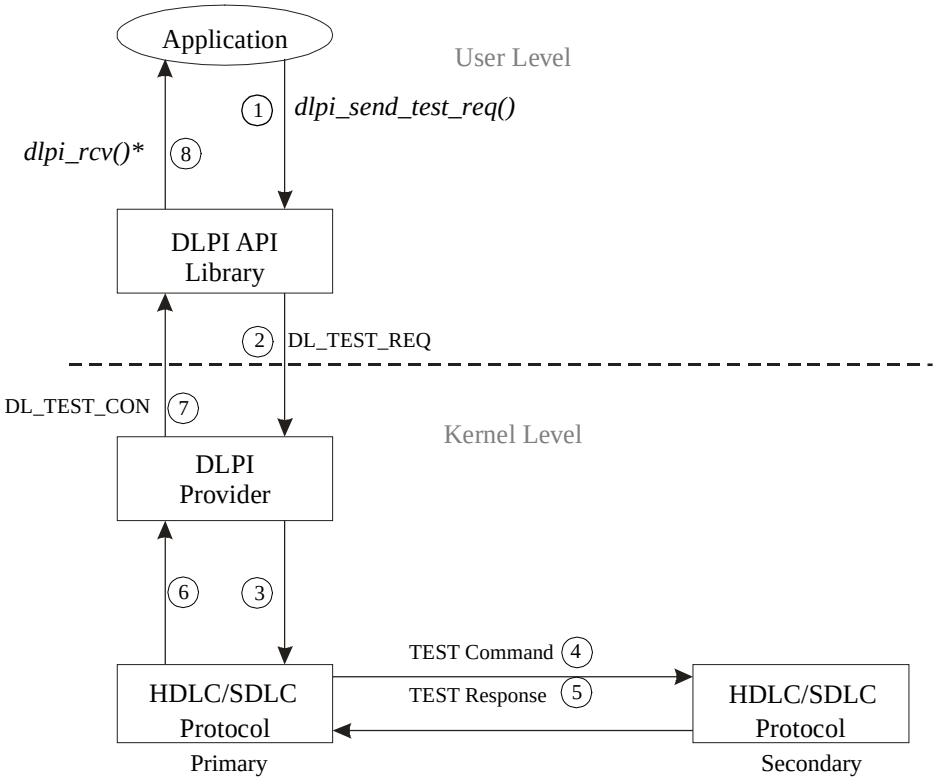


* *dlpi_read_data()* can also substitute for events 7 and 14 if you are using the unnumbered frame handler routine.

Figure 34 XID service for connection-oriented HDLC/SDLC

TEST Service

The local DLS user requests that TEST command response be sent to the remote DLS user. According to the DLPI specification, the optional feature that allows the DLS user to request automatic handling of the TEST response at bind time is handled by the DLPI Provider. GCOM's implementation makes this a required feature that is handled by the HDLC/SDLC protocols in Figure 35, below.



* *dlpi_read_data()* can also substitute for events 7 and 14 if you are using the unnumbered frame handler routine.

Figure 35 TEST service for connection-oriented HDLC/SDLC

Connection-Oriented Unnumbered Information U-Frame Service for HDLC/SDLC Primary

Data are 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. The amount of user data that can be transferred in a single DLSDU is limited.

Each call to *dlpi_send_uic()* in Figure 36, below, conveys a DLSDU from the local DLS user to the DLS provider. Similarly, each call to *dlpi_read_data()* conveys a DLSDU from the DLS provider to the remote DLS user.

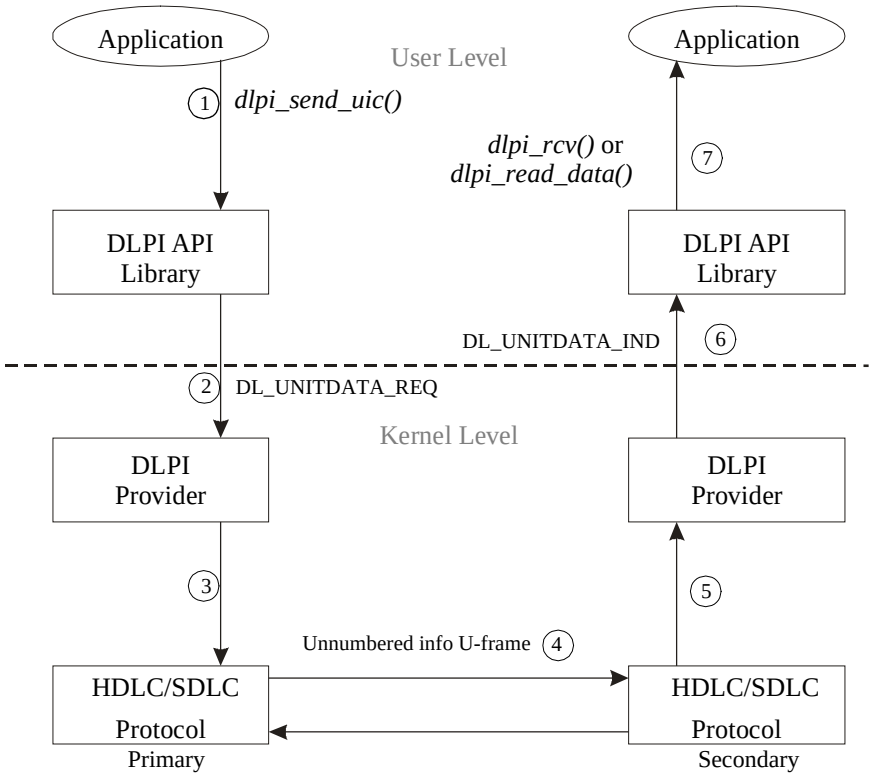


Figure 36 Unnumbered information u-frame service for connection-oriented HDLC/SDLC primary

Connection-Oriented Unnumbered Information U-Frame Service for HDLC/SDLC Secondary

Data are 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. The amount of user data that can be transferred in a single DLSDU is limited.

Each call to *dlpi_send_uic()* in Figure 37, below, conveys a DLSDU from the local DLS user to the DLS provider. Similarly, each call to *dlpi_read_data()* conveys a DLSDU from the DLS provider to the remote DLS user.

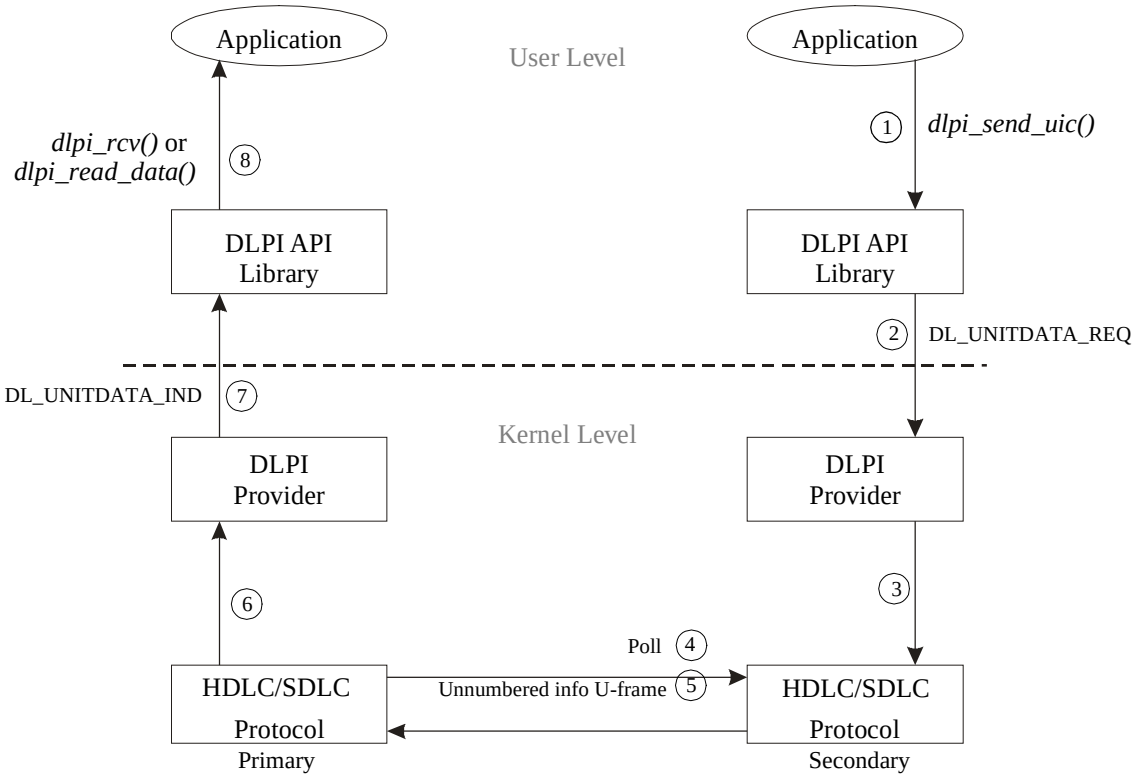


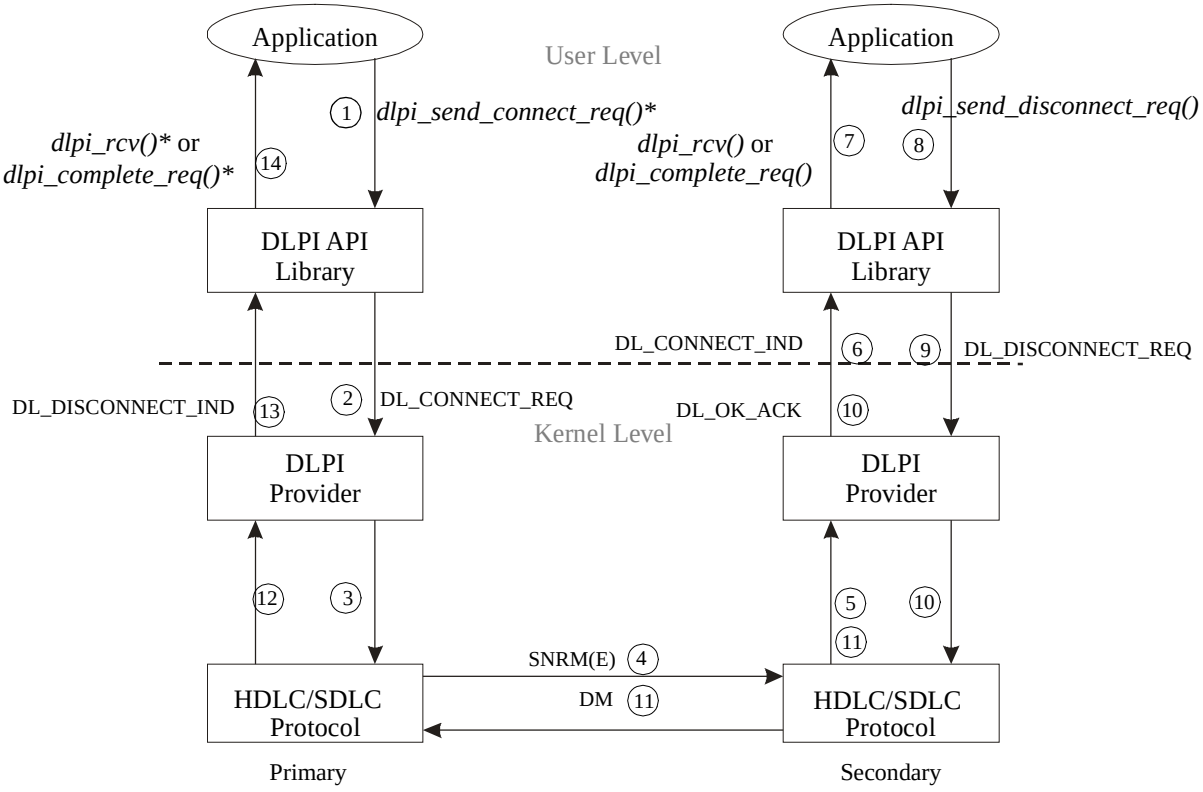
Figure 37 Unnumbered information u-frame service for connection-oriented HDLC/SDLC secondary

Connection Establishment Rejections for HDLC/SDLC

In certain situations, the connection establishment request cannot be completed. The following subsections describe instances where a DL_DISCONNECT_IND DLPI Provider primitive is flowing during the connection establishment phase. That is, a local DLS user issued a *dlpi_send_connect_req()*, *dlpi_connect()* or *dlpi_connect_req()*, but the peer rejected the connection request.

Called DLS User Connection Rejection

In Figure 38, below, the DLS user chooses to reject the connect request by issuing a DL_DISCONNECT_REQ primitive instead of a DL_CONNECT_RES.

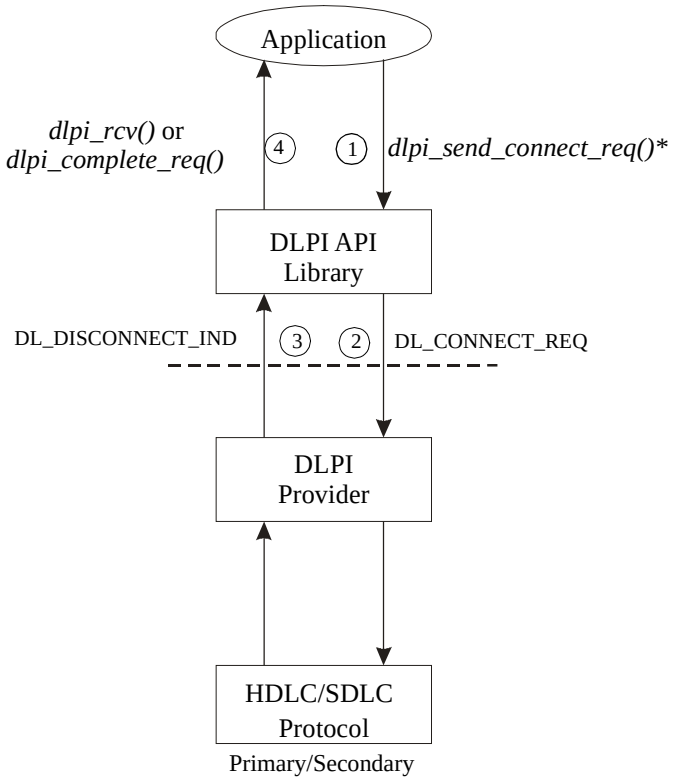


* *dlpi_connect()* performing open, attach and bind can substitute for events 1 and 14. *dlpi_connect_req()* can also substituted for events 1 and 14.

Figure 38 Called DLS user connection rejection for HDLC/SDLC

DLS Provider Connection Rejection

In Figure 39, below, the DLS provider rejects a connect request for lack of resources or other reasons. The DLS provider sends DL_DISCONNECT_IND in response to the connect request.



* *dlpi_connect()* performing open, attach and bind can substitute for event 1. *dlpi_connect_req()* can also substitute for event 1.

Figure 39 DLS provider connection rejection for HDLC/SDLC

Connection Retraction for HDLC/SDLC

The next subsections show scenarios where the calling DLS user chooses to abort a previous connection attempt. That is, the DLS user issues a disconnect request after a connect request. The resulting sequence of events depends on the relative timing of the DLPI primitives involved.

User Retracts Connection Request

Figure 40, below, shows a situation where the retraction takes place before a SNRM(E) can be sent to the remote DLS provider.

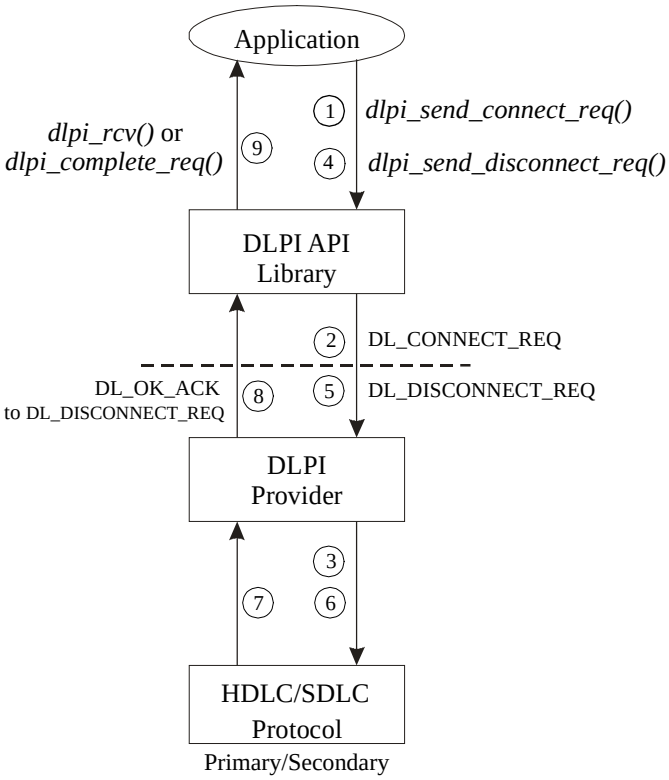


Figure 40 User retracts connection request for HDLC/SDLC

DL_DISCONNECT_IND Arrives After DL_CONNECT_RES is Sent

Figure 41 shows a scenario where the calling DLS user chooses to abort a previous connection attempt. That is, the DLS user issues a disconnect request after a connect request. The resulting sequence of events depends on the relative timing of the DLPI primitives involved. Figure 41 shows a situation where both primitives are destroyed by the provider.

Figure 41 DL_DISCONNECT_IND Arrives After DL_CONNECT_RES is Sent for HDLC/SDLC

The following network events in Figure 41 are defined as follows:

event 12 Connect sequence ends here

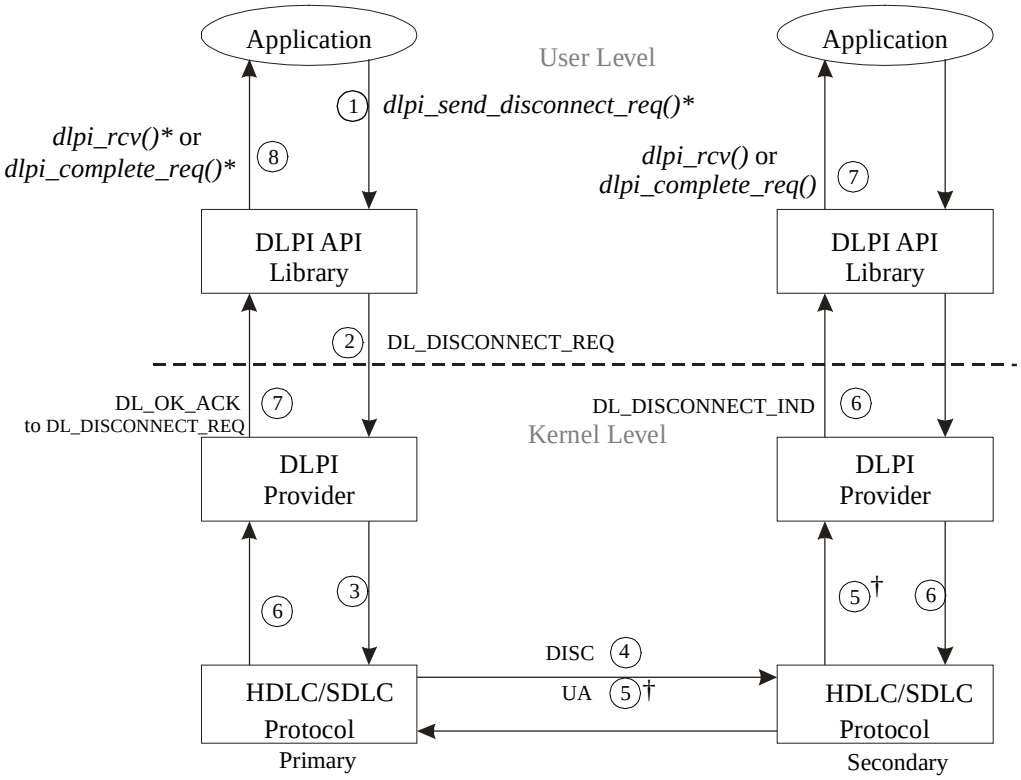
event 13 Disconnect starts here

Connection Release Services for HDLC/SDLC

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 that has not been delivered to the DLS user will be discarded.A DL_DISCONNECT_REQ primitive requests that a connection be released and DL_DISCONNECT_IND informs the DLS user that a connection has been released.

DLS User-Invoked Connection Release for HDLC/SDLC Primary

Normally, one DLS user requests disconnection and the DLS provider issues an indication of the ensuing release to the other DLS user, as shown in Figure 42, below.



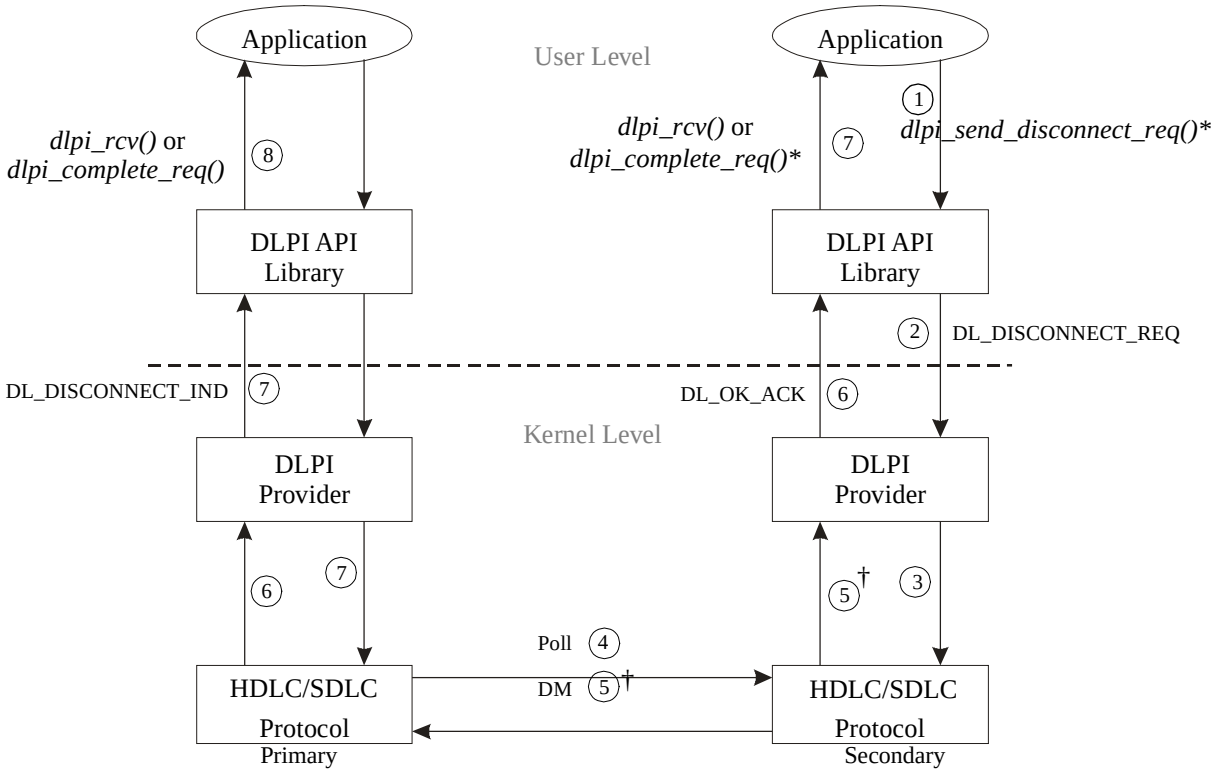
* *dlpi_disconnect_req()* can also substitute for events 1 and 8.

† The time sequence runs uncoupled starting at event 5.

Figure 42 DLS user-invoked connection release for HDLC/SDLC primary

DLS User-Invoked Connection Release for HDLC/SDLC Secondary

Normally, one DLS user requests disconnection and the DLS provider issues an indication of the ensuing release to the other DLS user, as shown in Figure 43, below.



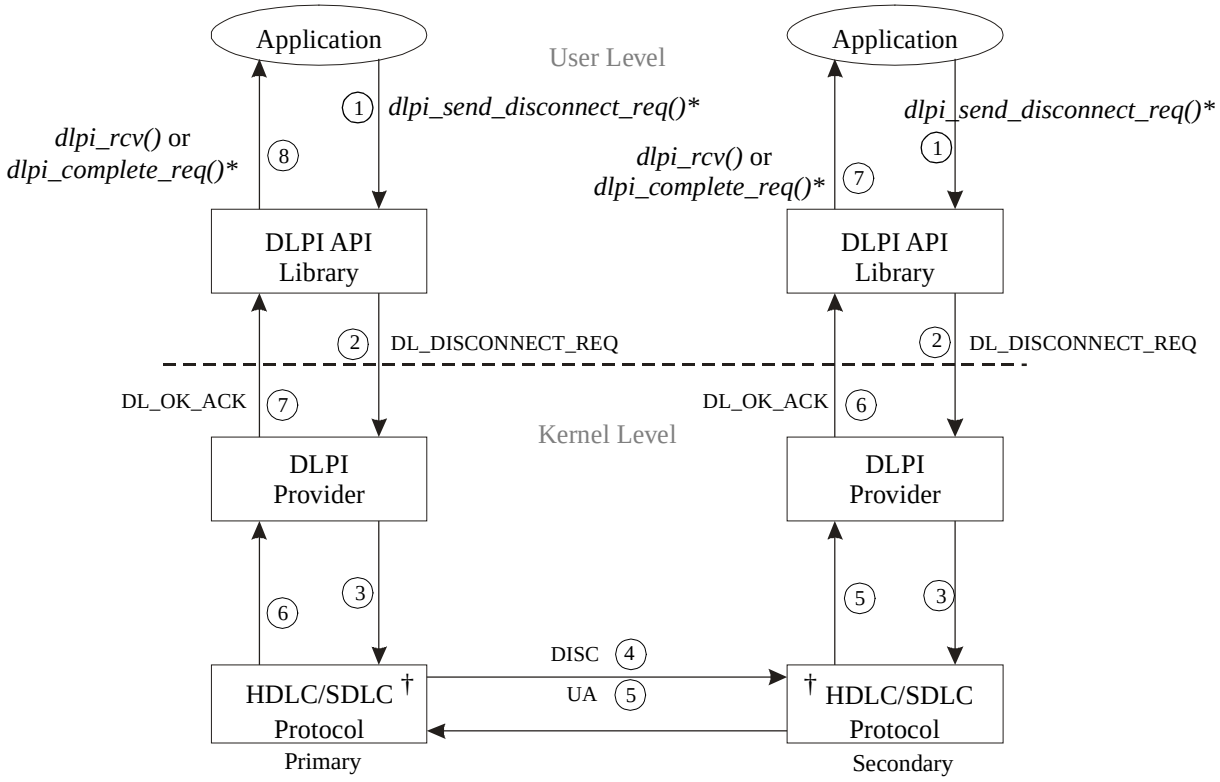
* *dlpi_disconnect_req()* can also substitute for event 1 and 7.

† The time sequence runs uncoupled starting at event 5.

Figure 43 DLS user-invoked connection release for HDLC/SDLC secondary

Simultaneous DLS User-Invoked Connection Release

Figure 44, below, illustrates that when two DLS users independently invoke the connection release service, neither one receives a DL_DISCONNECT_IND primitive.



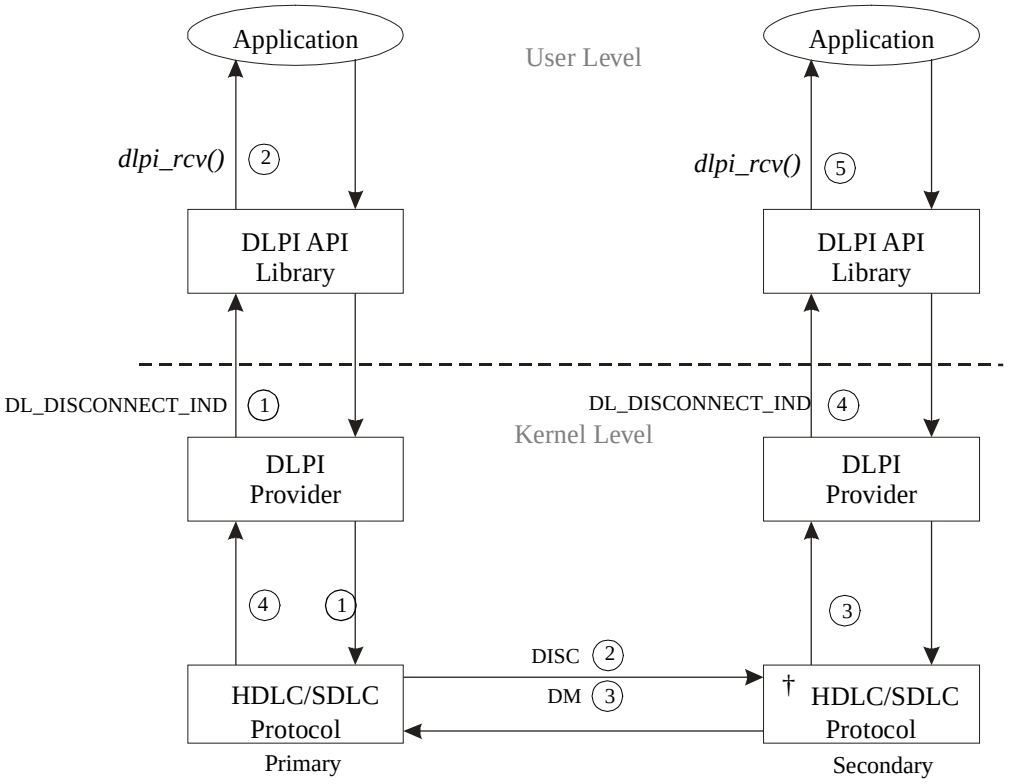
* *dlpi_disconnect_req()* can also substitute for events 1, 7 and 1, 8.

† Rendezvous. Uncoupled after this point.

Figure 44 Simultaneous DLS user-invoked connection release for HDLC/SDLC

DLS Provider-Invoked Connection Release for HDLC/SDLC Primary

Figure 45, below, illustrates that when the DLS provider initiates the connection release service, each DLS user receives a DL_DISCONNECT_IND primitive.

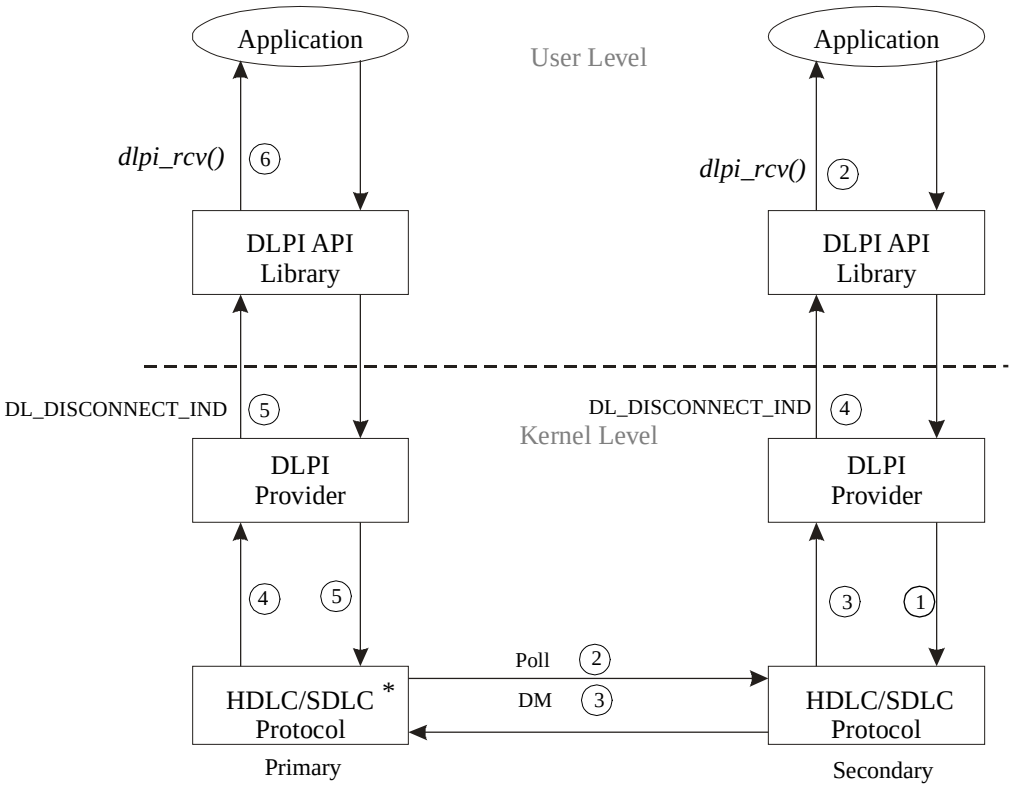


† Events are uncoupled after this point.

Figure 45 DLS provider-invoked connection release for HDLC/SDLC primary

DLS Provider-Invoked Connection Release for HDLC/SDLC Secondary

Figure 46, below, illustrates that when the DLS provider initiates the connection release service, each DLS user receives a DL_DISCONNECT_IND primitive.



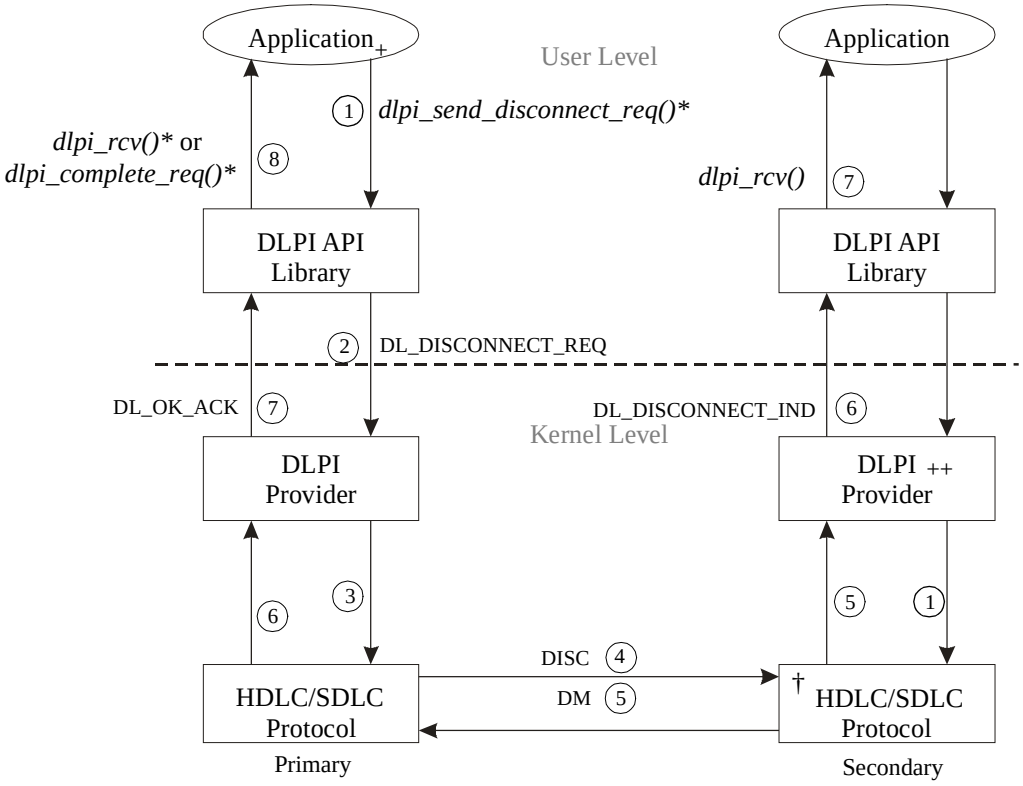
† Wait for poll.

* Events are uncoupled after this point.

Figure 46 DLS provider-invoked connection release for HDLC/SDLC secondary

Simultaneous DLS User- and DLS Provider-Invoked Connection Release for HDLC/SDLC Primary

Figure 47, below, shows that when the remote DLS provider and the local DLS user simultaneously invoke the connection release service, the remote DLS user receives a DL_DISCONNECT_IND primitive.



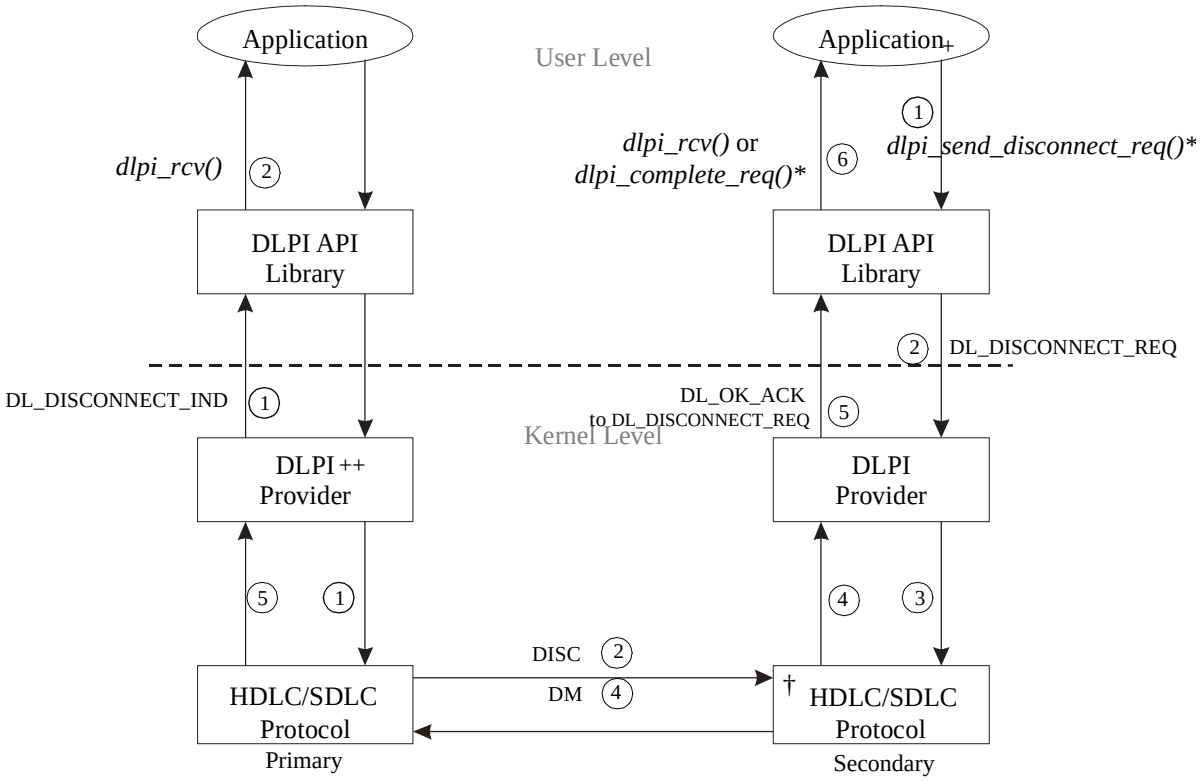
* *dlpi_disconnect_req()* can also substitute for events 1 and 8.

† Wait for Poll/DISC.

Figure 47 Simultaneous DLS User- (+) and DLS provider- (++) invoked connection release for HDLC/SDLC primary

Simultaneous DLS User- and DLS Provider-Invoked Connection Release for HDLC/SDLC Secondary

Figure 48, below, shows that when the remote DLS provider and the local DLS user simultaneously invoke the connection release service, the remote DLS user receives a DL_DISCONNECT_IND primitive.



* *dlpi_disconnect_req()* can also substitute for events 1 and 7.

† Wait for poll; disconnect received. Events are uncoupled after this point.

Figure 48 Simultaneous DLS user- (+) and DLS provider- (++) invoked connection release for HDLC/SDLC secondary

Connection Reset Service for HDLC/SDLC

The *reset service* can 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 that is unrecoverable within the data link service. The invocation of the reset service unblocks the flow of Data Link Service Data Units (DLSDUs) if the data link connection is congested. DLSDUs can be discarded by the DLS provider. The DLS 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.

Interaction between DLS user and DLS provider

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

- A reset request is invoked by the DLS user, followed by a reset confirmation from the DLS provider
- A reset indication from the DLS provider, followed by a reset response from the DLS user and an DL_OK_ACK returned to the DLS user

Primitives involved in the connection reset service

The DL_RESET_REQ acts as a synchronization mark in the streams 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 that originally issued the reset.

Resynchronizing properties of the reset service

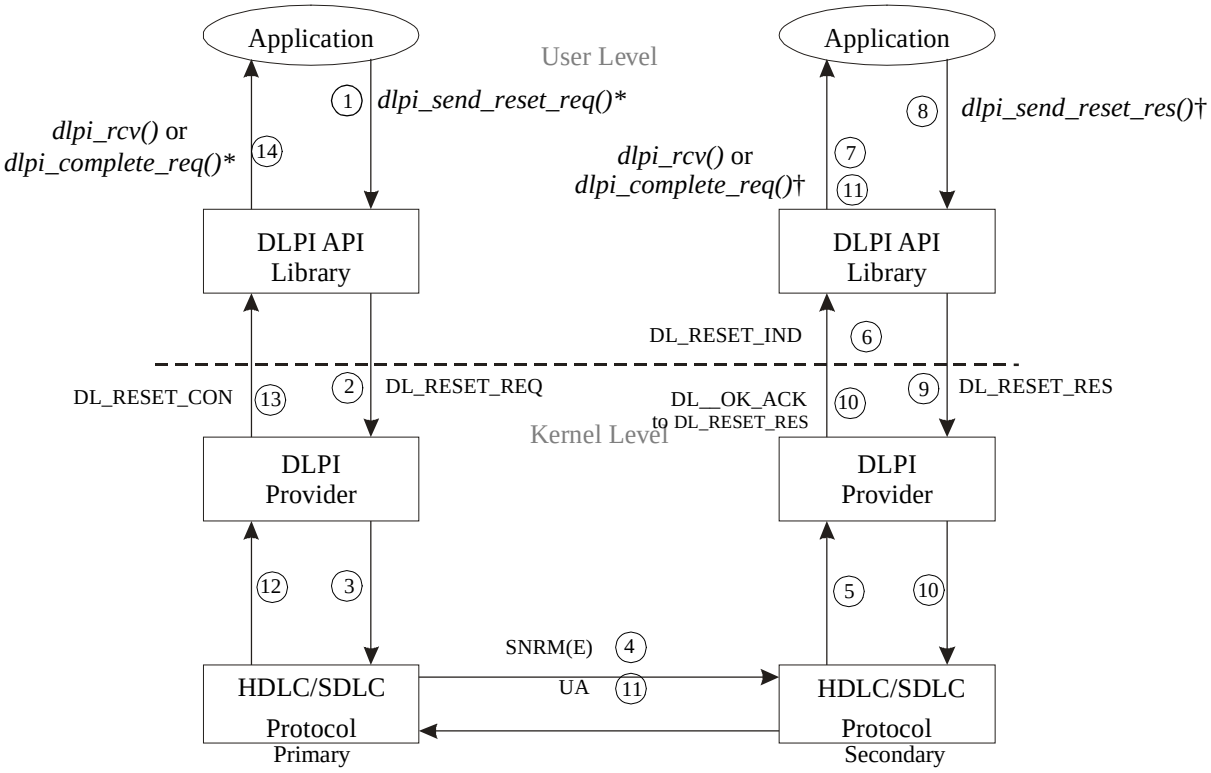
These are the resynchronizing properties of the reset service:

- 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 discards 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 the 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 upon the origin of the reset, which might be the DLS provider or either DLS user.

DLS User-Invoked Connection Reset for HDLC/SDLC Primary

Figure 49 illustrates the message flow for a reset invoked by one DLS user.



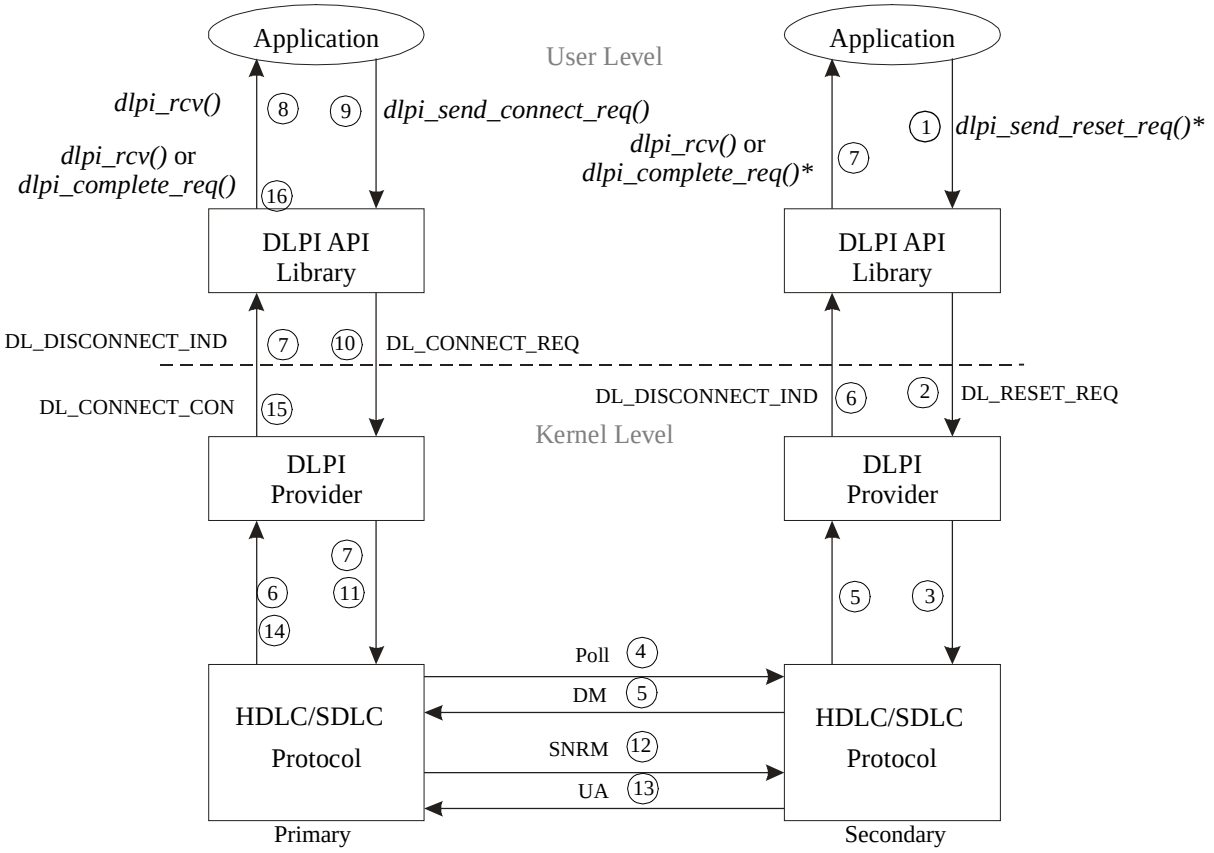
* *dlpi_reset_req()* can also substitute for events 1 and 14.

† *dlpi_reset_res()* can also substitute for events 8 and 11.

Figure 49 DLS User-Invoked Connection Reset for HDLC/SDLC Primary

DLS User-Invoked Connection Reset for HDLC/SDLC Secondary

Figure 50 illustrates the message flow for a reset invoked by one DLS user. The HDLC/SDLC protocol does not support a secondary initiating a reset sequence. A DLPI provider reset request results in the SDLC connection being terminated. Figure 50 shows the primary side application responding to the disconnect indication with a connect request. The resulting connection setup is not shown for the secondary.



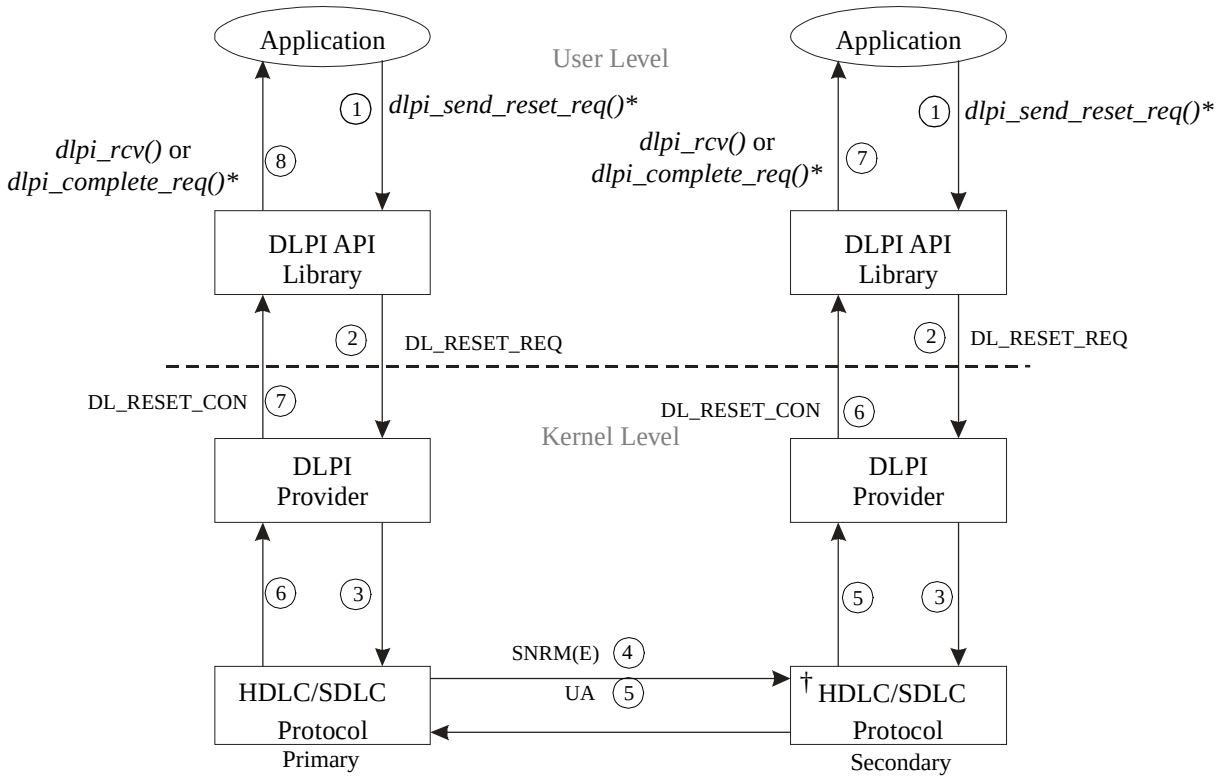
* *dlpi_reset_req()* can also substitute for events 1 and 15.

Figure 50 DLS User-Invoked Connection Reset for HDLC/SDLC Secondary

Simultaneous DLS User-Invoked Connection Reset

SECTION

Figure 51 illustrates the message flow for a reset invoked by both DLS users simultaneously.



* *dlpi_reset_req()* can also substitute for events 1, 7 and 1, 8.

† Here, the SNRM(E) arrives at the secondary before the DL_RESET_REQ (event 3).

Figure 51 Simultaneous DLS User-Invoked Connection Reset for HDLC/SDLC

Understanding the Sample Application

Figure 51 Sample DLPI API Program

```
1  #include <stdio.h>
2  #include "dlpiapi.h"
3  char            buf[1000] ;
4  int             fil ;
5  int             n ;
6  int             frms ;
7
8  main()
9  {
10      dlpi_init(DLPI_LOG_DEFAULT
11                  | DLPI_LOG_RX_PROTOS | DLPI_LOG_TX_PROTOS
12              ,DLPI_LOG_NAME
13              ) ;
14      fil = dlpi_listen(0L, 0x01L, 0x00L, 0x00L, DLPI_LISTEN_NO_FORK);
15      if (fil < 0) exit(1) ;
16      while ((n = dlpi_read_data(fil, buf, sizeof(buf))) >= 0)
17      {
18          frms++ ;
19          if (dlpi_write_data(fil, buf, n) < 0) exit(1) ;
20      }
21      dlpi_printf("End of test: frames received = %d\n", frms) ;
22      exit(0) ;
23  }
```

The test program in Figure 51 illustrates the use of the DLPI API library. The program, called *Gcom_lstn*, is a simple passive loopback program. It listens for any incoming connections, forks off a copy of itself to handle the incoming connection and loops any received data back to the sender.

Refer to Appendix A starting on page 125 for a list of programs you can call from the DLPI API Library.

The sample program on the opposite page contains the following features:

Line 2 The program includes the **dlpiapi.h** file.

Lines 10–13 The program initializes the DLPI API library. The first parameter to the *dlpi_init()* function specifies logging options to be used by the library. The set of options on line 11 make the logging verbose and unsuitable for production code. The second parameter to *dlpi_init()* is the name of the log file that the library is to use. The default name is **/usr/spool/gcom/dlpi.log**.

Line 14 The program calls the *dlpi_listen()* function to wait for incoming calls. The *dlpi_listen()* function returns the file descriptor of a stream which has an open connection associated with it. The first parameter is zero, which indicates that the stream is to be attached to the default physical line. The second parameter is the bind DLSAP that is to be used for the stream. The third and fourth parameters are the local and remote addresses to configure for the stream. A zero value equals the default setting.

The fifth parameter is an option that specifies that the *dlpi_listen()* function should not fork a new copy of itself to process the incoming connection. Thus, when *dlpi_listen()* returns it will be on the same process as the original caller of *dlpi_listen()*.

Figure 51 Sample DLPI API Program *(repeated)*

```
1  #include <stdio.h>
2  #include "dlpiapi.h"
3  char            buf[1000] ;
4  int             fil ;
5  int             n ;
6  int             frms ;
7
8  main()
9  {
10      dlpi_init(DLPI_LOG_DEFAULT
11                  | DLPI_LOG_RX_PROTOS | DLPI_LOG_TX_PROTOS
12              ,DLPI_LOG_NAME
13              ) ;
14      fil = dlpi_listen(0L, 0x01L, 0x00L, 0x00L, DLPI_LISTEN_NO_FORK);
15      if (fil < 0) exit(1) ;
16      while ((n = dlpi_read_data(fil, buf, sizeof(buf))) >= 0)
17      {
18          frms++ ;
19          if (dlpi_write_data(fil, buf, n) < 0) exit(1) ;
20      }
21      dlpi_printf("End of test: frames received = %d\n", frms) ;
22      exit(0) ;
23  }
```

Line 16 The program calls the *dlpi_read_data()* function to read a single data message from the stream. The function will return a negative number if a protocol message arrives or if the stream encounters an error.

Note: *The parameters for* dlpi_read_data() *are the same as for the standard C library read routine.*

Line 19 The program writes back any received data to the stream in loopback fashion.

Note: *The parameters for* dlpi_write_data() *are the same as for the standard C library write routine.*

Line 21 The program uses the *dlpi_printf()* routine to write a message into the log file. This routine has the same calling sequence as the C library *printf()* routine.

Understanding the DLPI API Header File

The **dlpiapi.h** file contains defines, global variables and prototypes that can be used by the application program to communicate with the GCOM DLPI streams driver.

Including the dlpiapi.h Header File in Your Application

Prototypes for the API procedures and callbacks, as well as various useful macros and definitions of symbolic constants, are contained in the **dlpiapi.h** header file. This header files should be *#included* in application source files containing code that interacts with the API.

Linking DLPI Header Files

To link the header files with a program, issue the UNIX *cc* command using the following format:

cc -o *program_name program_name*.c **/usr/lib/gcom/dlpiapi.a**

Example The following command links header files for the *foo()* program:

```
> cc -o foo foo.c /usr/lib/gcom/dlpiapi.a
```

DLPI API Constants

The following constants parameterize the internal behavior of the DLPI API library. These constants were used when the library was compiled. Changing these in your application will not have the desired effect on the GCOM DLPI API Library.

DLPI_CTL_BUF_SIZE The size of the character array *dlpi_ctl_buf* compiled into the DLPI API library. This array is available for use by the application (see below). Its size is larger than the largest possible streams message buffer. At this writing, it is set to 5,000.

DLPI_DATA_BUF_SIZE The size of the character array *dlpi_data_buf* compiled into the DLPI API library. This array is available for use by the application (see below). Its size is larger than the largest possible streams message buffer. At this writing, it is set to 5,000.

DLPI_DEFAULT_PPA This is the default PPA used for the attach phase. At this writing, this is an unsigned long type with a value of ~0.

DLPI_LOG_NAME The default name of the log file into which the DLPI API library writes messages. At this writing, this is set to **/usr/spool/gcom/dlpi.log**.

DLPI_N_CONINDS Number of incoming connection indications that can be queued on a listener stream. This constant is passed to DLPI in a DL_BIND_REQ for a listener stream. Since the DLPI driver does not support connection manager streams, the maximum useful value is 1. The default value is set to 1.

DLPI API Library Routine Error Return Defines

When a DLPI API routine is called, a negative return value indicates an error. Many of those routines use the following return values when an error occurs:

DLPIAPI_UNSUPPORTED_MSG
: A DLPI API Library routine received an inappropriate message from the data stream. For example, *dlpi_read_data()* does not process reset messages.

DLPIAPI_NO_NOTHING
: This is a hang-up notification. The UNIX *getmsg* system call succeeded but did not return control or normal data.

DLPIAPI_STYLE_UNKNOWN
: Provider style unknown. This error should not occur.

DLPIAPI_PARAM_ERROR
: Invalid parameter error. The buffer pointer and output pointer must be non-NULL and the buffer length must be a positive integer.

DLPIAPI_NOT_INIT
: *dlpi_init()* has not been called.

DLPIAPI_OPEN_ERROR
: Data stream open error.

DLPIAPI_REJECT
: Either *dlpi_complete_req()* was rejected with a DL_ERROR_ACK or *dlpi_connect_req()* was rejected with a DL_DISCONNECT_IND.

DLPIAPI_UNUSABLE
: A UNIX streams *getmsg* or *putmsg* system call failed. One possible error recovery action is to close the stream and start over.

DLPIAPI_EINTR
: A UNIX system call interrupted; retry not provided.

DLPIAPI_EAGAIN
: Non-blocking I/O is set on the stream and no DLPI messages are available to process.

DLPI API Logging Options

The DLPI API logging options control the kinds of messages that are written into the DLPI API log file. These options represent individual bits of a mask. They are ordered together to form the set of options passed to *dlpi_init()*.

DLPI_LOG_FILE	Write messages to the log file.
DLPI_LOG_STDERR	Write messages to *stderr*.
DLPI_LOG_RX_PROTOS	Log all received protocol messages (M_PROTOS) in ASCII decoded form.
DLPI_LOG_TX_PROTOS	Log all transmitted protocol messages (M_PROTOS) in ASCII decoded form.
DLPI_LOG_ERRORS	Log all UNIX error messages in a manner similar to *perror*.
DLPI_LOG_SIGNALS	Log signal handling.
DLPI_LOG_DISCONNECTS	Log disconnect indications.
DLPI_LOG_RESETS	Log reset indications.
DLPI_LOG_DEFAULT	The default settings of logging options, consisting of DLPI_LOG_FILE, DLPI_LOG_STDERR, DLPI_LOG_ERRORS, DLPI_LOG_DISCONNECTS and DLPI_LOG_RESETS.

Signal Handling Prototype

This is the typedef for the user-supplied function passed to *dlpi_set_signal_handling():*

```
#ifdef PROTOTYPE
typedef int (*dlpi_sig_func_t) (int fid,
                                char *ctl_ptr,  int ctl_length,
                                char *data_ptr, int data_length);
#else
typedef int (*dlpi_sig_func_t) ();
#endif
```

When called, the value returned from the user-supplied function is currently ignored by the API. Returning zero is recommended.

Global Variables Accessible By Your Application

The DLPI API package makes a certain set of its global variables available to the user. The variables and their intended uses are defined in the following subsections.

dlpi_bind_ack

Prototype `unsigned char dlpi_bind_ack[] ;`

This array contains a copy of the DL_BIND_ACK received by the DLPI API routines. You may examine it for whatever information you may find useful.

dlpi_conn_con

Prototype `unsigned char dlpi_conn_con[] ;`

This array contains a copy of the DL_CONNECT_CON (connect confirm) received by the DLPI API library in response to a DL_CONNECT_REQ sent by the library (active connection).

dlpi_conn_ind

Prototype `unsigned char dlpi_conn_ind[] ;`

This array contains a copy of the DL_CONNECT_IND received by the DLPI API routines. When forking child processes, each child will have its own copy of this protocol message.

dlpi_ctl_buf

Prototype `unsigned char dlpi_ctl_buf[DLPI_CTL_BUF_SIZE] ;`

This array is used by the DLPI API driver to receive the M_PROTO portion of messages from the DLPI driver. It will contain the most recent M_PROTO received by the DLPI API library. A call to *dlpi_read_data()* will overwrite this area with an invalid value; upon return, if the *PRIM_type* field does not contain all ones, then an M_PROTO was received while reading data.

dlpi_ctl_cnt

Prototype `int dlpi_ctl_cnt ;`

This variable contains the length of the M_PROTO portion of the last message received from the DLPI driver. If the last received message is a data-type message, then this count will be negative. A call to *dlpi_read_data()* may fail because of a received prototype message. In such a case, the count in *dlpi_ctl_cnt* will be positive and the protocol message will reside in the array *dlpi_ctl_buf*.

dlpi_data_buf

Prototype `unsigned char dlpi_data_buf[DLPI_DATA_BUF_SIZE] ;`

This array may be used by the application program as a place to build data messages to send on a connection or as a place into which to receive data messages. It is an array that is made available for use to the application program.

dlpi_data_cnt

Prototype `int dlpi_data_cnt ;`

This variable contains the count of the number of bytes contained in the most recently sent or received data message from the DLPI driver.

dlpi_service_mode

Prototype `int dlpi_service_mode ;`

This variable can be set to the logical “or” of any of the following values from <sys/dlpi.h>:DL_CODLS (connection oriented service), DL_CLDLS (connection-less service), DL_ACLDLS (acknowledged connection-less service). The default value is DL_CODLS. DL_CODLS is appropriate for reliable link layer protocols such as HDLC, LAPB, LLC AND LAPD. DL_CLDLS is appropriate for non-reliable protocols such as frame relay. The value DL_ACLDLS is not supported by the GCOM DLPI provider.

The value of the dlpi_service_mode variable is used by the API routine dlpi_bind_dlsap in sending a DL_BIND_REQ to the DLPI provider.

DLPI API Fork Options

At this writing, the fork options for the DLPI API are reserved for future use. DLPI_LISTED_NO_FORK is the only valid option. This option returns without forking after accepting an incoming connection.

APPENDIX A

DLPI API Library Routines Reference

This section of the manual documents the routines that are provided in the **dlpiapi.a** library. Refer to Architecture of the Data Link Layer, page 26, for the sample DLPI API application.

dlpi_attach_ppa()

Prototype
```
int dlpi_attach_ppa(int           dlpi_data,
                    unsigned long ppa) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine attaches the stream to a Physical Point of Attachment (PPA). A PPA can be expressed as a UNIX multiplexor ID or a driver Lower Point of Attachment (LPA). This routine can be used for both connectionless and connection-oriented data transfer mode.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
ppa	If this is negative, it is an LPA. Otherwise, it is a streams multiplexor ID.

Return

< 0	The attach failed.
> 0	The attach succeeded.

dlpi_bind_dlsap()

Prototype

```
int dlpi_bind_dlsap(int           dlpi_data,
                    unsigned long dlsap,
                    int           conind_nr) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine issues a DL_BIND_REQ to DLPI and waits for a DL_BIND_ACK response. The bind acknowledgment is copied to the global array *dlpi_bind_ack* so that it can be viewed directly by the application program.

Parameters

dlpi_data	stream over which to send the DL_BIND_REQ.
dlsap	DLSAP address to be bound to the stream.
conind_nr	Number of connection indications that can be queued for this stream. If this number is non-zero, then the stream becomes a listener stream. That is, it becomes eligible as a target of in incoming connection. If this number is zero then this stream cannot be the target for an incoming connection but is to be used for an outgoing connection.

Return

< 0	An error occurred.
> 0	Size of DL_BIND_ACK if success.

dlpi_clear_zombies()

Prototype `void dlpi_clear_zombies(void) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine can be used by a parent process to “clean up” after its children. Under most Unix-like operating systems, when a parent process forks a child and the child exits, the operating system retains status information for the child. Until the parent process retrieves this status information, the child process is maintained in an expired state called a “zombie” state. This routine provides a convenient way to clean up zombie processes when the status information will not be checked.

dlpi_close()

Prototype `int dlpi_close(int fd)`

Include Files <**gcom/dlpiapi.h**>

Description Closes the file that was opened by *dlpi_open()*. This routine should be used to close the file rather than calling the system "close" routine directly. The *dlpi_close* routine takes into account the possibility that the file may be opened to a remote server via the Remote API.

Return

0	Success
-1	Failure. Upon failure, "errno" is set to indicate the reason for failure

dlpi_complete_req()

Prototype

```
int dlpi_complete_req (int   dlpi_data,
                       int   request,
                       char *caller,
                       int   discard_un_iframes) ;
```

Include File(s) **<gcom/dlpiapi.h>**, **<gcom/dlpi.h>**, **<gcom/dlpi_ext.h>**

Description This routine is used to wait for an acknowledge to the specified DLPI primitive and report whether or not it was accepted by the driver. This procedure processes all incoming messages while waiting for the request to complete. The **dlpi.h** and **dlpi_ext.h** files are required so that the request defines will be properly translated into the numerical request designation.

Parameters

dlpi_data	stream over which to send the DL_BIND_REQ.
request	One of the following DLPI primitives: • DL_ATTACH_REQ • DL_DETACH_REQ • DL_BIND_REQ • DL_UNBIND_REQ • DL_CONNECT_REQ • DL_CONNECT_RES • DL_RESET_REQ • DL_RESET_RES • DL_INFO_REQ • DL_DISCONNECT_REQ
**caller*	Used in generating error messages.
discard_un_iframes	If this flag is set, U-frames received while waiting for the request to complete are discarded. Otherwise, if your application set up a U-frame handler routine, the frame is delivered to your application using that routine.

Return	< 0	The *dlpi_complete_req()* routine returns interrupt system calls (EINTR). See for a complete list of the possible error return values.
	== 0	The request completed, but the stream is disconnected. This happens, for example, when a DL_CONNECT_REQ is rejected with a DL_DISCONNECT_IND.
	> 0	DLPI primitive accepted by the DLPI provider.

dlpi_configure_dlsaps()

Prototype

```
int dlpi_configure_dlsaps(int           dlpi_data,
                          unsigned long local_dlsap,
                          unsigned long remote_dlsap) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine configures the stream for the DLSAPs passed in as parameters. When a DLPI data stream is in the DL_IDLE state (bound but not connected), the protocol's local and remote addresses can be set. An address of 0L for both *local_dlsap* and *remote_dlsap* implies that no action is to be taken.

Once bound, the *local_dlsap* and *remote_dlsap* values are used to configure the addresses of the station. If the local and remote DLSAPs are zero, then the configured defaults for the station will be used. For an NRM primary or secondary, only one of the local or remote DLSAPs need be non-zero since these modes of operation require only one address. For ABM, both addresses must be supplied (or neither if using defaults).

Parameters

dlpi_data	stream to be configured
local_dlsap	The DLSAP of the local system secondary address
remote_dlsap	The DLSAP of the remote system primary address

Return

< 0	Failure
> 0	Configuration succeeded

dlpi_connect()

Prototype

```
Old: int dlpi_connect(unsigned long ppa,
                      unsigned long bind_dlsap,
                      unsigned long local_dlsap,
                      unsigned long remote_dlsap) ;

New: int dlpi_connect_host (char *hostname,
                      unsigned long ppa,
                      unsigned long bind_dlsap,
                      unsigned long local_dlsap,
                      unsigned long remote_dlsap) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description

This routine opens a DLPI stream, binds it using the *bind_sap* and then uses *dlpi_connect_req()* to issue a DL_CONNECT_REQ to DLPI and wait for a DL_CONNECT_CON response. The connect confirm response is copied to the global array *dlpi_conn_con* so that it can be viewed directly by the application program.

The routine *dlpi_connect()* is equivalent to *dlpi_connect_host()*.

The *ppa* parameter specifies either the multiplexor ID or the Lower Point of Attachment (LPA) over which the connection is to be issued. If the number is negative, then the absolute value is assumed to be the LPA. Otherwise, it is assumed to be the multiplexor ID of the lower stream of the DLPI multiplexor. If the value `0`L is passed, the default of `-1`L (line 1) is substituted.

The *bind_dlsap* is used to bind the stream to a station. Once bound, the *local_dlsap* and *remote_dlsap* values are used to configure the addresses of the station. If the local and remote DLSAPs are zero, then the configured defaults for the station will be used. For an NRM primary or secondary, only one of the local or remote DLSAPs need be non-zero since these modes of operation require only one address. For ABM both addresses must be supplied (or neither for using defaults).

For DLPI driver style 1, the DL_ATTACH_REQ is not sent to DLPI.

Parameters

ppa	The multiplexor ID or LPA to which to attach the stream
bind_dlsap	The DLSAP to use in the DL_BIND_REQ
local_dlsap	The DLSAP to use as the local address
remote_dlsap	The DLSAP of the remote system

Note: *All of these parameters are of type long.*

Return	< 0	An error occurred (message written to log file)
	>= 0	File descriptor of an DLPI stream which can be used to send data

dlpi_connect_req()

Prototype

```
int dlpi_connect_req(int  dlpi_data,
                     unsigned long peer_sap) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine issues a DL_CONNECT_REQ to DLPI and waits for a DL_CONNECT_CON response. Your application must have previously attached and bound the stream.

The connect confirm response is copied to the global array *dlpi_conn_con* so that it can be viewed directly by the application program.

Parameters

dlpi_data	stream over which to send the DL_CONDL_REQ
peer_sap	Address of the peer to which you wish to be connected

Return

< 0	An error occurred (message written to log file)
> 0	Size of DL_CONNECT_CON if success.

dlpi_connect_wait()

Prototype `int dlpi_connect_wait(int data);`

Include File(s) **<gcom/dlpiapi.h>**

Description The *dlpi_connect_wait()* routine provides a direct way to “listen” for incoming connections on a data stream which has already been opened, attached, and bound.

Parameters

data	The file descriptor for the data stream on which connections should be received.

Return Values

>0	File descriptor of the connected stream.
<0	An error occurred (message written to log file).

dlpi_decode_ctl()

Prototype `void dlpi_decode_ctl(char *p) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine decodes the DLPI protocol message located in the global *dlpi_ctl_buf* and writes it to the log file. The log message starts with *prefix*, which is typically the name of the procedure making the call. This routine is used mostly internally to log errors and message traffic.

Parameters *prefix* A character string to be prepended to the log messages.

dlpi_decode_disconnect_reason()

Prototype

```
char *dlpi_decode_disconnect_reason (int    dlpi_data,
                                     dl_uns32  pf,
                                     char      *datap,
                                     int       length);
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine returns a pointer to a string describing the reason code reason.

Parameters

reason The disconnect reason code to decode.

dlpi_detach_ppa()

Prototype `int dlpi_detach_ppa ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_DETACH_REQ primitive to the DLPI provider and waits for a DL_OK_ACK response.

Parameters

	dlpi_data	This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file. Typically, your application previously used DLPI API procedures to attach a PPA, bind a DLSAP and listen for or initiate a connection. However, these steps are not required.
Return	< 0	See for a complete list of the possible error return values.
	>= 0	The stream is now detached.

dlpi_discon_req()

Prototype
```
int dlpi_discon_req(int  dlpi_data,
                    int  reason) ;
```

Include File(s) **<gcom/dlpiapi.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description This routine is a deprecated form of *dlpi_disconnect_req()*. See dlpi_disconnect_req() on page 142 for additional details.

Parameters

dlpi_data	The streams file identifier. This is the file descriptor returned by a call to *dlpi_open()*.
reason	The disconnect reason code.

Return

< 0	See for a complete list of the possible error return values.
>= 0	The stream is now detached.

dlpi_disconnect_req()

Prototype

```
int dlpi_disconnect_req (int dlpi_data,
                         int reason) ;
```

Include File(s) **<gcom/dlpiapi.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description This routine sends a disconnect request primitive (DL_DISCONNECT_REQ) to DLPI and waits for a DL_OK_ACK response. Any XIDs, TESTs, unnumbered information U-frames and data messages are discarded while disconnecting.

Parameters

dlpi_data This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file. Typically, your application previously used DLPI API procedures to attach a PPA, bind a DLSAP and listen for or initiate a connection. However, these steps are not required.

reason The code to go into the *dl_reason* field of the DL_DISCONNECT_REQ. Valid codes include the following:

DL_DISC_NORMAL_CONDITION. Normal release of a data link connection.

DL_DISC_ABNORMAL_CONDITION. Abnormal release of a data link connection.

DL_DISC_PERMANENT_CONDITION. A permanent condition caused the rejection of a connect request.

DL_DISC_TRANSIENT_CONDITION. A transient (momentary) condition caused the rejection of a connect request.

DL_DISC_UNSPECIFIED. Reason unspecified.

Return

< 0 A failure to read/write on the stream occurred. See for a complete list of the possible error return values.

>= 0 Disconnect successful.

dlpi_get_a_msg()

Prototype

```
int dlpi_get_a_msg(int   dlpi_data,
                   char *buf,
                   int   cnt) ;
```

Include File(s) **<gcom/dlpiapi.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description This routine issues a *getmsg* system call on the indicated stream. The M_PROTO portion of the received message is read into the global array *dlpi_ctl_buf* and *dlpi_ctl_cnt* gives its length, negative if no M_PROTO portion received. The data portion is read into your buffer. The number of data bytes read is contained in the global *dlpi_data_cnt* upon return from the routine, negative if no data portion was read.

If the received data does not fit in your application's buffer, the UNIX *getmsg()* MOREDATA bit is returned. If the received control (M_PROTO) does not fit in the API's global *dlpi_ctl_buf,* MORECTL is returned. However, the MORECTL should not actually occur, because the API *dlpi_ctl_buf* is large. See the UNIX manual page concerning *getmsg* for further information.

Parameters

dlpi_data	The stream from which to get a message.
buf	The buffer into which to receive the data portion of the message.
cnt	The maximum amount of data to receive.

Return

< 0	An error occurred (message optionally written to log file). See for a complete list of the possible error return values.
== 0	Success.
> 0	MOREDATA and/or MORECTL bit set as described previously.

dlpi_get_both()

Prototype:
```
int dlpi_get_both(int strm,
                  char **ctrl_ptr,
                  char **data_ptr);
```

Include Files: **<gcom/dlpiapi.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description: Much like the *dlpi_get_a_msg(strm, data_buf, data_buf_size)* with a different interface. Call the *getmsg* streams routine. Any data is read into the dlpi_data_buf, while any control bytes are read into dlpi_ctl_buf. The caller does not need to be aware of the names of the buffers, as the buffer pointers are returned. The global variable *dlpi_data_cnt* contains the number of data bytes read, while the global variable *dlpi_ctl_cnt* contains the number of control bytes.

Parameters:

strm	The stream from which to get data and control bytes.
ctrl_ptr	Points to the dlpi_ctl_buf char pointer
data_ptr	Points to the dlpi_data_buf char pointer

Return:

< 0	An error occurred (message optionally written to log file). See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
== 0	Success.
> 0	MOREDATA and/or MORECTL bit set as described previously.

dlpi_get_info_strm()

Prototype `int dlpi_get_info_strm (int dlpi_data, char *ptr) ;`

Include File(s) <gcom/dlpiapi.h>

Description This routine requests default information from the DLPI provider and waits for the response. The information is obtained pertaining to the stream represented by the file descriptor that is passed in as a parameter.

Upon successful return, the user's buffer contains a *dl_info_ack_t* structure containing the information.

Parameters

dlpi_data	Open stream file descriptor to the DLPI Provider.
**ptr*	Application's buffer.

Return

< 0	See "DLPI API Library Routine Error Return Defines" on page 118 for a complete list of the possible error return values.
> 0	Information returned. This is the size of the message pointed to by *ptr.

dlpi_get_style_strm()

Prototype `int dlpi_get_style_strm(int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>, <gcom/dlpi.h>**

Description This routine returns the style used to configure the DLPI provider. The inquiry is made using the stream represented by the file descriptor parameter.

Return DLPIAPI_UNUSABLE

Clone open failed or unable to get style from provider (probably because provider was not initialized by the *dlpi_init()* routine).

> 0 The provider style is returned. The two legal values are as follows:

DL_STYLE1 This indicates that the Physical Point of Attachment (PPA) is implicitly bound at open time.

Note: *In practice, this style almost never occurs.*

DL_STYLE2 This indicates that the PPA must be explicitly attached. Refer to *dlpi_attach_req()* for further details.

dlpi_init()

Prototype

```
int dlpi_init(unsigned  log_optns,
              char     *log_name) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine performs initialization functions for the DLPI API library. It should be called prior to using any other library routine.

Parameters

log_optns	Options for controlling messages that the DLPI API library writes to its log file. This parameter consists of a number of single-bit values that are ORed together to form the parameter value. See “DLPI API Logging Options” on page 119 for the options.
log_name	If a NULL log file name was specified, and if the DLPI_LOG_FILE options was specified, the log file default is as defined in “DLPI API Logging Options” on page 119.

Return

< 0	For unsuccessful initialization.
> 0	For successful initialization.

dlpi_init_FILE()

Prototype

```
int dlpi_init_FILE(unsigned log_optns,
                   FILE *log_FILE) ;
```

Include File(s) **<gcom/dlpiapi.h>, <stdio.h>**

Description This routine functions the same as the *dlpi_init()* routine except that it causes the DLPI API library to used the passed FILE for its log file rather than opening one of its own.

Parameters

log_optns	Options for controlling messages that the DLPI API library writes to its log file. This parameter consists of a number of single-bit values that are ORed together to form the parameter value. See Section 3.3, *Logging Option*, page 8, for the options.
log_FILE	Pointer to a FILE data structure.

Return

< 0	For unsuccessful initialization.
> 0	For successful initialization.

dlpi_listen()

Prototype

```
Old: int   dlpi_listen (unsigned long ppa,
                                  unsigned long bind_dlsap,
                                  unsigned long local_dlsap,
                                  unsigned long remote_dlsap,
                                  unsigned fork_options) ;
New: int   dlpi_listen_host (char *hostname,
                                  unsigned long ppa,
                                  unsigned long bind_dlsap,
                                  unsigned long local_dlsap,
                                  unsigned long remote_dlsap,
                                  unsigned fork_options) ;
```

Description

This routine listens for an incoming connection and returns the file descriptor of a data stream which is open for reading and writing data to DLPI.

The routine *dlpi_listen()* is equivalent to *dlpi_listen_host()*.

The *ppa* parameter specifies either the multiplexor ID or the Lower Point of Attachment (LPA) over which the connection is to be issued. If the number is negative, then the absolute value is assumed to be the LPA, otherwise it is assumed to be the multiplexor ID of the lower stream. If the value 0L is passed, the default of -1L (line 1) is substituted.

The routine issues a DL_ATTACH_REQ to the indicated PPA to attach a DLPI data stream to a line.

The routine issues a DL_BIND_REQ using the routine *dlpi_bind_dlsap()*. Once bound, it configures the addresses as specified by the local and remote DLSAPs. It then waits for an incoming DL_CONNECT_IND message from DLPI. It accepts the connection and returns the file descriptor for the new stream to the caller.

The *bind_dlsap* is used to bind the stream to an SDLC station. Once bound, the *local_dlsap* and *remote_dlsap* values are used to configure the addresses of the station. If the local and remote DLSAPs are zero, then the configured defaults for the station will be used. For an NRM primary or secondary, only one of the local or remote DLSAPs need be non-zero since these modes of operation require only one address. For ABM, both addresses must be supplied (or neither for using defaults).

Parameters	*ppa*	The multiplexor ID or LPA to which to attach the DLPI stream.
	bind_dlsap	DLSAP to use in the DL_BIND_REQ.
	local_dlsap	The DLSAP to use as the local address.
	remote_dlsap	The DLSAP of the remote system.
	fork_options	Reserved for future use. Must be set to 0.

Return	< 0	Any kind of error that occurred in the binding or connection process. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
	> 0	Successful return. The return value is the UNIX file descriptor for the stream that has the open connection assigned to it. This descriptor is suitable for passing to any of the DLPI API routines that have a stream parameter, or the UNIX *read()*, *write()*, *getmsg()*, *putmsg()* family of routines.

dlpi_open()

Prototype

```
New: int   dlpi_open(char *hostname)
Old: int   dlpi_open_data(void);
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine opens a stream to the DLPI driver. It uses the clone open facility to do so. This routine is used internally by the DLPI API library to open files to the DLPI driver. It is ordinarily not called by the user but is provided to allow you to perform low level functions with the DLPI driver.

The dlpi_open_data(void) routine is equivalent to dlpi_open(NULL).

Return

< 0	An error occurred indicating that the system was not initialized or not opened. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	File descriptor handle (identifier) for the open file.

Parameters

hostname	A pointer to an ASCII string name of the machine on which the operation is to be performed. If the pointer is NULL, or points to an empty string, the operation is performed on the machine on which the call to the API library is made (i.e., the local host).

dlpi_open_log()

Prototype `void dlpi_open_log(void) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine is used internally by the API to open the log files. The application ordinarily should not need to invoke it directly.

dlpi_perror()

Prototype `void dlpi_perror(char *prefix) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine mimics the standard C library's *perror()* routine. The *dlpi_perror()* routine differs in that *dlpi_perror()* prints to the DLPI logfile instead of standard error.

Parameters

prefix The string pointed to by this argument will be printed, then a colon and a space, then a message describing the most recent error, then a newline.

dlpi_print_msg()

Prototype

```
void dlpi_print_msg(unsigned char *msg,
                    unsigned       length,
                    int            indent ) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine translates a binary message into an ASCII hex dump. This can be useful when an application wishes to log message content.

Parameters

msg	Pointer to the message to be printed.
length	The number of bytes to print from the message.
indent	The number of spaces to indent the printout.

dlpi_printf()

Prototype `void dlpi_printf(char *fmt, ...) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine performs the same function as the UNIX *printf()* routine. The logging options specified in the *dlpi_init()* call determine whether the output is written to the log file, *stderr*, both or neither. This is the routine that the DLPI API library uses internally to write messages to the log.

The format of the output produced by *dlpi_printf()* consists of the process ID of the process that called the function, a time stamp and the message formatted according to the arguments passed to *dlpi_printf()*. For example:

```
dlpi_printf("Hello world!\n") ;
```

would produce output similar to the following:

```
  609 08:14:33 Hello world
```

Parameters

fmt	Format string compatible with UNIX *printf* function
...	Additional arguments to print (optional)

dlpi_put_both()

Prototype

```
int dlpi_put_proto(int   dlpi_data,
                   char *hdr_ptr,
                   int   hdr_lgth,
                   char *data_ptr,
                   int   data_lgth ) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a message with both control and data parts. Generally, this routine will only be used internally, but it is presented here in the event that an application may need this functionality.

Parameters

dlpi_data	stream to which to write protocol message.
hdr_ptr	Pointer to the control part of the message. May be null if *hdr_lgth* is <= 0.
hdr_lgth	Length of the data pointed to by *hdr_ptr*.
data_ptr	Pointer to the data part of the message. May be null if *data_lgth* is <= 0.
data_lgth	Length of the data pointed to by *data_ptr*.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Return value from the UNIX *putmsg* call.

dlpi_put_proto()

Prototype

```
int dlpi_put_proto(int dlpi_data,
                   int lgth) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine writes a prototype message to the DLPI driver on the given stream. The prototype message is assumed to have been built in the global array *dlpi_ctl_buf*. The system call to write the protocol message is retried in the event that the call was interrupted by a UNIX signal.

Parameters

dlpi_data	stream to which to write protocol message.
lgth	Number of bytes to write.

Return

< 0	See for a complete list of the possible error return values.
> 0	Return value from the UNIX *putmsg* call.

dlpi_rcv()

Prototype

```
int dlpi_rcv (int   dlpi_data,
              char *data_ptr,
              int   bfr_len,
              int   flags,
                long  *out_code) ;
```

Include File(s) **<gcom/dlpiapi.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description This routine receives data generated from connectionless or connection-oriented environments and processes DLPI control messages from the stream. It is designed to support applications that need to do more than simply set up a connection and exchange data with a peer until the connection is terminated. Your application can control the behavior of *dlpi_rcv()* by setting input flags.

The *dlpi_rcv()* routine supports the following features:

- Responses to management requests from your application are processed (such as DL_ATTACH_REQ, DL_BIND_REQ and DL_INFO_REQ)
- Transparent connection maintenance after the connection is established
- Application buffers smaller that incoming frames by interpreting the *getmsg* MOREDATA bit
- Connectionless and connection-oriented data transfer
- U-frame exchanges while connected

Received data are read into your application's buffer with the length of the received data specified in the global integer *dlpi_data_cnt.* Any received control information is read into the *dlpi_ctl_buf* global, with its length specified in global integer *dlpi_ctl_cnt.*

Receiving U-Frames

U-frames (XIDs, TESTs and unnumbered information U-frames) can be exchanged once the stream has been attached and bound or when a connection has been established. Five return codes are used to signal the delivery of U-frames: DLPIAPI_XID_IND, DLPIAPI_XID_CON, DLPIAPI_TEST_IND, DLPIAPI_TEST_CON and DLPIAPI_UIC_IND. (These are described later.)

To receive U-frames, the corresponding input *flags* bit must be set: ReturnXID, ReturnTEST or ReturnUIC. If the corresponding *flags* bit is not set, an attempt is made to deliver the U-frame using a U-frame handler. Your application may set up a U-frame handler using

dlpi_set_unnum_frame_handler(). If a U-frame handler has not been specified, the U-frame is silently discarded.

Your application buffer might not be large enough to hold the U-frame. If so, the U-frame is delivered in fragments, one per call on *dlpi_rcv()* to your application.

First fragment in U-Frame

In the first U-frame fragment, DLPIAPI_MOREDATA is set in *out_code.* The return value corresponds to the type of U-frame received (XID, TEST or unnumbered information U-frame).

Middle U-Frame Fragments

In fragments that occur after the first and before the last fragment, DLPIAPI_MOREDATA is set in *out_code* and the return value is set to DLPIAPI_DATA.

Last Fragment in U-Frame

In the last fragment in a segmented U-frame, DLPIAPI_MOREDATA is not set in *out_code* and the return value is set to DLPIAPI_DATA.

Non-Blocking I/O

Non-blocking I/O is partially supported. That is, non-blocking I/O is supported in the sense that if *getmsg* returns -1 and if *errno* equals EAGAIN, DLPIAPI_EAGAIN is returned. Non-blocking I/O is enabled by setting the O_NDELAY flag, which called the O_NONBLOCK flag for POSIX compatibility (see the *fcntl()* UNIX system call). Your application must recover from any write calls (to the *putmsg* command) that defer because non-blocking I/O is set on the stream.

If the AutoConnect, AutoReset, or AcceptConnect *flags* bit is set, the API generates DLPI protocol messages in response to specific DLPI protocol messages. If your application has specified non-blocking I/O on the data stream, then an API attempt to send such a message may fail. The API does not have access to a retry mechanism. That is, if your applications using non-blocking I/O, these flags should not be used. Your application may use *dlpi_send_reset_res(), dlpi_send_connect_res(),* and *dlpi_send_connect_req()* in response to connection-oriented events.

Parameters

dlpi_data stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file. Typically, your application previously used DLPI API procedures to attach a PPA, bind a DLSAP and listen for or initiate a connection. However, these steps are not required.

**data_ptr* Pointer to your application's buffer. Connection-oriented data and U-frames are returned to your application using this pointer. The *data_ptr* parameter must not be NULL. The length of the actual data placed in your application's buffer is in the integer global *dlpi_data_cnt.*

bfr_len A positive integer specifying the length of the application's buffer.

out_code A pointer to an application variable used to returned additional information. The pointer must *not* be null. The semantics of the value returned via this pointer depends on the value returned by the function, as follows:

If the DLPIAPI_DATA return code is set and *out_code* is set to DLPIAPI_MOREDATA, this indicates a fragment (more data). Other bits are reserved for future use. The last fragment in a frame is indicated by DLPIAPI_MOREDATA being reset.

DLPIAPI_POLL_FINAL
: This is set when delivering DLPIAPI_XID_IND, DLPIAPI_XID_CON, DLPIAPI_TEST_IND, DLPIAPI_TEST_CON or DLPIAPI_UIC_IND if the poll/final bit is set in the received message.

DLPIAPI_OK_ACK.
: The acknowledged DLPI primitive

DLPIAPI_ERROR_ACK.
: The rejected DLPI primitive

DLPIAPI_RESET_INDICATION.
: Reason code

DLPIAPI_DISC_IND.
: Reason code

DLPIAPI_OTHER.
: Unsupported DLPI primitive

See **dlpi.h** for DLPI primitive definitions and disconnect and reset indication reason codes.

flags Input flags used to control the operation of *dlpi_rcv()* by indicating how it should react to various DLPI protocol messages. The flags specify how received U-frames are to be handled (or discarded) and how *dlpi_rcv()* should react to connect, disconnect and reset messages.

Input Flags in Detail

Each valid *flags* value is explained in more detail as follows:

AutoReset Requests *dlpi_rcv()* to respond to a DLPI reset indication with a reset response. The *dlpi_rcv()* routine then returns DLPIAPI_RESET_INDICATION. Your application and its peer cannot yet exchange data. After your application has completed its response to the reset, it should call *dlpi_rcv()* back and wait for the reset sequence to complete. The reset complete is indicated when DLPIAPI_RESET_COMPLETE is returned.

If the AutoReset *flags* bit is not set, DLPIAPI_RESET_INDICATION is returned without further action taken.

Note: *If your application has specified non-blocking I/O on the data stream (see the UNIX* fcntl() *system call), this flag should not be used.*

AutoConnect Requests *dlpi_rcv()* to respond to a DLPI disconnect indication with a connect request. The *dlpi_rcv()* routine has no way to determine the destination DLSAP used when the connection was originally setup. Therefore, a DLSAP of “0L” is used. When the connection completes, DLPIAPI_CONNECT_COMPLETE is returned to your application.

Note: *If your application has specified non-blocking I/O on the data stream (see the UNIX fcntl() system call), this flag should not be used.*

Input Flags in Detail *(continued)*

AutoListen — Requests *dlpi_rcv()* to respond to a DLPI disconnect indication by waiting for an incoming connect indication. When the connect indication arrives, a connect response is sent to the peer and DLPIAPI_CONNECT_IND is returned to your application.

After your application has completed its response to the DLPIAPI_CONNECT_IND event, your application should call *dlpi_rcv()* to wait for the connection setup to be completed. This is reported to your application by returning DLPIAPI_CONNECT_COMPLETE.

If AutoListen and AcceptConnect are reset when a DLPI disconnect indication is received, DLPIAPI_DISC_IND is returned to your application without further action.

AcceptConnect — The semantics of this flag are similar to those of the AutoListen flag.

This flag is useful to listen for an incoming connection. If *dlpi_rcv()* receives a DLPI connect indication and AcceptConnect or AutoListen is set, a connect response is returned to the peer and DLPIAPI_CONNECT_IND is returned to your application.

After your application has completed its response to the DLPIAPI_CONNECT_IND event, your application should call *dlpi_rcv()* to wait for the connection setup to be completed. This is reported to your application by returning DLPIAPI_CONNECT_COMPLETE.

If AutoListen and AcceptConnect are reset when a DLPI connected indication is received, DLPIAPI_CONNECT_IND is returned to your application without further action.

Note: *If your application has specified non-blocking I/O on the data stream (see the UNIX fcntl() system call), this flag should not be used.*

ReturnInfo — If this flag is set, DLPIAPI_INFO_ACK is returned to your application in response to a DLPI information acknowledge (DL_INFO_ACK). Otherwise the DL_INFO_ACK is silently discarded.

Input Flags in Detail *(continued)*

RetryOnSignal	If RetryOnSignal is set, *dlpi_rcv()* retries the *getmsg* call when a system call is interrupted. Otherwise, DLPIAPI_EINTR is returned. If a *putmsg* is interrupted with a signal, the *putmsg* is retried independent of the setting of the RetryOnSignal flag. UNIX signals may interrupt most system calls, including *getmsg* (see the EINTR signal defined in **dlpiapi.h**). If your application is using signals, your application may need to control how *dlpi_rcv()* reacts when *getmsg* is interrupted with a signal.
ReturnXID ReturnUIC ReturnTEST	For your application to receive a U-frame event code (XID, TEST or unnumbered information U-frame), the corresponding *flags* bit must be set.

Return Values

The return value is an event code corresponding to the message type read from the stream. The set of return codes that your application may encounter depends on the *flags* bits that are set and how your application sets up a DLPI connection, if any. For example, if *dlpi_connect()* is used to set up a connection, the DLPI connection primitive are not processed here. In addition, U-frames are silently discarded if the unnumbered input flags are reset.

In general, the return code values are grouped into three categories:

- negative values indicate an error
- zero indicates data (normal data or U-frame fragment)
- positive values indicate a DLPI protocol message.

Negative error codes

See for a complete list of the possible error return values.

Zero data code

DLPIAPI_DATA

Data has been returned. The *dlpi_data_cnt* global contains the length of the data read into your application's buffer.

If your application buffer is not large enough to hold the received frame, DLPIAPI_MOREDATA is returned through *out_code*. That is, the frame is returned in fragments to your application. Your application can detect the last fragment of the frame when DLPIAPI_MOREDATA is reset to zero.

Note: *The U-frames (TESTs, XIDs and unnumbered information U-frames) described later may also be received in fragments when your application buffer is too small. For the U-frames, the first fragment in the frame is returned with the corresponding event code, while the remaining fragments are returned with the DLPIAPI_DATA event code.*

DLPIAPI_DATA_ACK

Reserved for Future Use.

Return Values (continued)

Positive protocol message event codes

DLPIAPI_ATTACHED
DLPIAPI_DETACHED
DLPIAPI_BOUND
DLPIAPI_UNBOUND

These four event codes are received by your application only when it is explicitly attaching/binding or detaching/unbinding. The DLPI API primitives used for these functions wait for the response from the DLPI Provider. For further information, refer to *dlpi_attach_ppa(), dpi_send_attach_req(), dlpi_send_unbind_req(), dlpi_bind_dlsap(), dlpi_send_bind_req()* and *dlpi_send_detach_req()*.

DLPIAPI_DISC_IND

If the AutoConnect *flags* bit is set when a DL_DISCONNECT_IND protocol message is received, a connect request is returned to the DLPI provider, and *dlpi_rcv()* reads again, waiting for a response to the connect request.

Note: *The API sleeps for one second after sending the connect request to prevent extended buzz loops.*

If the AutoListen *flags* bit is set instead when a DL_DISCONNECT_IND protocol message is received, *dlpi_rcv()* reads again waiting for a connect indication or U-frames.

If AutoConnect and AutoListen are not set, the DLPIAPI_DISC_IND is returned without further action.

DLPIAPI_DISC_COMPLETED

Your application previously sent a disconnect request and the DLPI Provider's response has been received.

DLPIAPI_RESET_INDICATION

Indicates that a DL_RESET_IND protocol message was received. Data may have been lost. If the AutoReset *flags* bit was set, a reset response was returned to the DLPI Provider. Your application should call *dlpi_rcv()* again to wait for the reset sequence to complete.

Return Values (continued)

DLPIAPI_RESET_COMPLETE
: A reset sequence has completed and your application may resume transmitting data. The reset sequence may have been initiated by your application with a reset request, or by the peer with a reset indication.

DLPIAPI_CONNECT_IND
: The peer is requesting a connection. If the AcceptConnect *flags* bit was set, *dlpi_rcv()* has returned a connect response. Your application should call *dlpi_rcv()* to wait for connection setup to complete.

DLPIAPI_CONNECT_COMPLETE
: A connection setup sequence has completed and your application can now exchange data with it's peer. The connection setup may have been initiated by your application with a connection request or by the peer with a connection indication.

DLPIAPI_ERROR_ACK
: The DLPI Provider rejected a request. The DLPI request code is returned in *out_code.*

DLPIAPI_OK_ACK
: This return value should not occur. The DLPI Provider is reporting the acceptance of a request. DL_OK_ACKs to attach, bind, connect, reset and disconnect requests should be reported through other return values.

  The accepted request code is returned through *out_code.*

DLPIAPI_INFO_ACK
: Contains a response to a previously issued information request. The response is in the global *dlpi_ctl_buf.*

DLPIAPI_TOKEN_ACK
: Reserved for future use.

DLPIAPI_PHYS_ADDR_ACK
: Reserved for future use.

DLPIAPI_STATISTICS_ACK
: Reserved for future use.

Return Values (continued)

DLPIAPI_OTHER

A DLPI primitive unsupported by *dlpi_rcv()* was read. The DLPI primitive code is returned through *out_code*. Your application can examine the received message through the *dlpi_ctl_buf* global or it can ignore the message entirely.

DLPIAPI_XID_IND
DLPIAPI_XID_CON
DLPIAPI_TEST_IND
DLPIAPI_TEST_CON
DLPIAPI_UIC_IND

These five event codes are used to deliver U-frames to your application. Your application must explicitly request U-frames or else they are silently discarded.

For your application to receive a U-frame event code, the corresponding *flags* bit (ReturnXID, ReturnTEST, ReturnUIC) must be set.

If the appropriate *flags* bit is not set, an attempt is made to deliver the U-frame using the unnumbered handler mechanism. See *dlpi_set_unnum_frame_handler()* for details. If your application has not requested this service, the U-frame is silently discarded.

DLPIAPI_UIC_ERROR_IND

Reserved for Future Use.

dlpi_rcv_msg()

Prototype

```
int dlpi_rcv_msg(int    dlpi_data,
                 char *data_ptr,
                 int   data_cnt,
                 int   flags ) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine

Parameters

dlpi_data stream from which to read data

data_ptr Buffer to which to read the data

bfr_len Maximum number of bytes to read

flags Flags controlling the behavior of dlpi_rcv_msg(). A bitwise OR of the following options:

AutoReset: If a reset indication is received, this procedure will complete the reset sequence, then will return a DL_OK_ACK for a DL_RESET_CON when completed. Failure to complete the reset sequence will be indicated with a DL_ERROR_ACK for a DL_RESET_REQ.

RetryOnSignal: If the getmsg() system call is interrupted with a signal and this flag is set, the getmsg() will be tried again.

DISC_CONNECT: If specified, respond to a DL_DISCONNECT_IND by initiating a connect request. The *peer_sap* specified in the most recent *dlpi_send_connect_req()* or *dlpi_connect_req()* is used. Note that only one *peer_sap* is saved per process. A *peer_sap* is NOT saved for each connected stream. Failure will be indicated with a DL_ERROR_ACK of a connect primitive.

DISC_LISTEN: If specified, respond to a DL_DISCONNECT_IND by listening for an incoming connect indication. A successful connection will be indicated with a DL_OK_ACK of a DL_CONNECT_CON. Failure will be indicated with a DL_ERROR_ACK of a connect primitive.

ReturnInfo: If specified, DL_INFO_ACK, DL_TOKEN_ACK, DL_PHYS_ADDR_ACK, and DL_GET_STATISTICS_ACK messages are returned to the user. Otherwise, they are discarded. These messages are generated by the DLPI Provider in response to their corresponding requests.

ReturnUnnum: If set, XIDs, TESTs, and UIs are returned to the user. If not set, then the un-numbered frame handler mechanism is used to optionally deliver these frames to the user.

Return	< 0	An error occurred (message written to log file)
	0	DLPI control message is present in *dlpi_ctl_buf*, length *dlpi_ctl_cnt*. Any associated data is in the user's buffer, length in the global *dlpi_data_cnt*.
	> 0	Number of bytes read into user buffer

dlpi_read_data()

Prototype

```
int dlpi_read_data(int   dlpi_data,
                   char *buf,
                   int   cnt) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine reads a single data message from the DLPI driver on the indicated stream. Up to *cnt* bytes of data can be read into the buffer area pointed to by *buf*. Connection-oriented data are returned directly by this routine. If connectionless data are being returned, *dlpi_read_data()* makes an attempt to call the *dlpi_set_unnum_frame_handler()* routine, whose code must be modified to fit the circumstances. The *dlpi_set_unnum_frame_handler()* routine is described on page 193.

This routine does not expect to read a protocol message from the stream. It is considered an error to receive a protocol message. Similarly, if the return from *getmsg* indicates that no data message has been read, an error is returned. Under these circumstances, messages are written to the log file.

Note: *To read data and process protocol messages, use the* dlpi_rcv() *procedure. For connectionless data transfer environments, using* dlpi_read_data() *is usually sufficient.*

The ordinary case is that *dlpi_read_data()* will receive a message with no protocol portion and valid data. In such a case it simply returns the length of the data.

Parameters

	dlpi_data	stream from which to read data
	buf	Buffer to which to read the data
	cnt	Maximum number of bytes to read
Return	< 0	An error occurred (message written to log file)
	> 0	Number of bytes read into user buffer

dlpi_reset_req()

Prototype `int dlpi_reset_req (int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_RESET_REQ primitive and waits for the corresponding DL_RESET_CON.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	See for a complete list of the possible error return values.
== 0	A disconnect indication was received. Connection is now in the DL_IDLE state.
> 0	Reset sequence completed successfully. Connection is now in the data transfer state.

dlpi_reset_res()

Prototype `int dlpi_reset_res(int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a reset response to DLPI and awaits the receipt of a DL_OK_ACK from DLPI. It is appropriate to call this routine after receiving a DL_RESET_IND on a data stream.

If you are using *dlpi_read_data()* and if it returns a specific result, you may want to check the *dlpi_ctl_buf* to see if it contains a DL_RESET_IND. If so, and if you wish to keep your connection going, you may then call *dlpi_reset_res()* to acknowledge the reset and put the connection back in the data state.

Caution: The receipt of a DL_RESET_IND means that data messages may have been lost.

Parameters

dlpi_data	stream to which to send the DL_RESET_RES.

Return

< 0	See for a complete list of the possible error return values.
== 0	Connection disconnected.
> 0	Reset sequence completed successfully. Connection is now in the data transfer state.

dlpi_send_attach_req()

Prototype
```
int dlpi_send_attach_req (int dlpi_data,
                          unsigned long ppa) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends an attach request to the DLPI provider. Your application is responsible for reading the response. For example, you might want to use *dlpi_complete_req()* to read the response. This request is legal only in the DL_UNATTACHED state.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
ppa	If this is negative, it is an LPA. Otherwise, it is a streams multiplexor ID.

Return

< 0	See for a complete list of the possible error return values.
>= 0	Successfully sent.

dlpi_send_bind_req()

Prototype

```
int dlpi_send_bind_req (int dlpi_data,
                        unsigned long dlsap,
                        int conind_nr,
                        int service_mode,
                        int conn_mgmt,
                        int auto_flags) ;
```

Include File(s) **<gcom/dlpiapi.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description This routine sends a DL_BIND_REQ primitive to the DLPI provider. Your application is responsible for reading the response. This request is legal only in the DL_UNBOUND state.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
dlsap	DLSAP address to be bound to the stream.
conind_nr	Connection indication value. Zero implies connect and one implies listen.
service_mode	The service mode, which can be DL_CODLS (indicating connection-oriented service) or DL_CLDLS (indicating connectionless service).
conn_mgnt	This parameter is unsupported at this time and should be set to zero. A non-zero value would indicate connection management.
auto_flags	This parameter is ignored.

Return

< 0	See for a complete list of the possible error return values.
> 0	Success. This is set to the size of the successful bind request.

dlpi_send_connect_req()

Prototype
```
int dlpi_send_connect_req(int           dlpi_data,
                          unsigned long peer_sap) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine formats and sends a DLPI connect request in a connection-oriented environment.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
peer_sap	Address of the peer to which you wish to be connected.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Success.

dlpi_send_connect_res()

Prototype

```
int dlpi_send_connect_res(int   dlpi_data,
                          ulong correlation,
                          ulong dlpi_token ) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine formats and sends a connect response in a connection-oriented environment. It does not wait for a response. DLPI must be initialized for this to work.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
correlation	Typically, this is the correlation value contained in a *dl_connect_ind_t* structure.
dlpi_token	This parameter must be set to zero.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values. Perhaps DLPI was not initialized.
>= 0	Success.

dlpi_send_detach_req()

Prototype `int dlpi_send_detach_req(int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This optional routine sends a detach request to DLPI. It can be used in both connectionless and connection-oriented environments. However, *dlpi_send_detach_req()* is usually not called, because a simple *dlpi_close* command is sufficient in place of the more formal unbind/detach/close process. Refer to your UNIX system administration manual for details about the *close* command.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Success.

dlpi_send_disconnect_req()

Prototype

```
int dlpi_send_disconnect_req (int dlpi_data,
                              int reason) ;
```

Include File(s) **<gcom/dlpiapi.h>, <gcom/npi.h>, <gcom/npi_ext.h>**

Description This routine formats and sends a disconnect request primitive (DL_DISCONNECT_REQ) to DLPI. Any XIDs, TESTs, unnumbered information U-frames and data messages are discarded while disconnecting. Your application is responsible for reading the response.

Parameters

dlpi_data stream file ID over which to send the DL_DISCONNECT_REQ. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file. Typically, your application previously used DLPI API procedures to attach a PPA, bind a DLSAP and listen for or initiate a connection. However, these steps are not required.

reason The code to go into the *dl_reason* field of the DL_DISCONNECT_REQ. Valid codes include the following:

DL_DISC_NORMAL_CONDITION. Normal release of a data link connection.

DL_DISC_ABNORMAL_CONDITION. Abnormal release of a data link connection.

DL_DISC_PERMANENT_CONDITION. A permanent condition caused the rejection of a connect request.

DL_DISC_TRANSIENT_CONDITION. A transient (momentary) condition caused the rejection of a connect request.

DL_DISC_UNSPECIFIED. Reason unspecified.

Return

< 0 See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.

>= 0 Success.

dlpi_send_info_req()

Prototype `int dlpi_send_info_req (int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine formats and sends a DL_INFO_REQ primitive. Your application is responsible for reading the response.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Request successfully sent.

dlpi_send_reset_req()

Prototype `int dlpi_send_reset_req (int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine formats and sends a DL_RESET_REQ primitive on the specified data stream. Your application is responsible for reading the response.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Success.

dlpi_send_reset_res()

Prototype `int dlpi_send_reset_res(int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine formats and sends a DLPI reset response on the specified connection-oriented data stream. Your application is responsible for reading the response.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Message sent.

dlpi_send_stats_req()

Prototype `int dlpi_send_stats_req(int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine formats and sends a DLPI Get Statistics Request. The caller is responsible for interpreting the response.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by *dlpi_open()*.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Message sent.

dlpi_send_test_req()

Prototype

```
int dlpi_send_test_req (int            dlpi_data,
                        ulong          pfb,
                        char          *datap,
                        int            length
                        unsigned char *addr_ptr,
                        int            addr_len) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a TEST request. If *addr_ptr* is not NULL and *addr_len* is greater than zero, the address in *addr_ptr* is sent as the destination address. Otherwise, the TEST's destination address is set to NULL.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
pfb	Poll/Final bit.
datap	Pointer to the data for the TEST primitive.
length	Length of data pointed to by *datap.*
**addr_ptr*	Pointer to an address.
addr_len	Length of the address pointed to by *addr_ptr*.

Return

< 0	Failure. See "DLPI API Library Routine Error Return Defines" on page 118 for a complete list of the possible error return values.
>= 0	The TEST request was successfully sent.

dlpi_send_test_res()

Prototype

```
int dlpi_send_test_res (int            dlpi_data,
                        ulong          pfb,
                        char          *datap,
                        int            length
                        unsigned char *addr_ptr,
                        int            addr_len) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a TEST response. If *addr_ptr* is not NULL and *addr_len* is greater than zero, the address in *addr_ptr* is sent as the destination address. Otherwise, the TEST's destination address is set to NULL.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
pfb	Poll final bit.
datap	Pointer to the data for the TEST primitive.
length	Data length.
**addr_ptr*	Pointer to an address.
addr_len	Length of the address pointed to by *addr_ptr*.

Return

< 0	Failure. See "DLPI API Library Routine Error Return Defines" on page 118 for a complete list of the possible error return values.
>= 0	Message successfully sent.

dlpi_send_uic()

Prototype

```
int dlpi_send_uic     (int            dlpi_data,
                       char          *datap,
                       int            data_len,
                       unsigned char *addr_ptr,
                       int            addr_len) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends the specified data in a unnumbered information U-frame information request (DL_UNITDATA_REQ). It assumes there is a specific address associated with the data. This might occur if your address provided a Media Access (MAC) address, such as in a token ring environment.

If *addr_ptr* is not NULL and *addr_len* is greater than zero, the address in *addr_ptr* is sent as the destination address. Otherwise, the unnumbered information U-frame's destination address is set to NULL.

Parameters

dlpi_data	stream file ID that is attached and bound. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
**datap*	Pointer to the data.
data_len	Length of the data pointed to by *datap*.
**addr_ptr*	Pointer to an address.
addr_len	Length of the address pointed to by *addr_ptr*.

Return

< 0	Request failed. See "DLPI API Library Routine Error Return Defines" on page 118 for a complete list of the possible error return values.
>= 0	The data was successfully sent.

dlpi_send_unbind_req()

Prototype `int dlpi_send_unbind_req(int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This optional routine sends an unbind request to DLPI. It could be used in both connectionless and connection-oriented environments. However, *dlpi_send_unbind_req()* is usually not called, because a simple *dlpi_ close* command is sufficient in place of the more formal unbind/detach/close process. Refer to your UNIX system administration manual for details about the *close* command.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Message sent.

dlpi_send_xid_req()

Prototype

```
int dlpi_send_xid_req (int            dlpi_data,
                       ulong          pfb,
                       char          *datap,
                       int            length
                       unsigned char *addr_ptr
                       int            addr_len) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends an XID request. If *addr_ptr* is not NULL and *addr_len* is greater than zero, the address in *addr_ptr* is sent as the destination address. Otherwise, the XID's destination address is set to NULL.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
pfb	Poll final bit.
datap	Pointer to the data for the TEST primitive.
length	Length of data pointed to by *datap.*
**addr_ptr*	Pointer to an address.
addr_len	Length of the address pointed to by *addr_ptr*.

Return

< 0	Failure. See "DLPI API Library Routine Error Return Defines" on page 118 for a complete list of the possible error return values.
>= 0	The XID request was successfully sent.

dlpi_send_xid_res()

Prototype

```
int dlpi_send_xid_res (int            dlpi_data,
                       ulong          pfb,
                       char          *datap,
                       int            length
                       unsigned char *addr_ptr
                       int            addr_len) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends an XID response. If *addr_ptr* is not NULL and *addr_len* is greater than zero, the address in *addr_ptr* is sent as the destination address. Otherwise, the XID's destination address is set to NULL.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
pfb	Poll/Final bit.
**datap*	Pointer to the data for the TEST primitive.
length	Data length.
**addr_ptr*	Pointer to an address.
addr_len	Length of the address pointed to by *addr_ptr*.

Return

< 0	Failure. See "DLPI API Library Routine Error Return Defines" on page 118 for a complete list of the possible error return values.
>= 0	Message successfully sent.

dlpi_set_log_size()

Prototype `int dlpi_set_log_size (long  log_size) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sets the maximum length of the DLPI log file. When the logfile reaches this length, it will wrap and begin writing new data at the beginning of the file. The newest data will be followed by a line marking the end of the log.

Parameters

log_size	Maximum length, in bytes, for the log file.

Return

< 0	Failure. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Message successfully sent.

dlpi_set_signal_handling()

Prototype

```
int dlpi_set_signal_handling
                              (int             dlpi_data,
                               dlpi_sig_func_t func,
                               int             sig_num,
                               int             primitive_mask) ;
```

Include File(s) **<gcom/dlpiapi.h>, <signum.h>, <gcom/dlpi.h>, <gcom/dlpi_ext.h>**

Description This routine requests that the specified signal be generated by the DLPI provider when the DLPI provider sends any of the messages indicated by *primitive_mask* up stream.

After the DLPI provider generates the signal, the signal is caught by a DLPI API signal handling procedure. This procedure reads messages from *dlpi_data* and, for each message, calls the user's function. The user's function is defined by the typedef *dlpi_sig_func_t* as follows:

```
#ifdef PROTOTYPE
typedef int (*dlpi_sig_func_t) (int fid,
                                char *ctl_ptr,  int ctl_length,
                                char *data_ptr, int data_length);
#else
typedef int (*dlpi_sig_func_t) ();
#endif
```

The user-specified function, whose address is passed in the *func* parameter, should return zero, indicating that the API signal handler should take no action. There are no other valid return values specified at this time.

It is assumed that your application does not want any more signals if any one of the following statements are true:

- *func* is set to NULL
- *sig_num* == 0
- *primitive_mask* == 0

If *sig_num* == SIGPOLL, this routine requests that the stream head generate a SIGPOLL signal when an M_SIG or M_PCSIG containing a SIGPOLL reaches the stream head. DLPI generates M_PCSIGs so that the signal will be generated immediately, even when other messages are queued.

The primitive can consist of any of the following, ORed together in the *primitive_mask* parameter:

- 1 << DL_DISCONNECT_IND
- 1 << DL_RESET_IND
- 1 << DL_CONNECT_IND
- 1 << DL_RESET_CON
- 1 << DL_CONNECT_CON

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.
func	User application's signal message handler function.
sig_num	Signal to be generated by the DLPI provider as it sends to the user a message specified in the *primitive_mask* argument. If *sig_num* is zero, no further signals are generated by the DLPI provider.
primitive_mask	The set of DLPI protocol messages that cause the DLPI provider to generate a signal as it sends the message to the user.

Return Unused. Zero is recommended.

dlpi_set_unnum_frame_handler()

Prototype
```
int dlpi_set_unnum_frame_handler(int          dlpi_data,
                                 unnum_frame_t handler) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine specifies an application routine to be called when an XID, TEST or unnumbered information U-frame is read by any of the following API routines:

- *dlpi_connect_req()*, which is called by *dlpi_connect()*
- *dlpi_connect_wait()*, which is called by *dlpi_listen()*
- *dlpi_read_data()*
- *dlpi_rcv()*
- *dlpi_complete_req()*

Your application's U-frame handler is defined as follows:

```
#ifdef PROTOTYPE
typedef void (*unnum_frame_t) (int fid,
                               unsigned char *ctl_ptr,  int ctl_length,
                               unsigned char *data_ptr, int data_length);
#else
typedef void (*unnum_frame_t) ();
#endif
```

Parameters

dlpi_data	The stream from which to receive a protocol message.
handler	Specify NULL to disable *dlpi_set_unnum_frame_handler()*. Otherwise, *handler* specifies an application routine. The specified handler applies to all DLPI streams that the process is using. However, there is not a table that associates FIDs to handlers.

Return

< 0	Failure.
>= 0	The TEST request was successfully sent.

dlpi_test_req()

Prototype

```
int dlpi_test_req (int             dlpi_data,
                   unsigned long   pfb,
                   char           *datap,
                   int             length) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_TEST_REQ.

Parameters *dlpi_data*

s file ID. This is the file descriptor returned by a call to *dlpi_open()*.

pfb	If non-zero, poll final bit will be set in the request.
datap	Pointer to a user-supplied buffer of data to send with the request.
length	Length of the buffer at *datap*.

Return

< 0	Request failed. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Sent.

dlpi_test_res()

Prototype

```
int dlpi_test_res (int             dlpi_data,
                   unsigned long   pfb,
                   char           *datap,
                   int             length) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_TEST_RES, the response to a DL_TEST_IND.

Parameters

dlpi_data	streams file ID. This is the file descriptor returned by a call to *dlpi_open()*.
pfb	If non-zero, poll final bit will be set in the request.
datap	Pointer to a user-supplied buffer of data to send with the request.
length	Length of the buffer at *datap*.

Return

< 0	Request failed. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Sent.

dlpi_uic_req()

Prototype

```
int dlpi_uic_req (int            dlpi_data,
                  char           *datap,
                  int            length) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends the user-supplied data via an unnumbered info request.

Parameters

dlpi_data	streams file ID. This is the file descriptor returned by a call to *dlpi_open()*.
datap	Pointer to a user-supplied buffer of data to send with the request.
length	Length of the buffer at *datap*.

Return

< 0	Request failed. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Sent.

dlpi_unbind_dlsap()

Prototype `int dlpi_unbind_dlsap (int dlpi_data) ;`

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_UNBIND_REQ primitive to the DLPI provider and waits for the expected DL_OK_ACK response.

Parameters

dlpi_data	stream file ID. This is the file descriptor returned by an open call on the **/dev/dlpi_clone** file.

Return

< 0	Request failed. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	stream successfully unbound.

dlpi_xid_req()

Prototype

```
int dlpi_xid_req  (int             dlpi_data,
                   unsigned long   pfb,
                   char           *datap,
                   int             length) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_XID_REQ.

Parameters

dlpi_data	streams file ID. This is the file descriptor returned by a call to *dlpi_open()*.
pfb	If non-zero, poll final bit will be set in the request.
datap	Pointer to a user-supplied buffer of data to send with the request.
length	Length of the buffer at *datap*.

Return

< 0	Request failed. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Sent.

dlpi_xid_res()

Prototype

```
int dlpi_xid_res (int             dlpi_data,
                  unsigned long    pfb,
                  char            *datap,
                  int              length) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine sends a DL_XID_RES, the response to a DL_XID_IND.

Parameters

dlpi_data	streams file ID. This is the file descriptor returned by a call to *dlpi_open()*.
pfb	If non-zero, poll final bit will be set in the request.
datap	Pointer to a user-supplied buffer of data to send with the request.
length	Length of the buffer at *datap*.

Return

< 0	Request failed. See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Sent.

dlpi_write_data()

Prototype

```
int dlpi_write_data(int   dlpi_data,
                    char *buf,
                    int   cnt) ;
```

Include File(s) **<gcom/dlpiapi.h>**

Description This routine writes a data message to the DLPI driver on the indicated stream. The data are located in the buffer area pointed to by *buf* and consist of *cnt* bytes.

Parameters

dlpi_data	The stream to which to write data
buf	The buffer from which to write the data
cnt	The number of bytes to write

Return

< 0	See “DLPI API Library Routine Error Return Defines” on page 118 for a complete list of the possible error return values.
>= 0	Data successfully sent.

dlpi_xray_req()

Prototype:

```
int dlpi_xray_req( int   fid,
                   int   upa,
                   int   on_off,
                   int   hi_wat,
                   int   lo_wat);
```

Include File(s) **<gcom/dlpiapi.h>**

Description: This routine is used with a newly-opened data stream. When processed, the request sent by this routine links the stream to a DLPI UPA. Any data traffic passing through the UPA will also be presented to this data stream. When data is presented to the X-ray stream, a descriptive header is prepended to the data, providing some insight into the nature of the data which follows. This header conforms to the format:

```
typedef struct
{
   dl_uns8    xr_type ;        /* 1 = send, 2 = receive */
   dl_uns8    xr_rsvd1 ;       /* reserved              */
   dl_uns16   xr_seq ;         /* sequence number       */
   dl_uns32   xr_timestamp ;   /* Rsys time (millisecs) */
   dl_uns16   xr_modid ;       /* Rsys process number   */
   dl_uns16   xr_upa ;         /* DLPI UPA number       */
} dl_x_ray_hdr_t ;
```

The Rsys time is the number of elapsed milliseconds since the Rsystem was initialized. The process number is an internal module ID number.

Sequence numbers can be useful in keeping track of flow control. Flow control for X-ray streams works a little differently than flow control for other streams. A “normal” stream will queue data until the high water mark is reached, then exert backpressure to stop data flow on that stream until the low water mark is reached. An X-ray stream begins discarding data when the high water mark is reached, then begins re-queuing it when the low water mark is reached. Monitoring sequence numbers will allow the user to determine when data was dropped.

The data which follow this header are the raw CDI message, formatted according to the protocol rules, with all the headers included. An application with some knowledge of the underlying protocols can decipher pieces of these messages to perform data tracing.

As a practical note, when X-ray streams are going to be used, the streams configuration must have an extra CDI UPA or two beyond those needed to support the protocol drivers. These extra UPA's are used by the X-ray streams.

Parameters:	*fid:*	The file descriptor of the data stream to use as the X-ray stream.
	upa:	The DLPI UPA to be X-rayed.
	on_off:	Non-zero to turn X-ray on, zero to turn X-ray off.
	hi_wat:	A high-water mark for the stream. Should probably be relatively large (60000 or so).
	lo_wat:	A low-water mark for the stream. Should probably be about 75% of the high-water mark.
Return Values:	0:	The request was successfully sent.
	< 0:	The request was not sent; error condition.

INDEX

Index

a

b

c

d

e

f

g

h

i

k

l

m

n

o

p

r

S

t

u

v

w

x