X.25/HDLC Configuration Guide

DC 900-1345H

Protogate, Inc.
12225 World Trade Drive, Suite R
San Diego, CA 92128
October 2004

Protogate, Inc.
12225 World Trade Drive, Suite R
San Diego, CA 92128
(858) 451-0865

Contents

List of Figures

List of Tables

Preface

Purpose of Document

This document contains information necessary for the configuration and management of the X.25 and HDLC protocol services on Protogate's Freeway communications server or embedded intelligent communications processor (ICP). The document describes software installation and verification, configuration options, the x25_manager configuration utility program, and the low-level interface accessible to a client program with MANAGER privileges.

> **Note**
>
> In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user's guide for your ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*).

Intended Audience

This document should be read by the Systems Administrator responsible for the installation, configuration and maintenance of Freeway. No programming experience is necessary to use the x25_manager utility for configuring X.25 and HDLC (LAPB) protocol services on Freeway.

However, familiarity with the C programming language is essential if the user intends to write an application that uses MANAGER privileges to configure Freeway under program control and/or engage in on-line X.25 facilities negotiation with the network Data

Circuit-terminating Equipment (DCE). In this case, experience in applying state machine (*finite-state automata*) concepts to program design may also be helpful.

Required Equipment

Protogate's X.25/HDLC protocol service is available on Freeway.

Protogate's Call Service Application Program Interface (CS API) is provided as a subroutine library that must be installed on each client computer. Refer to the *Freeway Server User's Guide*.

The CS API supports access to X.25/HDLC protocol services on Freeway. Refer to the *X.25 Call Service API Guide*.

Organization of Document

Chapter 1 gives an overview of Protogate's Freeway product, a summary of the X.25 protocol, and the sequence of steps normally used to configure and enable the Freeway data links.

Chapter 2 describes how to install the X.25/HDLC software in both the UNIX and VMS environments.

Chapter 3 discusses the Freeway X.25 configuration options.

Chapter 4 describes optional on-line facilities registration procedures for X.25 networks.

Chapter 5 compares call service configuration and on-line facilities registration procedures and describes potential conflicts.

Chapter 6 describes how to manage basic Freeway operations to support USER applications.

Chapter 7 describes Protogate's X.25 OSI network service support.

Chapter 8 discusses X.25 certification.

Chapter 9 describes how to use the x25_manager utility program to configure Freeway interactively.

Chapter 10 describes MANAGER application program access to Freeway through Protogate's Call Service Application Program Interface (CS API).

Chapter 11 describes the non-standard HDLC configuration options.

Chapter 12 discusses the X.25 physical level considerations.

The Glossary contains acronyms and terms used in this document.

The Index provides a comprehensive cross reference between Freeway configuration information in Chapter 3 and Chapter 4, and the configuration procedures described in Chapter 9 and Chapter 10. To locate the cross references, refer to the index entry "Cross reference."

Protogate References

The following documents provide useful supporting information, depending on the customer's particular hardware and software environments. Most documents are available on-line at Protogate's web site, www.protogate.com.

General Product Overviews

- *Freeway 1100 Technical Overview* 25-000-0419
- *Freeway 2000/4000/8800 Technical Overview* 25-000-0374
- *ICP2432 Technical Overview* 25-000-0420
- *ICP6000X Technical Overview* 25-000-0522

Hardware Support

- *Freeway 1100/1150 Hardware Installation Guide* DC 900-1370
- *Freeway 2000/4000 Hardware Installation Guide* DC 900-1331
- *Freeway 8800 Hardware Installation Guide* DC 900-1553
- *Freeway 2000/4000 Hardware Maintenance Guide* DC 900-1332
- *Freeway ICP6000R/ICP6000X Hardware Description* DC 900-1020
- *ICP6000(X)/ICP9000(X) Hardware Description and Theory of Operation* DC 900-0408
- *ICP2424 Hardware Description and Theory of Operation* DC 900-1328
- *ICP2432 Hardware Description and Theory of Operation* DC 900-1501
- *ICP2432 Hardware Installation Guide* DC 900-1502

Freeway Software Installation Support

- *Freeway Server User's Guide* DC 900-1333
- *Freeway Software Release Addendum: Client Platforms* DC 900-1555
- *Getting Started with Freeway 1100/1150* DC 900-1369
- *Getting Started with Freeway 2000/4000* DC 900-1330
- *Getting Started with Freeway 8800* DC 900-1552
- *Loopback Test Procedures* DC 900-1533

Embedded ICP Installation and Programming Support

- *ICP2432 User's Guide for Digital UNIX* DC 900-1513
- *ICP2432 User's Guide for OpenVMS Alpha* DC 900-1511
- *ICP2432 User's Guide for OpenVMS Alpha (DLITE Interface)* DC 900-1516
- *ICP2432 User's Guide for Windows NT* DC 900-1510
- *ICP2432 User's Guide for Windows NT (DLITE Interface)* DC 900-1514

Application Program Interface (API) Programming Support

- *Freeway Data Link Interface Reference Guide* DC 900-1385
- *Freeway QIO/SQIO API Reference Guide* DC 900-1355
- *Freeway Server-Resident Application Programmer's Guide* DC 900-1325
- *Freeway Transport Subsystem Interface Reference Guide* DC 900-1386

Socket Interface Programming Support

- *Freeway Client-Server Interface Control Document* DC 900-1303

Toolkit Programming Support

- *OS/Impact Programmer's Guide* DC 900-1030
- *Protocol Software Toolkit Programmer's Guide* DC 900-1338

Protocol Support

- *ADCCP NRM Programmer's Guide* DC 900-1317
- *Asynchronous Wire Service (AWS) Programmer's Guide* DC 900-1324
- *Addendum: Embedded ICP2432 AWS Programmer's Guide* DC 900-1557
- *BSC Programmer's Guide* DC 900-1340
- *BSCDEMO User's Guide* DC 900-1349
- *BSCTRAN Programmer's Guide* DC 900-1406
- *DDCMP Programmer's Guide* DC 900-1343
- *Freeway AUTODIN Programmer's Guide* DC 908-1558
- *Freeway FMP Programmer's Guide* DC 900-1339
- *Freeway Marketfeed 2000 Programmer's Guide* DC 900-1346
- *Freeway SIO STD-1300 Programmer's Guide* DC 908-1559
- *Freeway SWIFT and CHIPS Programmer's Guide* DC 900-1344
- *Military/Government Protocols Programmer's Guide* DC 900-1602
- *SIO STD-1200A (Rev. 1) Programmer's Guide* DC 908-1359
- *X.25 Call Service API Guide* DC 900-1392
- *X.25/HDLC Configuration Guide* DC 900-1345
- *X.25 Low-Level Interface* DC 900-1307

Other Helpful References

- *CCITT Blue Book, Volume VIII—Fascicle VIII.2, Data Communication Networks: Services and Facilities, Interfaces, Recommendations X.1–X.32*, Geneva, 1989.
- *CCITT Red Book, Volume VIII—Fascicle VIII.3, Data Communication Networks Interfaces, Recommendations X.20–X.32*, Geneva, 1985.
- *CCITT Yellow Book, Volume VIII—Fascicle VIII.2, Data Communication Networks Services and Facilities Terminal Equipment and Interfaces, Recommendations X.1—X.29*, Geneva, 1981.
- International Standard ISO 7776:1986(E)
- International Standard ISO 8208:1987(E)

For general X.25/HDLC information and familiarization:

- *Inside X.25: A Manager's Guide*, by Sherman K. Schlar
- *Computer Networks*, by Andrew S. Tanenbaum
- *ISDN An Introduction*, by William Stallings

Document Conventions

Protogate's CS API for Freeway X.25/HDLC operates on a variety of client computer systems. In this document, bits within a byte, word, or longword are identified by the binary logarithm of their value. That is, bit *n* is valued as 2 to the *n*th power (bit 0 is 1, bit 1 is 2, bit 2 is 4, bit 3 is 8, and so on).

The term "Freeway" refers to any of the Freeway server models (for example, Freeway 500/3100/3200/3400 PCI-bus servers, Freeway 1000 ISA-bus servers, or Freeway 2000/4000/8800 VME-bus servers). References to "Freeway" also may apply to an embedded ICP product using DLITE (for example, the embedded ICP2432 using DLITE on a Windows NT system).

Physical "ports" on the ICPs are logically referred to as "links." However, since port and link numbers are usually identical (that is, port 0 is the same as link 0), this document uses the term "link."

Program code samples are written in the "C" programming language.

Revision History

The revision history of the *X.25/HDLC Configuration Guide*, Protogate document DC 900-1345H, is recorded below:

Document Revision	Release Date	Description
DC 900-1345A	April 1995	Original release
DC 900-1345B	June 1995	Updated Chapter 2
DC 900-1345C	September 1996	Minor changes for 2.4.1 server release
DC 900-1345D	November 1997	Add Chapter 12, "*Physical Level Considerations*"
DC 900-1345D	March 1998	Update Section 1.1 through Section 1.4. Restore Communication and Segmentation buffer size information to Revision B level (Chapter 3, Chapter 9, and Chapter 10). Clarify EIA information (Section 9.3.3.4 on page 130). Add notes on page 51 and page 59. Add options 13–15 (Section 10.3.4.1 on page 158).
DC 900-1345F	April 1998	Add EIA Mil-Std 188C support (Section 3.4.15 on page 61, Section 9.3.3.4 on page 130, and Section 10.3.4.1 on page 158)
DC 900-1345G	November 1998	Change setup file names to svc.setup and hdlc.setup Add help feature for test programs (Chapter 2) Add monitoring of exceptions (Section 9.6.4 on page 150 Add monitoring packet formats (Chapter 10) Add 32-bit statistics support (Chapter 10)

Document Revision	Release Date	Description
DC 900-1345H	October 2004	Update contact information for Protogate. Add ISO HDLC Option 4 for UI frames (Section 11.3 on page 193). Add ISO HDLC Option 12 for TEST frames (Section 11.4 on page 194). Add HTESTcommand (Section 10.3.16 on page 177) and ITEST response (Section 10.4.13 on page 189) for MANAGER applications.

Customer Support

If you are having trouble with any Protogate product, call us at (858) 451-0865 Monday through Friday between 8 a.m. and 5 p.m. Pacific time.

You can also fax your questions to us at (877) 473-0190 any time. Please include a cover sheet addressed to "Customer Service."

We are always interested in suggestions for improving our products. You can use the report form in the back of this manual to send us your recommendations.

Chapter 1 Introduction

This manual contains information necessary for the configuration and management of the X.25 and HDLC protocol services on Protogate's Freeway communications server.

1.1 Product Overview

Protogate provides a variety of wide-area network (WAN) connectivity solutions for real-time financial, defense, telecommunications, and process-control applications. Protogate's Freeway server offers flexibility and ease of programming using a variety of LAN-based server hardware platforms. Now a consistent and compatible embedded intelligent communications processor (ICP) product offers the same functionality as the Freeway server, allowing individual client computers to connect directly to the WAN.

Both Freeway and the embedded ICP use the same data link interface (DLI). Therefore, migration between the two environments simply requires linking your client application with the proper library. Various client operating systems are supported (for example, UNIX, VMS, and Windows NT).

Protogate protocols that run on the ICPs are independent of the client operating system and the hardware platform (Freeway or embedded ICP).

1.1.1 Freeway Server

Protogate's Freeway communications servers enable client applications on a local-area network (LAN) to access specialized WANs through the DLI. The Freeway server can be any of several models (for example, Freeway 1100, Freeway 2000/4000, or Freeway

8000/8800). The Freeway server is user programmable and communicates in real time. It provides multiple data links and a variety of network services to LAN-based clients. Figure 1–1 shows the Freeway configuration.

To maintain high data throughput, Freeway uses a multi-processor architecture to support the LAN and WAN services. The LAN interface is managed by a single-board computer, called the server processor. It uses the commercially available VxWorks operating system to provide a full-featured base for the LAN interface and layered services needed by Freeway.

Freeway can be configured with multiple WAN interface processor boards, each of which is a Protogate ICP. Each ICP runs the communication protocol software using Protogate's real-time operating system.

1.1.2 Embedded ICP

The embedded ICP connects your client computer directly to the WAN (for example, using Protogate's ICP2432B PCIbus board). The embedded ICP provides client applications with the same WAN connectivity as the Freeway server, using the same data link interface. The ICP runs the communication protocol software using Protogate's real-time operating system. Figure 1–2 shows the embedded ICP configuration.

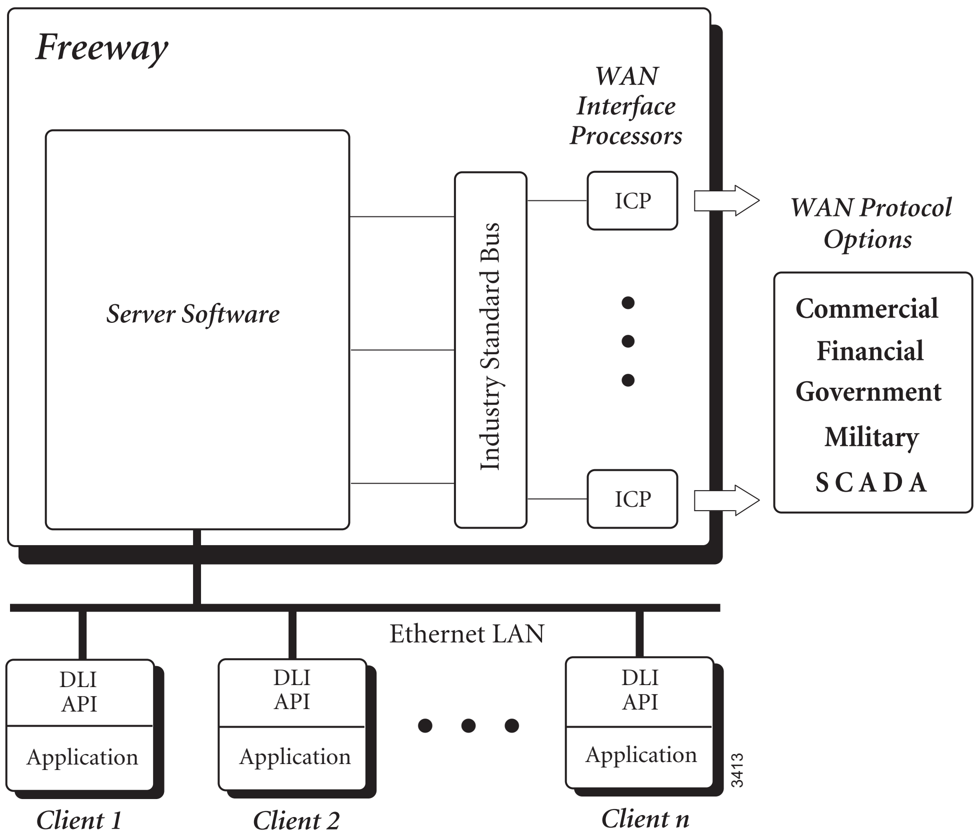

Figure 1–1: Freeway Configuration

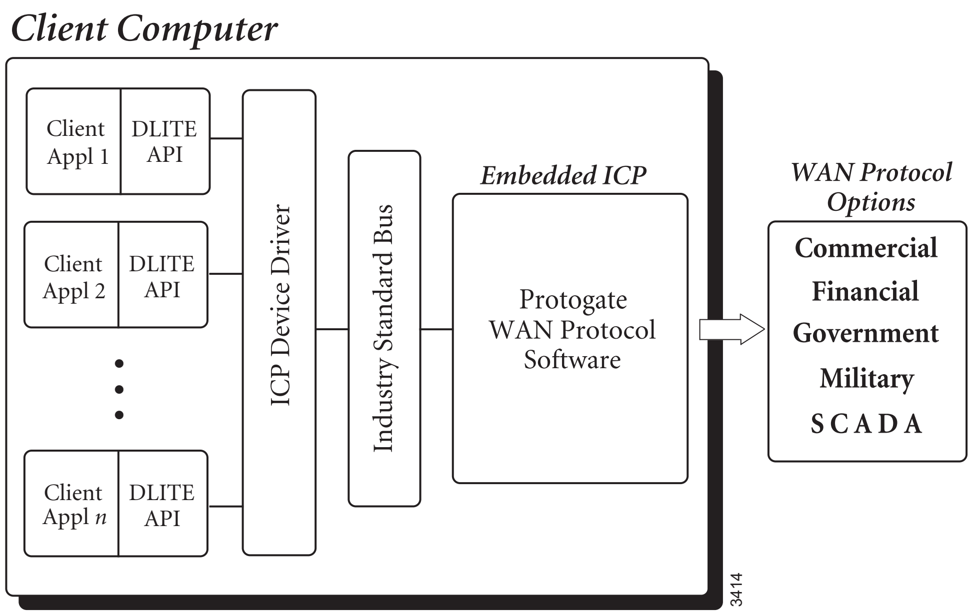

Figure 1–2: Embedded ICP Configuration

Summary of product features:

- Provision of WAN connectivity either through a LAN-based Freeway server or directly using an embedded ICP
- Elimination of difficult LAN and WAN programming and systems integration by providing a powerful and consistent data link interface
- Variety of off-the-shelf communication protocols available from Protogate which are independent of the client operating system and hardware platform
- Support for multiple WAN communication protocols simultaneously
- Support for multiple ICPs (two, four, eight, or sixteen communication lines per ICP)
- Wide selection of electrical interfaces including EIA-232, EIA-449, EIA-485, EIA-530, EIA-562, V.35, ISO-4903 (V.11), and MIL-188
- Creation of customized server-resident and ICP-resident software, using Protogate's software development toolkits
- Freeway server standard support for Ethernet and Fast Ethernet LANs running the transmission control protocol/internet protocol (TCP/IP)
- Freeway server standard support for FDDI LANs running the transmission control protocol/internet protocol (TCP/IP)
- Freeway server management and performance monitoring with the simple network management protocol (SNMP), as well as interactive menus available through a local console, telnet, or rlogin

1.2 Freeway Client-Server Environment

The Freeway server acts as a gateway that connects a client on a local-area network to a wide-area network. Through Freeway, a client application can exchange data with a remote data link application. Your client application must interact with the Freeway server and its resident ICPs before exchanging data with the remote data link application.

One of the major Freeway server components is the message multiplexor (MsgMux) that manages the data traffic between the LAN and the WAN environments. The client application typically interacts with the Freeway MsgMux through a TCP/IP BSD-style socket interface (or a shared-memory interface if it is a server-resident application (SRA)). The ICPs interact with the MsgMux through the DMA and/or shared-memory interface of the industry-standard bus to exchange WAN data. From the client application's point of view, these complexities are handled through a simple and consistent data link interface (DLI), which provides dlOpen, dlWrite, dlRead, and dlClose functions.

Figure 1–3 shows a typical Freeway connected to a locally attached client by a TCP/IP network across an Ethernet LAN interface. Running a client application in the Freeway client-server environment requires the basic steps described in Section 1.2.1 and Section 1.4.

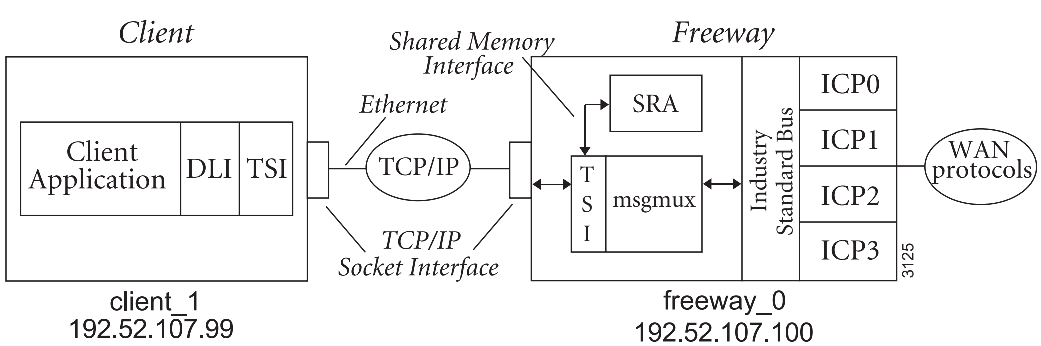

Figure 1–3: A Typical Freeway Server Environment

1.2.1 Establishing Freeway Server Internet Addresses

The Freeway server must be addressable in order for a client application to communicate with it. In the Figure 1–3 example, the TCP/IP Freeway server name is freeway2, and its unique Internet address is 192.52.107.100. The client machine where the client application resides is client1, and its unique Internet address is 192.52.107.99. Refer to the *Freeway User's Guide* to initially set up your Freeway and download the operating system, server, and protocol software.

1.3 Embedded ICP Environment

Refer to the user's guide for your embedded ICP and operating system (for example, the *Freeway Embedded ICP2432 User's Guide for Windows NT*) for software installation and setup instructions. The user's guide also gives additional information regarding the data link interface (DLI) and embedded programming interface descriptions for your specific embedded environment. Refer back to Figure 1–2 on page 28 for a diagram of the embedded ICP environment. Running a client application in the embedded ICP environment requires the basic steps described in Section 1.4

1.4 Client Operations

1.4.1 Defining the DLI and TSI Configuration

In order for your client application to communicate with the ICP's protocol software, you must define the DLI sessions and the transport subsystem interface (TSI) connections between your client application and Freeway (or an embedded ICP). To accomplish this, you first define the configuration parameters in DLI and TSI ASCII configuration files, and then you run two preprocessor programs, dlicfg and tsicfg, to create binary configuration files. The dlInit function uses the binary configuration files to initialize the DLI environment.

1.4.2 Opening a Session

After the DLI and TSI configurations are properly defined, your client application uses the dlOpen function to establish a DLI session with an ICP link. As part of the session establishment process, the DLI establishes a TSI connection with the Freeway MsgMux through the TCP/IP BSD-style socket interface for the Freeway server, or directly to the ICP driver for the embedded ICP environment.

1.4.3 Exchanging Data with the Remote Application

After the link is enabled, the client application can exchange data with the remote application using the dlWrite and dlRead functions.

1.4.4 Closing a Session

When your application finishes exchanging data with the remote application, it calls the dlClose function to disable the ICP link, close the session with the ICP, and disconnect from the Freeway server or the embedded ICP driver.

1.5 Overview of X.25/HDLC

This document describes the procedures required to properly configure the Freeway X.25 protocol service before applications may access X.25 virtual circuits through Freeway. This document also describes procedures required to configure the Freeway High-level Data Link Control (HDLC) protocol service for direct access to HDLC, bypassing the X.25 protocol service. Figure 1–4 shows examples of Freeway X.25 and HDLC connections.

Chapter 3 and Chapter 4 discuss X.25 configuration options and their effects on Freeway operation. You can configure Freeway either by using the x25_manager utility program (Chapter 9), or under MANAGER application program control (Chapter 10). Both methods require the installation of Protogate's Call Service Application Program Interface (CS API). The CS API presents a consistent high-level common interface across multiple hosts and operating systems. Refer to the *X.25 Call Service API Guide*.

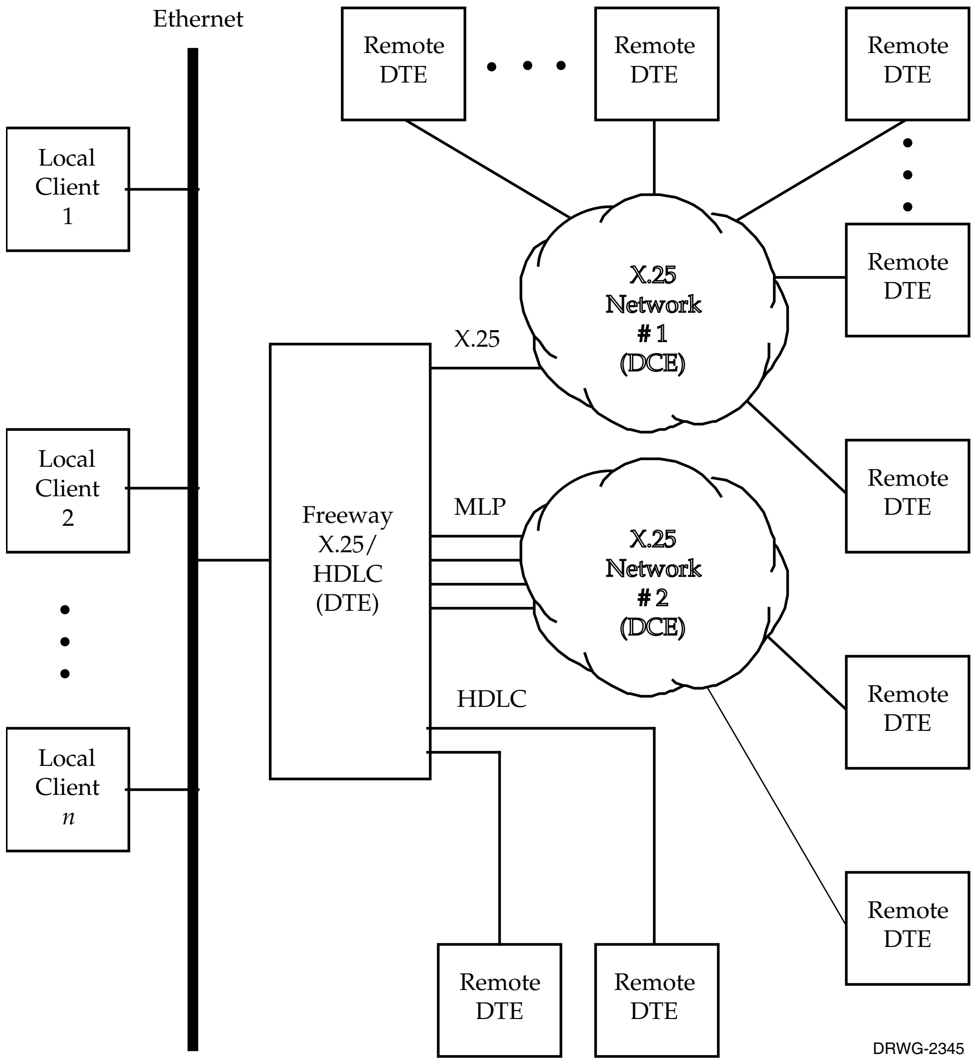

Figure 1–4: Freeway X.25 and HDLC Connections

1.5.1 X.25 Protocol Summary

The X.25 protocol is based on the International Standards Organization (ISO) seven-layer model for open systems interconnect and implements the first three layers of this model. From the lowest, most "primitive" level, the seven levels of the ISO model are defined as follows:

1. Physical level	This level defines the line characteristics for the physical connection.
2. Link (frame) level	This level defines a bit- or byte-oriented protocol for information exchange, acknowledgment, error detection, and retransmission on the data link.
3. Network (packet) level	This level defines a higher-level protocol to provide the multiplexing function required to route information between a local user and a remote user over the data link.
4. Transport level	This level ensures the integrity of user-to-user data transfer, including all required error recovery not handled at lower levels.
5. Session level	This level handles the establishment and termination of the virtual connection between two users.
6. Presentation level	This level handles data format translation between the user's data format and the network's data format.
7. Application level	This is the user level.

At the physical level, X.25 offers two choices: X.21/V.11 or X.21 bis. For more information, refer to the CCITT X.25 reference documents. Protogate's default X.25 physical-level interface is X.21 bis, which is available in EIA-232, EIA-449, EIA-530, or V.35 format.

At the link level, referred to as the frame level or single link procedure (SLP) in this document, X.25 employs the HDLC LAPB[1] protocol. HDLC LAPB is a standard, full-duplex protocol that simplifies the exchange of information between computers by using network or direct connections. It provides link-level functions such as link connect, link reset, link disconnect, information exchange, frame acknowledgment, information flow control, frame sequence number generation and checking, frame check sequence (FCS) generation and error detection, frame rejection, and frame retransmission. The content of information exchanged on the link is unknown (transparent) at this level and does not affect link operation.

At the network level (referred to as the packet level in this document), X.25 provides a method for establishing a logical channel (a virtual circuit or data path) between the local Data Terminal Equipment (DTE) and a remote DTE elsewhere on the X.25 network. A DTE may operate several such logical channels to different remote DTEs simultaneously. The data exchange on each logical channel is unaffected by that on other logical channels. Data exchange on all logical channels (at the packet level) is statistically multiplexed transparently at the frame level.

Implementation of the ISO levels 4 through 7 is the responsibility of the application.

1.5.2 Multilink Procedures

Both the 1984 and 1988 CCITT recommendations for X.25 and the ISO 7776 standard support the optional use of a multilink procedure (MLP) to allow packet-level traffic to be distributed across more than one physical data link. When the multilink procedure is enabled, the packet level sends and receives data by means of the MLP rather than interfacing directly with the frame-level SLP.

MLP operation provides the following features:

1. High-level Data Link Control Link Access Procedure Balanced

Bandwidth economy Although a network DCE may arbitrarily limit the bandwidth of each HDLC LAPB data link, MLP permits the DTE to increase the effective bandwidth of its network interface by coordinating the use of several physical data links simultaneously to implement a single logical DTE/DCE interface with a bandwidth equal to the sum of the individual data link bandwidths.

Load-sharing MLP management of the logical DTE/DCE interface ensures that X.25 demands for transmission bandwidth are evenly distributed across all available data links under MLP control.

Reliability MLP operation includes a sophisticated fail-over feature that gracefully handles data link failure by shifting the transmission load to other active data links without losing data.

Graceful degradation The reliability of MLP results in graceful degradation of service when a data link fails or is taken off-line for maintenance.

With respect to the ISO seven-layer model, MLP logic is on the thin line between the frame level and the packet level. The MLP logic relies heavily on frame-level (SLP) indications of successful or unsuccessful transmission, MLP-level timers, and MLP-level sequence numbers to support DCE/DTE packet-level operation by means of the MLP/SLPs transmission pathway.

Note

The Protogate X.25 protocol services provide *optional* support for multilink procedures. The HDLC protocol services do not support multilink procedures.

1.5.3 DTE and DCE

When X.25 is used with a network, the connection to the network is made through Data Circuit-terminating Equipment (DCE). The computer connected to the network is referred to as Data Terminal Equipment (DTE). In this environment, each X.25 interface in the network has a DTE-to-DCE connection. The remote DTEs are attached to a different DCE elsewhere on the network.

When X.25 is used for a direct point-to-point connection between computers, it is DTE-to-DTE. One end of the connection must be configured to play the role of the DCE while the other remains a DTE. The differences between the DCE and the DTE in this environment are primarily found in the characteristics of the HDLC frame addressing. Other behavioral traits of a genuine network DCE are not necessarily preserved in the point-to-point environment.

The designation of a call as *incoming* or *outgoing* is always from the perspective of the DTE. When Freeway is configured to adopt the role of the DCE, it also adjusts its definition of incoming and outgoing calls to fit the perspective of the other DTE.

1.5.4 Freeway Configuration and Startup Steps

After Freeway hardware and software installation and downloading of the X.25 software to the ICP, the system administrator must configure the required X.25 and/or HDLC parameters before the associated protocol service(s) can be used to establish connections and transfer data.

Configuration of the X.25 protocol service must be requested by a MANAGER application using the service access point (SAP) for X.25, and includes the following steps:

1. Configure buffer and station resource limits
2. Configure data links
3. Configure X.25 multilink procedures (optional)
4. Configure X.25 call service (optional)
5. Configure X.25 stations for each link (optional)

6. Enable X.25 data links

Note

Buffer configuration through the X.25 service access point is also performed before HDLC data link configuration.

Configuration of the HDLC protocol service must be requested by a MANAGER application using the SAP for HDLC, and includes the following steps:

1. Configure data links

2. Configure TL1 link activation timer (optional)

3. Configure modem control signal monitoring (optional)

For descriptions of the configuration options, see Chapter 3. Chapter 9 and Chapter 10 explain two methods to perform the configurations.

Section 9.3.8.1 on page 142 and Section 10.3.2 on page 157 describe how to enable the X.25 data links. An HDLC data link is automatically enabled when a USER application requests a connection.

1.5.5 Monitoring X.25/HDLC Data Links

The x25_manager program provides a MONITOR command that allows the system administrator to view and record activity on a selected data link. The feature can be used to diagnose data-line failure when an external data-link analyzer is not available. Even when an external data-link analyzer is available, this feature might be a convenient way to capture data for hard-copy output or to compare Freeway-reported data-link activity to that reported by the analyzer.

Chapter 2 Testing the X.25/HDLC Software

This chapter describes how to use the test programs provided with the X.25/HDLC software. These test programs are written in C and communicate with Freeway through the CS API function calls to perform the following functions:

- Establish virtual circuit or data link connections.
- Initiate the transmission and reception of data on the serial lines.
- Terminate virtual circuit or data link connections.

The test programs can be used to verify that the installed Freeway devices and cables are functioning correctly and as a template for designing applications that interface with the CS API layer.

2.1 Hardware Setup

The test programs run in loopback mode. Before running any test program, perform the following procedure to install the loopback cabling:

Step 1: Provide a synchronous modem. Configure the modem to supply continuous clocking at a data rate between 300 and 64,000 bits per second. The Freeway ICPs are default configured for external clocking, and the modem will supply the clock signal for loopback testing.

Step 2: Install the special three-headed loopback cable between two selected Freeway ports (links) and the synchronous modem. Links are usually looped back in the following pairs: (0,1), (2,3), (4,5), and so on. Attach the male connector on the loopback cable to the modem. For a Freeway 1000, attach a serial cable between each of the links you have selected and a female connector on the loopback cable. For a Freeway 2000 or Freeway 4000, attach the female connectors on the loopback cable directly to the links you have selected.

2.2 Software Configuration

Note

If you installed the software into a directory other than the default directory, you must edit the boot configuration file, the download script file, and the Freeway System Boot Parameters menu. See the *Freeway Server User's Guide*.

Change to the freeway/client/test/x25mgr directory and edit the transport subsystem interface (TSI) configuration file, apitcfg, changing the default value of the Freeway server parameter, freeway_0, to the name (or Internet address) of your current Freeway server. Enter *one* of the following commands depending on the system you are using:

For UNIX:

make -f makefile.sun *[option]*[1]	(for a Sun system)
make -f makefile.hpux *[option]*[1]	(for an HP/UX system)
make -f makefile.sol *[option]*[1]	(for a Solaris system)
make -f makefile.aix *[option]*[1]	(for an RS6000/AIX system)
make -f makefile.osf1 *[option]*[1]	(for an OSF/1 system)

1. The option "clean" compiles and links all executables. The option "all" links executables from existing object files. The options "clean all" can be used together.

For VMS:

@MAKEVMS "" MULTINET	(for VMS with Multinet)
@MAKEVMS "" TCPWARE	(for VMS with TCPware)
@MAKEVMS "" UCX	(for VMS with UCX)

The make file generates the new executable file in the freeway/client/*op-sys*/bin directory. Note that *op-sys* is the identifier for the operating system you are using.

Before running the X.25 test program, x25_svc, or HDLC test program, hdlc_user, you must run the x25_manager utility to configure the X.25/HDLC software. This utility runs interactively or uses an input setup file to configure the links to test either X.25 or HDLC. Table 2–1 shows the appropriate setup file for each test program.

Table 2–1: Files Installed for Testing the X.25/HDLC Software[a]

Program	Description	Setup File for Input to x25_manager
x25_manager	This is the configuration utility program described fully in Chapter 9. It runs interactively or can take a setup file as input to the x25_manager file command.	—
x25_svc	This is the sample test program used to verify the installation and configuration of the X.25 protocol service on Freeway as described in Section 2.3.	svc.setup
hdlc_user	This is the sample test program used to verify the installation and configuration of the HDLC protocol service on Freeway as described in Section 2.4.	hdlc.setup

[a] These programs are located in the freeway/client/test/x25mgr directory. The executable files are located in the freeway/client/*op-sys*/bin directory, where *op-sys* is the identifier for the operating system you are using.

The following sections describe how to use x25_manager to prepare for testing, then run the X.25 or HDLC test program. For full details on the x25_manager configuration utility, refer to Chapter 9. Figure 9–2 on page 120 through Figure 9–4 on page 124 show the complete configuration file contents and x25_manager output for both X.25 and HDLC.

2.3 Running the X.25 Test Program

Step 1: If you have just rebooted Freeway, you can skip this step. Otherwise, reboot Freeway to download the X.25/HDLC software to the ICP.

Caution

To run the test program successfully, you must have write privileges in the bin directory.

Step 2: Change to the freeway/client/*op-sys*/bin directory, where *op-sys* is the identifier for the operating system you are using.

Step 3: Enter the following command at the system prompt. If you omit the optional CS API configuration file name, x25_manager uses the default cs_config file. Figure 2–1 shows how to invoke the help feature of the x25_manager test program.

x25_manager [CS API configuration file name] for UNIX

or

RUN X25_MANAGER [CS API CONFIGURATION FILE NAME] for VMS

Step 4: At the x25_manager prompt, enter the file command with the appropriate setup file:

: **file(svc.setup)**

The svc.setup input file instructs the x25_manager program to configure the ICP links on Freeway for running X.25. Figure 9–2 on page 120 shows the svc.setup file contents, and Figure 9–3 on page 123 shows a complete output example.

Step 5: To start the x25_svc test program, enter the following command at the system prompt. If you omit the optional CS API configuration file name, x25_manager uses the default cs_config file. Figure 2–2 shows how to invoke the help feature of the x25_svc test

```
x25_manager ?

SIMPACT X.25 MANAGER UTILITY
( VI-100-0381: X25CFW 1.2-0 )
----------------------------
SYNTAX:
        x25_manager [config|?] [dbg] [mgr] [setup]

WHERE:
        [?]       == display this help text
        [config]  == replacement for cs_config    (default == cs_config)
        [dbg]     == debuglog flag 1=yes, 0=no    (default == 0)
        [mgr]     == manager session in [config]  (default == mgr)
        [setup]   == setup command file           (NO DEFAULT)

EXAMPLES:
        x25_manager
        x25_manager  ?
        x25_manager  cs_config
        x25_manager  cs_config  1
        x25_manager  cs_config  0  mgr
        x25_manager  cs_config  0  mgr  svc.setup
```

Figure 2–1: Help Feature of x25_manager Test Program

program. Figure 2–3 shows the typical output from the program in typewriter type; your input is in **bold type**.

x25_svc [CS API configuration file name] for UNIX

or

RUN X25_SVC [CS API CONFIGURATION FILE NAME] for VMS

Step 6: The program prompts you for the following parameters to run the test:

- Test length in minutes
- Packet data field size; this must not exceed the larger of the two buffer sizes configured in the svc.setup file
- Packet transmit window size. The svc.setup file configures Freeway to support a window size of 1–7. To use a window size greater than 7, you must change the

```
x25_svc ?
SYNTAX:
        x25_svc [config|?] [dbg] [s]

WHERE:
        [?]       == display this help text
        [config]  == replacement for cs_config    (default == cs_config)
        [dbg]     == debuglog flag 1=yes, 0=no    (default == 0)
        [s]       == seconds instead of minutes   (default == minutes)

EXAMPLES:
        x25_svc
        x25_svc  ?
        x25_svc  cs_config
        x25_svc  cs_config  1
        x25_svc  cs_config  0  s
```

Figure 2–2: Help Feature of x25_svc Test Program

svc.setup file to support packet level modulo 128 operation. See Section 9.3.5.6 on page 136.

- Link numbers of the links that were looped back in Step 2 of Section 2.1
- User data field value. This may be any value in the given range. However, if you run multiple copies of the x25_svc test program, you must specify a different user data field value for each.

Step 7: The installation is verified if x25_svc successfully completes without errors.

```
SIMPACT X.25 SVC OPTIONS
------------------------

Test Length in Minutes (1 to 1440): 1

Packet data field size (32 to 1024): 512

Packet transmit window (1 to 127): 7

Lowest link ID in test (0 to 15): 0

Highest link ID in test (0 to 15): 1

User data field value (0 to 32767): 2

Connecting clients
transferring data

4 links in test
Packet data size 512 bytes.
Packets/second: XMIT       37   RECV       37   TOTAL       74
Bits/second:    XMIT   151552   RECV   151552   TOTAL   303104
Link ID number         0        1      2        3
LCN reset errors       0        0      0        0
Transport errors       0        0      0        0
RCV data packets     573      565    559      555
XMT data packets     571      580    561      566

Allowing ICP to settle
Disconnecting clients
SVITEST test terminated
```

Figure 2–3: Sample x25_svc Test Program Output

2.4 Running the HDLC Test Program

Step 1: If you have just rebooted Freeway, you can skip this step. Otherwise, reboot Freeway to download the X.25/HDLC software to the ICP.

Caution

To run the test program successfully, you must have write privileges in the bin directory.

Step 2: Change to the freeway/client/*op-sys*/bin directory, where *op-sys* is the identifier for the operating system you are using.

Step 3: Enter the following command at the system prompt. If you omit the optional CS API configuration file name, x25_manager uses the default cs_config file.

x25_manager [CS API configuration file name] for UNIX

or

RUN X25_MANAGER [CS API CONFIGURATION FILE NAME] for VMS

Step 4: At the x25_manager prompt, enter the file command with the appropriate setup file:

: **file(hdlc.setup)**

The hdlc.setup input file instructs the x25_manager program to configure the ICP links on Freeway for running HDLC. Figure 9–4 on page 124 shows the hdlc.setup file contents.

Step 5: To start the hdlc_user test program, enter the following command at the system prompt. If you omit the optional CS API configuration file name, x25_manager uses the default cs_config file. Figure 2–4 shows how to invoke the help feature of the hdlc_user test program. Figure 2–5 shows the typical output from the program in typewriter type; your input is in **bold type**.

hdlc_user [CS API configuration file name] for UNIX

or

RUN HDLC_USER [CS API CONFIGURATION FILE NAME] for VMS

```
hdlc_user ?
SYNTAX:
        hdlc_user [config|?] [dbg] [s]

WHERE:
        [?]       == display this help text
        [config]  == replacement for cs_config    (default == cs_config)
        [dbg]     == debuglog flag 1=yes, 0=no    (default == 0)
        [s]       == seconds instead of minutes   (default == minutes)

EXAMPLES:
        hdlc_user
        hdlc_user  ?
        hdlc_user  cs_config
        hdlc_user  cs_config  1
        hdlc_user  cs_config  0  s
```

Figure 2–4: Help Feature of hdlc_user Test Program

Step 6: The program prompts you for the following parameters to run the test:

- Test length in minutes
- HDLC data field size; this must not exceed the larger of the two buffer sizes configured in the hdlc.setup file
- HDLC transmit window size. The hdlc.setup file configures Freeway to support a window size of 1–7. To use a window size greater than 7, you must change the hdlc.setup file to support frame level modulo 128 operation with the desired window size. See Section 9.3.3.7 on page 130 and Section 9.3.3.17 on page 132.
- Link numbers of the links that were looped back in Step 2 of Section 2.1

Step 7: The installation is verified if hdlc_user successfully completes without errors.

```
SIMPACT HDLC OPTIONS
--------------------

Test Length in Minutes (1 to 1440): 1

HDLC data field size (32 to 1024): 512

HDLC transmit window (1 to 127): 7

Lowest link ID in test (0 to 15): 0

Highest link ID in test (0 to 15): 1

Connecting
Transferring data

4 links in test
Packet data size 512 bytes.
Packets/second: XMIT       41   RECV       41   TOTAL       82
Bits/second:    XMIT   167936   RECV   167936   TOTAL   335872
Link ID number         0        1      2        3
LCN reset errors       0        0      0        0
Transport errors       0        0      0        0
RCV data packets     621      623    606      610
XMT data packets     631      625    616      615

Allowing ICP to settle
Disconnecting
HDLC TEST test terminated
```

Figure 2–5: Sample hdlc_user Test Program Output

Chapter

3 X.25 Configuration Options

This chapter describes each configuration option available for the X.25 protocol service on Freeway.

Chapter 9 explains how to use the x25_manager utility to configure these Freeway options interactively. Chapter 10 explains how to write an application program that uses the Protogate CS API to perform the configurations. Each main section heading in this chapter includes the packet type in parentheses to aid in cross referencing to Chapter 9 and Chapter 10.

The index provides a comprehensive cross reference between this chapter and Chapter 9 and Chapter 10. To locate the cross references, refer to the index entry entitled "**Cross reference.**"

3.1 Software Version Data (**HVERSION**)

Information about the version of X.25 protocol services software resident on Freeway may be obtained from Freeway itself. The MANAGER application requests software version data, and Freeway returns data in the form of an ASCII text string that may be displayed or printed. Software version data may be requested through the X.25 SAP at any time after Freeway has been downloaded.

3.2 Buffer and Station Resource Limits (**HBUFI**)

Freeway buffer sizes and the maximum number of virtual circuits are configurable. Section 3.2.1 through Section 3.2.3 describe these configuration options. Before initializing buffers and virtual circuits, all data links on Freeway must be disabled, which is the case immediately after downloading the X.25 software to Freeway. If you do not send an initialization packet to Freeway after download, the default communication buffer size is 256 bytes, no segmentation buffers are used, and the maximum number of virtual circuits is 256.

3.2.1 Segmentation Buffer Size

The Freeway X.25 protocol service provides optional support for X.25 message segmentation. The segmentation feature is enabled when the segmentation buffer size is configured to a valid non-zero value. Segmentation is disabled when a segmentation buffer size of zero is configured. Segmentation is not supported by the Freeway HDLC protocol service.

The Freeway message segmentation feature improves host CPU efficiency by reducing the number of I/O calls to the host operating system. The host application reads and writes each message as a block of data. Freeway then converts each outgoing client message into an X.25 complete packet sequence. The message is transmitted as a series of message fragments, and is reassembled at the remote DTE into its original form.

Freeway supports a maximum segmentation buffer size of 8192 bytes. If the client message exceeds the size of the segmentation buffer, the client may use the CS_DF_X25MORE flag value in the proto_flag parameter of the cs_write request to indicate that more data follows an initial full segment. This process may be repeated for each additional full segment, until the final segment of the message is sent without the CS_DF_X25MORE flag.

The segmentation buffer size is normally configured to fit the maximum size of a single client message. The segmentation buffer size (in bytes) must be a multiple of 64 between 128 and 8192 bytes. A client may issue a cs_write request with a buf_length any value up to the segmentation buffer size. The cs_read request does not limit the buf_length parameter to the segmentation buffer size. It is the system administrator's responsibility to make the segmentation buffer size known to all application programmers. Refer to the *X.25 Call Service API Guide* for descriptions of the CS API requests and parameters.

Segmentation buffers are not needed if the sizes of the data blocks sent by the host to Freeway are the same size as the communication buffers. However, if segmentation buffers are not configured, Freeway can negotiate and accept only a *local* DTE packet data size (outgoing data) exactly equal to the communication buffer size. On the other hand, if segmentation buffers are configured, Freeway can negotiate and accept all valid *local* DTE packet data sizes up to the configured communication buffer size. In both cases, Freeway can negotiate and accept all valid *remote* DTE packet data sizes (incoming data) up to the configured communication buffer size.

3.2.2 Communication Buffer Size

Freeway permits the frame data size for each link to be set independently (Section 3.4.9). The Freeway communication buffer size must be big enough to contain the largest required frame data size, but should otherwise be the smallest multiple of 64 between 64 and 8192 sufficient to do so. If segmentation buffers are configured, the communication buffer size must be less than or equal to the segmentation buffer size.

Note

Communication buffer sizes larger than 4096 should be specified only when required to support transfer of large HDLC I-frames. The maximum I-frame size for X.25 is 4096.

The specified communication buffer size need only accommodate actual data. Freeway reserves extra room for various protocol headers required for actual transmission and reception on the data links.

3.2.3 Virtual Circuit Maximum

Although limited to a maximum of 128 separate client processes distributed on the LAN, both the CS API and Freeway support multiple client attachments (sessions) per distinct client process. Each client attachment supports one virtual circuit. Freeway allocates one station resource per possible virtual circuit.

The maximum number of virtual circuits supported on Freeway is configurable. The default limit is 256 virtual circuits per ICP. This can be increased to a maximum of 1024 virtual circuits per ICP. The limit applies to the total number of simultaneously active virtual circuits on all data links on an ICP. Control of this large number of virtual circuits may be managed by a single client process, or may be distributed among up to 128 distinct client processes. In either case, a separate CS API client attachment is required for each virtual circuit.

The configured limit on number of virtual circuits also limits the number of clients bound to the Freeway X.25 protocol service. Although a MANAGER application cannot access virtual circuits, it does count as a client bound to the X.25 protocol service, and therefore reduces (by one) the actual maximum number of virtual circuits supported as long as the MANAGER application is bound.

3.3 ICP Buffer Clearing (HBUFCLEAR)

Each Freeway ICP meets data buffering requirements by obtaining buffers from a buffer resource pool on the ICP when needed, and releasing buffers to the pool when no longer needed. The ICP does not normally clear buffers before releasing them to the pool; instead, the ICP overwrites old data when the buffer is reused.

Each Freeway ICP may be configured to clear each buffer before returning it to the ICP buffer pool. This ensures that data is not kept on the ICP longer than is required to successfully complete reception or transmission of the data. Buffer clearing may be enabled at any time after Freeway is downloaded.

Note

Once enabled, buffer clearing cannot be disabled without downloading the affected Freeway ICP.

3.4 Data Links (**HCONFIG**)

Each HDLC LAPB data link is individually configurable. Configuring a link cancels all previous local station assignments on that link. If the SLP controlling the data link belongs to an MLP, reconfiguring the link removes the SLP from MLP control, but does not cancel local station assignments until all SLPs are disassociated from the MLP. The links must be configured before configuring MLP, call service, or station parameters.

All links assigned together under the control of the same multilink procedure (MLP) must use the same configuration option values. Section 3.4.1 through Section 3.4.15 describe individual options applicable to link configuration.

3.4.1 Bit Encoding Format

The method for encoding bits on the link is configurable. The two options are non-return to zero (NRZ) and non-return to zero inverted (NRZI). Most X.25 implementations use NRZ encoding, which is the default bit encoding format used by Freeway.

3.4.2 Clock Source

Freeway may be configured either to use internally generated transmit timing, or to use an external clock for transmit timing. Since Freeway is shipped with each ICP set for external clock, software configuration must also be set for external clock.

The clock source can be selected independently for each link on an ICP. If you need to set internal clock, call the Protogate customer support number given in the *Preface* on page 24.

Note

Clock source configuration applies to transmit timing only. Timing for received data is always supplied as an external input.

3.4.3 Data Rate

The nominal data rate must be specified regardless of the selected clock source. When Freeway is configured to use the internal clock source, it supports data rates from 300 to 64000 b/s on all links simultaneously. Specification of data rates in excess of 64000 b/s may yield an increase in the number of recoverable errors recorded in Freeway link statistics.

3.4.3.1 Custom Data Rate

Freeway permits the specification of custom data rates not found in the standard data rates listed in the next section. Since the serial line controller chips on Freeway cannot support all internal clock bit rates, Freeway substitutes the nearest supported data rate for the specified custom data rate.

The following formula may be used to determine whether a selected custom data rate is supported accurately. Substitute the selected data rate (bits per second) in place of the *bps* variable, and compute the indicated quotient ($Q1$). If the quotient ($Q1$) is an integer (*i.e.*, there is no remainder), the data rate is 99.99% accurate.

$$Q1 = \frac{3686400}{bps}$$

If the above computation indicates that the selected data rate is not accurately supported, the actual data rate may be approximated as follows, where $INT(Q1)$ is the integer value obtained by truncating any fractional portion of the quotient ($Q1$) obtained from the above computation.

$$bps = \frac{3686400}{INT(Q1)}$$

3.4.3.2 Standard Data Rate

Freeway supports the following standard data rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 56000, 57600 and 64000 bits per second. Standard data rate accuracies are typically as follows when the configured clock source is internal: 56000 is 98.73% accurate; 64000 is 98.94% accurate; all other standard data rates are 99.99% accurate.

3.4.4 Custom Frame Addressing

For each HDLC LAPB data link, transmitted and received frames contain a single frame address byte. Two choices are permitted for the frame address byte: the DTE address, or the DCE address. Frames transmitted by the DTE contain the DCE address in commands, or the DTE address in responses. Similarly, frames transmitted by the DCE contain the DTE address in commands, or the DCE address in responses. All frames exchanged on the data link contain one of these two addresses.

The custom frame addressing option permits the specification of non-standard DTE and DCE frame addressing. Both a local address and a remote address must be specified.

3.4.5 DTE/DCE Role Selection

The DTE/DCE selection option determines the data link's role (DTE vs. DCE). Protogate's X.25 is primarily DTE software, and the Freeway physical interface is strictly DTE. When two X.25 links are connected to each other through a modem-eliminator or loopback cable, one X.25 link must use DTE addressing and the other must use DCE addressing. X.25 does not recognize DTE-to-DTE or DCE-to-DCE connections.

Selection of the DCE role affects the following only:

Frame address The default frame address is determined by the role selected (DTE or DCE), unless custom frame addressing is also specified. For a non-MLP data link, the default local address for a DTE is 3, and the default remote address is 1. Correspondingly, the default local address for a DCE is 1, and the default remote address is 3. For an MLP data link, the default local address for a DTE is 15, and the default remote address is 7. Correspondingly, the default local address for a DCE is 7, and the default remote address is 15.

Call collision[1] Normally, the network DCE is responsible for resolving call collisions, should they occur. In a point-to-point connection between two DTEs, one DTE must adopt the role of the DCE. When Protogate's X.25 is configured for DCE operation, it handles call collisions by immediately clearing the call. When the DTE role is selected, Protogate's X.25 waits for the DCE to clear or accept the call.

LCN assignment To decrease the probability of call collisions, the Consultative Committee on International Telephone and Telegraph (CCITT) recommends that the DTE makes logical channel number (LCN) assignments high-to-low, while the DCE makes LCN assignments low-to-high. For switched virtual circuit (SVC) stations, Protogate's X.25 follows the LCN assignment strategy appropriate to the DTE/DCE role selected. LCN assignments for permanent virtual circuit (PVC) stations are made during station configuration (Section 3.7).

REJ packet When optional packet retransmission facilities are supported, the DTE may transmit REJ (reject) packets, and the DCE must process them by initiating retransmission of the requested X.25 data packets. Since the DTE cannot receive REJ packets and the DCE cannot send REJ packets (Section 3.6.14), the DTE/DCE role is critical to correct handling of packet retransmission procedures.

1. A call collision is defined as the simultaneous occurrence of a DCE call indication and a DTE call request on the same logical channel group number (LCGN)/LCN channel.

3.4.6 EIA Electrical Interface

The EIA electrical interface for each Freeway ICP card complies with one or more of the following interface standards:

- EIA_232
- EIA_449
- EIA_530
- EIA_V35
- MIL_188C

A Freeway ICP that supports more than one electrical interface standard requires that the link configuration specify which EIA interface is to be used. Software-selectable EIA configuration is supported on the ICP2424 and ICP2432 only. The ICP6000 disregards this option because EIA is determined by the hardware.

3.4.7 Frame Modulus

The HDLC LAPB data link may be configured for either modulo 8 or modulo 128 sequence number operation. Frame sequence numbers cycle from 0 through one less than the modulus; that is, modulo 8 sequence numbers are 0–7, while modulo 128 sequence numbers are 0–127. Modulo 8 operation is normal for ground-based data links, while modulo 128 operation is more common for data links via satellite.

Note

Frame-level modulo 128 operation is not supported by the CCITT X.25 1980 recommendation, but is optional for other supported X.25 operation profiles.

3.4.8 Frame Transmit Window Size

The frame transmit window size limits the number of information frames (I-frames) that may be transmitted by a data link without acknowledgment. If the number of unacknowledged I-frames reaches the frame transmit window size, the frame transmit window closes and transmission of additional I-frames stops until acknowledgment is received.

The configured frame transmit window size must always be greater than 0 and less than the configured frame modulus. For modulo 8 operation, a frame transmit window size of 7 is customary. For modulo 128 operation, the frame transmit window size is usually at least 8, but must be less than 127.

3.4.9 N1 Maximum Frame Data Size

The CCITT X.25 recommendation describes the N1 parameter as the number of bits permitted within an I-frame, including all bits in the HDLC LAPB address and control fields, the MLP header (if present), the X.25 packet header, the X.25 data field, and the FCS. Protogate's X.25 requires only the specification of the X.25 data field size (in bytes), and automatically adjusts the implied N1 value for the size of the additional fields in a complete I-frame.

The maximum frame data size cannot be larger than the X.25 software communication buffer size (Section 3.2.2). If the configured communication buffer size exceeds 4096 (to accommodate large HDLC I-frames on a non-X.25 link), then the X.25 link configuration must specify an N1 parameter of 4096 or less.

Figure 3–1 shows the relationships between the various portions of an X.25 frame. The byte labeled GFI/LCGN consists of the high-order four bits which are the general format indicator (GFI) and the low-order four bits which are the LCGN.

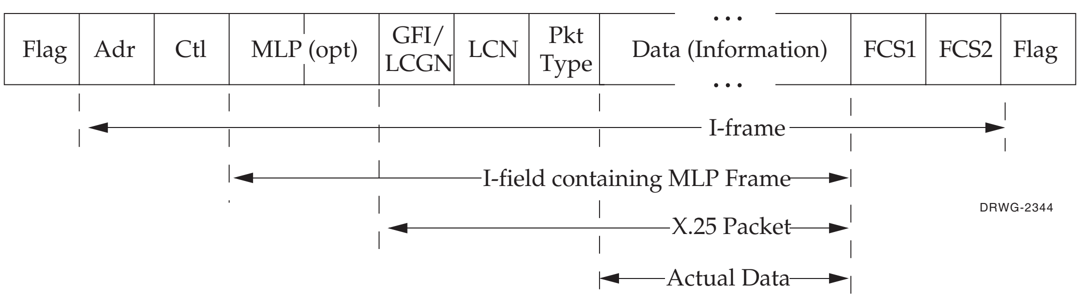

Figure 3–1: X.25 Modulo 8 Information Frame (I-frame)

Note

The maximum frame data size permitted for CCITT X.25 1980 operation is 1024 bytes. For CCITT X.25 1984/1988 and ISO 8208, the maximum frame data size is 4096.

3.4.10 N2 Retry Limit (for T1 Timer)

The N2 retry limit is the maximum number of times that the HDLC LAPB data link attempts to retransmit the same frame. Each retransmission attempt is triggered by expiration of the T1 timer. After N2 retransmission attempts for the same frame, Freeway automatically attempts to reset the HDLC LAPB data link. If Freeway also fails to reset the data link after N2 attempts, Freeway attempts to disconnect the data link. If Freeway then fails to obtain acknowledgment of the disconnect request, Freeway declares the data link inactive and attempts to reactivate the data link until it succeeds, or until an authorized X.25 `MANAGER` application or HDLC `USER` application commands Freeway to disable the link. For an HDLC `USER` application, link failure causes the CS API to report connection failure as a `CS_NOCONN` error status.

3.4.11 T1 CCITT/ISO Retry Timer

The T1 timer limits the period of time that the HDLC LAPB data link waits for transmission acknowledgment. This time limit is usually at least four times the transmission time of an I-frame of maximum size, and is rarely set lower than 2 seconds. Expiration of the T1 timer triggers Freeway attempts to retransmit the unacknowledged I-frame, request acknowledgment, or reset the data link.

Note

If the T1 timer is set too low, the HDLC LAPB protocol breaks down; if it is set too high, recovery from transmission failures takes an excessive period of time.

3.4.12 T2 CCITT/ISO Acknowledgment Delay Timer

The T2 timer specifies the maximum time that the HDLC LAPB data link may wait to acknowledge a received I-frame. Delaying transmission of a supervisory receiver-ready (RR) frame to acknowledge receipt of an I-frame permits the data link to increase the probability that the acknowledgment may be sent on the next I-frame available for transmission. This is especially true of X.25, since receipt of an I-frame containing an X.25 data packet is followed shortly thereafter by the transmission of an I-frame containing an X.25 packet acknowledging the data.

The actual delay between receipt of an I-frame and transmission of acknowledgment varies, and is influenced by the following factors:

Outgoing I-frame If an outgoing I-frame is available, acknowledgment is included in the I-frame as it is transmitted and the T2 timer is stopped.

T2 timer If the T2 timer expires before acknowledgment has been sent, a supervisory acknowledgment is transmitted immediately.

Window closure If the number of unacknowledged I-frames received reaches the configured frame transmit window size, a supervisory acknowledgment is transmitted immediately to authorize continued transfer of incoming I-frames.

3.4.13 T3 ISO Idle Link Timer

The ISO 7776 standard defines an optional T3 timer that limits the duration of an idle link condition on an active link. Receipt of continuous "1" bits on the data link for a period of T3 seconds causes Freeway to report the link inactive (disconnected).

Note

Although the T3 timer is not a CCITT-specified feature, it is compatible with CCITT X.25 operations.

3.4.14 T4 ISO Link Integrity (Keep Alive) Timer

The ISO 7776 standard defines an optional T4 timer that causes periodic transmission of a supervisory polling frame in the absence of other data link activity. Polling continues at T1 time intervals until a valid response is received. In the absence of a valid response, Freeway follows normal N2 retry limit procedures.

The T4 timer may be used as a "keep-alive" timer to periodically check data-link integrity. The T4 timer length must be greater than the configured T1 timer length.

Note

Although the T4 timer is not a CCITT-specified feature, it is compatible with CCITT X.25 operations.

3.4.15 X.21/V.11 Clock Source

The X.21/V.11 clock source configuration option is provided to permit the use of an X.21/V.11 physical layer interface instead of an X.21 bis interface. This option is valid only when Freeway is fitted with X.21/V.11 DTE connectors.

Since the X.21/V.11 physical interface utilizes only a single clock line, Freeway must be configured both to use an external clock source (Section 3.4.2) and to specify receive timing input as the X.21/V.11 clock source for send timing.

3.5 MLP — Multilink Procedures (**HCONMLP**)

The use of MLPs in X.25 effectively increases the throughput capacity of X.25 virtual circuits by supporting the use of several serial data links to carry X.25 data traffic simultaneously. The MLP provides a single access point for packet-level transmission and reception.

When using a multilink procedure (MLP), configure the MLP after configuring data links (or SLPs) but before configuring call service parameters or stations. This practice ensures that call service parameters and stations are validated correctly. If the host attempts to configure an MLP after configuring call service parameters or stations, Freeway may reject the request.

The host can configure more than one MLP, but no two MLPs can share the same SLP. *Each SLP to be assigned to an MLP must be in the disabled state.*

Both the DTE and the DCE must be configured for MLP operation over the same data links. MLP operation is local to the DTE/DCE interface, and does not impose any requirement for MLP operation at another DTE/DCE interface elsewhere on the network.

To X.25, an MLP-controlled set of data links appears as a single logical data link interface. The MLP itself does not have an associated identifier; all SLPs to be assigned to an MLP are included in one host configure MLP packet. Additional SLPs cannot be added without listing all SLPs again, and the requirement that all SLPs be inactive still holds. After MLP configuration, the link id field in host packets (sap_link field of the SAP header, Section 10.2 on page 156) must identify one of the links under the MLP's control. The link id field is used to find the associated MLP but does not determine the actual data link used for data transmission.

An SLP may be deleted from an MLP by reconfiguring the link. The more usual procedure is to disable an SLP to take it out of service, but leave it associated with its MLP. The host merely re-enables the SLP to place it in service again.

Section 1.5.2 on page 35 lists the features of MLP operation. Section 3.5.1 through Section 3.5.6 describe all parameters specific to MLP configuration.

Note

Multilink procedure (MLP) usage is not supported for CCITT X.25 1980 operation, but is optional for other supported X.25 operation profiles.

3.5.1 MT1 Lost Frame Timer Value

The MT1 timer is used during periods of low traffic to limit the time that the MLP waits to receive a missing MLP frame required to complete the original sequence of MLP frames. At the end of this period, the MLP assumes that the MLP frame for which it is waiting has been lost, and begins waiting for the next expected MLP frame.

Note

If MT1 is set too low, MLP processing of data link failures may result in the assumed loss of MLP frames.

Data loss may occur if the MT1 timer expires before the MLP data link fail-over processing can retransmit I-frames not acknowledged on the data link. The value chosen for the MT1 timer should not be less than the product of the T1 retry timer and the N2 retry limit values configured for the data link under MLP control, and should be large enough to permit transmission of an entire frame transmit window's worth of I-frames on the data link.

3.5.2 MT2 Group Busy Timer Value

The MT2 timer is used when all data links are busy[1] to limit the time that the MLP waits to receive a missing MLP frame required to complete the original sequence of MLP frames. At the end of this period, the MLP assumes that the MLP frame for which it is waiting has been lost, and begins waiting for the next expected MLP frame.

The value chosen for the MT2 timer is non-critical on Freeway. Its value may be set very large to avoid loss of MLP frames during local RNR conditions, should they occur.

3.5.3 MT3 Reset Confirmation Timer Value

The MT3 timer is used during MLP reset operations to limit the time that the MLP waits to receive confirmation of its MLP reset request. At the end of this period, the MLP assumes that its original MLP reset request was lost, and issues another MLP reset request.

Note

If MT3 is set too low and temporary data link transmission problems occur, MLP reset procedures may not complete successfully.

The value chosen for the MT3 timer should not be less than the product of the T1 retry timer and the N2 retry limit values configured for the data link under MLP control.

1. A data link is said to be *busy* after it transmits a supervisory receiver-not-ready (RNR) frame to inform the DCE that it is unable to handle additional incoming I-frames due to buffer congestion or other internal processing limitations. The data link later transmits a supervisory RR (receiver-ready) frame to notify the DCE that the busy condition is resolved.

3.5.4 MW Multilink Window Size

The MW parameter determines the size of the multilink receive window by specifying the maximum number of MLP frames that the multilink receive window can accommodate for resequencing. MLP frames received from the lower layer (data links) are held for resequencing and delivery to the higher layer (X.25) as long as each MLP frame's sequence number lies within the multilink receive window. As MLP frames are resequenced successfully and delivered to the higher layer, the position of the multilink receive window rotates within the modulo 4096 cycle used for MLP frame sequencing.

The value for MW must be the same for both the DTE and the DCE. It should also be larger than the product of the number of data links and the configured frame transmit window size, but should not be so large as to commit a majority of the available receive buffering capacity to resequencing of incoming MLP frames.

For example, the MW window size for an MLP controlling four data links, each with a frame transmit window size of 7 may reasonably be set to any value in the range 28–64; with a frame transmit window size of 127 over the same four data links, MW may reasonably be set to any value in the range 508–1024 (provided that the configured communication buffer size is small enough to guarantee a large number of available buffers).

3.5.5 MX Window Guard Region Size

The MX parameter defines the size of the MLP window guard region. The MX window guard region lies just beyond the MW multilink receive window. Receipt of an MLP frame with a sequence number outside the MW multilink receive window but within the MX window guard region signals the loss of MLP frames, and causes the MLP to rotate its MW multilink receive window and MX window guard region.

The value for MX must be large enough for the receiving MLP to recognize receipt of an MLP frame with the highest sequence number outside its multilink receive window that it may legitimately receive after a multilink frame loss has occurred. However, the value for MX should not exceed the value for MW, and the sum of MX and MW cannot exceed 4095.

3.5.6 MLP Data Links

When the MLP is configured, a list of HDLC LAPB data links must be explicitly assigned to the MLP. Each data link in the list must already be configured, must be inactive, and must not already be assigned to another MLP.

3.6 X.25 Call Service Configuration (**HCSCON**)

The host configures the optional call service parameters after configuring the link (and the MLP, if applicable). Each X.25 network connection has a unique call service configuration (an X.25 network connection might be a single link, or it could be an MLP). If you are using multiple X.25 network connections, you must separately configure each connection for call service. Most call service parameters may be adjusted either prior to or after beginning normal X.25 operations. However, certain parameters may not be adjusted if doing so would conflict with facilities registered with the network DCE through X.25 facilities registration procedures. See Chapter 5.

Do not confuse call service *configuration* (which remains in effect until changed) with the call service *facilities* that can be specified dynamically by a `USER` application during SVC call establishment. The latter category is implemented using a quality-of-service (`qos`) parameter with the CS API requests, described in the*X.25 Call Service API Guide*.

Section 3.6.1 through Section 3.6.17 describe the available X.25 call service configuration parameters. The function codes are shown in parentheses to aid in cross referencing to Chapter 10.

3.6.1 Calling DTE Address (**HF_CLLNG**)

The calling DTE address is an optional call service configuration parameter, and specifies the network address associated with the local DTE/DCE network interface. When configured, the DTE calling address is included in outgoing X.25 call request packets, unless specifically replaced by a quality-of-service (qos) parameter item in a client cs_connect request.

3.6.2 Fast Select (**HF_FASCN**)

This call service configuration parameter permits the MANAGER application to configure the manner in which Freeway handles incoming calls containing fast select facilities. Freeway may be configured to take one of the following actions:

BAR calls Freeway is configured to bar each incoming call containing a fast select facility by immediately clearing the call without notifying any client.

NOTIFY client (default) Freeway is configured to notify a registered USER application (if any) when such a call is received. The client so notified must issue one of the following CS API requests: cs_accept, cs_redirect, or cs_refuse. If no client can be notified, Freeway clears the incoming call.

Note

Freeway cannot automatically accept incoming fast select calls, even when incoming call handling is configured to accept incoming calls.

3.6.3 Reverse Charge (**HF_RVCN**)

This call service configuration parameter permits the MANAGER application to configure the manner in which Freeway handles incoming calls containing the reverse charging facility. Freeway may be configured to take one of the following actions:

BAR calls Freeway bars each incoming call containing the reverse charging facility by immediately clearing the call without notifying any client.

ACCEPT calls (default) Freeway automatically accepts each such incoming call, provided that a registered USER application is available to handle the call. If no USER application is available, Freeway instead clears the call without notifying any client.

NOTIFY client Freeway notifies a registered USER application (if any) when such a call is received. If no client can be notified, Freeway clears the incoming call.

3.6.4 Incoming Calls (HF_INCM)

This call service configuration parameter permits the MANAGER application to configure the manner in which Freeway handles incoming calls in general. Freeway may be configured to take one of the following actions:

BAR calls Freeway bars each incoming call by immediately clearing the call without notifying any client.

ACCEPT calls (default) Freeway automatically accepts each incoming call, provided that a registered USER application is available to handle the call. If no USER application is available, Freeway instead clears the call without notifying any application.

NOTIFY client Freeway notifies a registered USER application (if any) when a call is received. If no application can be notified, Freeway clears the incoming call.

3.6.5 T2X Timers (HF_T2XCN)

Each of the call service T2X timers listed below controls a specific aspect of X.25 error handling. A separate set of T2X timers is individually selectable for each configured Freeway X.25 network connection. That is, the T2X timers for one data link may differ from those configured for X.25 on another data link, if those two links belong to separate network connections. When configured to run over an MLP layer, the T2X timers apply to X.25 operations over that MLP (and all of its underlying data links).

T20 This CCITT/ISO restart request timer limits the time that Freeway waits for confirmation of an X.25 restart request. When the timer expires, Freeway repeats its X.25 restart request. The allowed range is 1–255 seconds; the default is 180.

T21 This CCITT/ISO call request timer limits the time that Freeway waits for the DCE to connect or clear an outgoing DTE call request. When the timer expires, Freeway issues a DTE clear request to terminate the outstanding call. The allowed range is 1–255 seconds; the default is 200.

T22 This CCITT/ISO reset request timer limits the time that Freeway waits for confirmation of an X.25 reset request. When the timer expires, Freeway repeats its X.25 reset request, unless doing so would exceed the R22 retry limit. The allowed range is 1–255 seconds; the default is 180.

T23 This CCITT/ISO clear request timer limits the time that Freeway waits for confirmation of an X.25 clear request. When the timer expires, Freeway repeats its X.25 clear request, unless doing so would exceed the R23 retry limit. The allowed range is 1–255 seconds; the default is 180.

T24 This optional ISO window status transmission timer defines the periodic interval at which the DTE transmits a supervisory RR or RNR X.25 packet on each active SVC or PVC that has not transmitted any packet within that interval. The timer is provided for compliance with ISO 8208, but its use is not generally required for operation of X.25 over HDLC LAPB layers. The allowed range is 1–255 seconds; by default the T24 timer is disabled.

T25 This optional ISO window rotation timer provides for periodic retransmission of unacknowledged X.25 data packets. The timer is provided for compliance with ISO 8208, but its use is not generally required for operation of X.25 over HDLC LAPB layers. The allowed range is 1–255 seconds; by default the T25 timer is disabled.

T26 This ISO interrupt response timer limits the time that Freeway waits for confirmation of an X.25 interrupt. When the timer expires, Freeway issues an X.25 reset request. The allowed range is 1–255 seconds; by default the T26 timer is disabled.

T27 This ISO reject response timer limits the time that Freeway waits for receipt of the X.25 data packet previously requested through transmission of an X.25 REJ packet. When the timer expires, Freeway retransmits an X.25 REJ packet (Section 3.6.14), unless the R27 retry limit would be exceeded. The allowed range is 1–255 seconds; by default the T27 timer is disabled.

T28 This CCITT/ISO registration request timer limits the time that Freeway waits for confirmation of an X.25 facilities registration request. When the timer expires, Freeway retransmits an X.25 facilities registration request, unless the R28 retry limit would be exceeded. The allowed range is 0.1–25.5 minutes; the default is 5.0.

Note

The T24–T27 ISO timers are not supported for CCITT X.25 operations. The T28 CCITT/ISO timer is not supported for CCITT X.25 1980 operations.

3.6.6 R2X Retry Limits (**HF_R2XCN**)

Each of the call service R2X retry limits listed below controls a specific aspect of T2X timeout error handling. A separate set of R2X retry limits is individually selectable for each configured Freeway X.25 network connection. That is, the R2X retry limits for one data link may differ from those configured for X.25 on another data link, if those two links belong to separate network connections. When configured to run over an MLP layer, the R2X retry limits apply to X.25 operations over that MLP (and all of its underlying data links).

R20 This is the retry limit for the T20 timer. After R20 attempts to restart X.25, Freeway reports an X.25 link timeout to the MANAGER application (if any) responsible for managing the X.25 service. The allowed range is 1–255 retries; the default is 2.

R22 This is the retry limit for the T22 timer. After R22 attempts to reset the virtual circuit, Freeway reports an SVC connection failure or a PVC procedure error. The allowed range is 1–255 retries; the default is 2.

R23 This is the retry limit for the T23 timer. After R23 attempts to clear the virtual circuit, Freeway reports an SVC connection failure. The allowed range is 1–255 retries; the default is 2.

R25 This is the retry limit for the T25 timer. After R25 attempts to retransmit X.25 data, Freeway issues an X.25 reset request. The allowed range is 1–255 retries; the default is 1.

R27 This is the retry limit for the T27 timer. After R27 attempts to request X.25 data by sending an REJ packet (Section 3.6.14), Freeway issues an X.25 reset request. The allowed range is 1–255 retries; the default is 1.

R28 This is the retry limit for the T28 timer. After R28 attempts to register facilities, Freeway reports a NULL registration confirmation to the MANAGER application (if any) responsible for managing the X.25 service. The allowed range is 1–255 retries; the default is 2.

Note

The R25 and R27 retry limits are not supported for CCITT X.25 operations. The R28 retry limit is not supported for CCITT X.25 1980 operations.

3.6.7 TL1 Link Activation Timer (**HF_TLX**)

This call service configuration parameter sets the periodic interval at which the X.25 MANAGER application or HDLC USER application is notified of continuous failure to activate a data link or reactivate a data link after it fails. After notifying the application of a TL1 timeout event, Freeway continues both to attempt to establish the data link and to provide periodic notification of TL1 timeout events unless the client specifically disables the data link. The allowed range is 1–255 seconds; the default is 180.

3.6.8 LCN Bounds — Logical Channel Types Ranges (**HF_LCN**)

The term logical channel number (LCN) is often used ambiguously to refer either to the least significant 8 bits, or to the entire 12 bits of the composite number formed by concatenating the 4-bit logical channel group number (LCGN) with the 8-bit LCN. In this context, LCN refers to the 12-bit composite LCGN/LCN number.

The LCN bounds call service configuration parameter sets the permitted 12-bit logical channel number range for each of the three categories of SVC call listed below. The ranges cannot overlap, and each number range must generally be higher than those that precede it. An exception is made for ranges that are to be omitted by specifying a range of zero.

The designation of a call as *incoming* or *outgoing* is always from the perspective of the DTE. When Freeway is configured to adopt the role of the DCE, it also adjusts its definition of incoming and outgoing calls to fit the perspective of the other DTE.

LIC–HIC This defines the LCN value range for calls from the DCE to the DTE. LIC is the lowest incoming call LCN, and HIC is the highest incoming call LCN. The HIC value must be greater than or equal to the LIC value. The LIC value must be higher than the highest LCN value assigned to a PVC, unless zero is specified to omit the LIC–HIC range. The default is zero for both LIC and HIC.

LTC–HTC This defines the LCN value range for calls from the DCE to the DTE or vice versa. LTC is the lowest two-way call LCN, and HTC is the highest two-way call LCN. The default LTC is 1; the default HTC is 4095. The HTC value must be greater than or equal to the LTC value. The LTC value must be higher than each of the following, unless zero is specified to omit the LTC–HTC range:

- The highest LCN value assigned to a PVC.
- The HIC value.

LOC–HOC This defines the LCN value range for calls from the DTE to the DCE. LOC is the lowest outgoing call LCN, and HOC is the highest outgoing call LCN. The default is zero for both LOC and HOC. The HOC value must be greater than or equal to the LOC value. The LOC value must be higher than each of the following, unless zero is specified to omit the LOC–HOC range:

- The highest LCN value assigned to a PVC.
- The HIC value.
- The HTC value.

Note

The LCN bounds configuration option may not be set using call service configuration if X.25 facilities registration procedures (Chapter 4) have already determined the logical channel types ranges permitted by the network DCE. See Chapter 5.

3.6.9 Certification Mode (**HF_CERT**)

DCE emulator equipment used to certify DTE X.25 operation is typically limited in its capacity to recognize valid X.25 protocol behavior that deviates from expected testable behavior. The certification mode call service configuration parameter is used to inform Freeway whether or not it is connected to DCE emulator test equipment for certification so that Freeway can accommodate typical limitations in the DCE emulator test equipment.

For example, both the CCITT X.25 recommendation and the ISO 7776 specification state that a DTE can initialize the data link by sending SABM. A network DCE handles receipt of a SABM correctly every time, but DCE emulator test equipment might not expect receipt of a SABM until after it sends a Disconnected Mode (DM) response.

Although call service certification mode is primarily intended for use during certification of X.25 operations, it can also be used during normal operations. Certification mode enforces the following modifications to data link operation, and has no effect on X.25 packet-level operation:

1. During data link startup, certification mode inhibits transmission of SABM (or SABME) prior to receiving a DM, SABM (or SABME) from the DCE. This ensures that the DCE simulator controls the timing and manner of data link startup.

2. Certification mode inhibits supervisory polling following receipt of an RNR frame from the DCE. This eliminates the need for the DCE simulator to handle RR frames from the DTE when the intent is to test DTE halting of I-frame transmissions.

3. Certification mode disables the N2 retry limit when Freeway is sending SABM (or SABME) to reset the data link. This eliminates a race condition between the DTE and the DCE simulator that might cause the DTE to start sending DISC frames.

4. Certification mode enforces the use of the configured T1 timer value when resetting or disconnecting the data link instead of using a fixed 2-second interval. This ensures that the DCE simulator can measure the DTE's T1 timer in any state.

Note

When not in certification mode, Freeway temporarily shortens the T1 timer to two seconds following transmission of FRMR, SABM, SABME or DISC because the transmission time for these frames is very short. The T1 timer value is always used during information transfer.

3.6.10 Flow Control Negotiation (**HF_FLOW**)

This call service configuration parameter permits the MANAGER application to configure the manner in which Freeway handles flow control negotiation. Freeway may be configured to take one of the following actions:

BAR negotiation (default) Freeway immediately clears calls that would negotiate flow control facilities[1] in conflict with Freeway configuration. Outgoing calls are not permitted to contain packet window size and/or packet data size facilities (specified by the qos parameter in the cs_connect request).

ACCEPT negotiation Freeway is configured to permit the use of flow control negotiation facilities during SVC call establishment. In particular, using the qos parameter in the cs_connect request, you may specify a packet window size and/or packet data size that do not match the Freeway configuration.

Note

Flow control negotiation may not be set using call service configuration if X.25 facilities registration procedures (Chapter 4) have already determined whether flow control negotiation is permitted by the network DCE. See Chapter 5.

3.6.11 Modem Control Signal Monitoring (**HF_CLM**)

This call service configuration parameter directs Freeway to begin or end the monitoring of changes in the modem input leads for data carrier detect (DCD) or clear to send (CTS). By default, both DCD and CTS monitoring are disabled. If the monitoring is enabled, changes in the signal condition are reported to the host in a modem control signal information packet (ICLSTATE). You can also set a time period for which the con-

1. Flow control negotiation specifies the packet data size and the packet window size for an SVC call.

dition must be true before the change is reported, using function code HF_CLTMR in the following section.

3.6.12 Modem Control Signal Debounce Time (**HF_CLTMR**)

This call service configuration parameter sets the time period a modem signal must remain on or off before a change is reported.

3.6.13 X.25 Restarts (**HF_RESTART**)

This call service configuration parameter controls Freeway handling of X.25 packet layer detection of lower layer (MLP or HDLC LAPB) initialization. When this option is enabled, Freeway transmits an X.25 restart packet upon detection of lower layer initialization. When this option is disabled, Freeway refrains from sending any X.25 restart packet following lower layer initialization.

3.6.14 REJ — Packet Retransmission Support (**HF_REJ**)

This call service configuration parameter determines whether Freeway supports the X.25 REJ packet type. When this option is enabled, the DTE may send an REJ packet to the DCE to request retransmission of all X.25 data packets beginning at a specified packet sequence number. The DCE processes REJ packets received from the DTE, but never sends an REJ packet to the DTE.

The X.25 REJ packet type is not normally used, since the robustness of the lower layer is generally sufficient to protect the X.25 packet layer from data loss. This option is provided primarily for full compliance with CCITT X.25 and ISO 8208 specifications for DTE operations. This option is disabled by default.

Note

The packet retransmission support option may not be set using call service configuration if X.25 facilities registration procedures (Chapter 4) have already determined whether packet retransmission is permitted by the network DCE. See Chapter 5.

3.6.15 Extended Packet Sequence Numbering (**HF_MOD128**)

This call service configuration parameter determines whether Freeway supports modulo 8 (default) or modulo 128 packet sequence numbers. All virtual circuits must use the same packet numbering modulus, and both the DTE and the DCE must be configured to use the same modulus.

Note

The extended packet sequence numbering option may not be set using call service configuration if X.25 facilities registration procedures (Chapter 4) have already determined whether extended packet sequence numbering is expected by the network DCE. See Chapter 5.

Note

If extended packet sequence numbering is to be used, the host must enable the facility by configuring call service prior to configuring stations. Attempts to configure stations with default packet window sizes greater than seven are rejected if call service has not been configured to support extended packet sequence numbering.

3.6.16 X.25 Operation Profile (**HF_X25_PROFILE**)

This call service configuration parameter selects the CCITT or ISO specification to which Freeway is expected to conform during normal X.25 operations. The option is individually selectable for each configured X.25 network connection. That is, the X.25

profile for one network connection may differ from that selected for another X.25 network connection. When configured to run over an MLP layer, the X.25 operation profile applies to the X.25 operation over that MLP (and all of its underlying data links).

3.6.16.1 Unrestricted X.25 Profile

The unrestricted X.25 profile permits the use of all Protogate X.25 configuration options. This selection permits the widest degree of freedom in X.25 usage, but also permits use of features that may not be supported by the network DCE.

3.6.16.2 CCITT X.25 1980 Profile

Selection of the CCITT X.25 1980 profile disables the use of X.25 packet layer features specific to CCITT X.25 1984 and enforces the following restrictions on X.25 operation:

- The maximum data field size for data packets is 1024 bytes.
- The maximum data field size for interrupt packets is 1 byte.
- The maximum optional user facilities size is 63 bytes.
- The DTE-specified cause code must be zero.
- The address length and facility length in CLEAR REQUEST and CLEAR INDICATION packets are permitted only when user data is present, and must be zero when present.
- The extended format for CLEAR CONFIRMATION packets is not permitted.
- Frame-level modulo 8 operation is mandatory.

3.6.16.3 CCITT X.25 1984 Profile

Selection of the CCITT X.25 1984 profile (default) enables the following X.25 packet layer features specific to CCITT X.25 1984:

- The maximum data field size for data packets is 4096 bytes (excluding header information fields).
- The maximum data field size for interrupt packets is 32 bytes.
- The maximum optional user facilities size is 109 bytes.
- The DTE-specified cause code must be zero or 128–255.
- The address length and facility length in CLEAR REQUEST and CLEAR INDICATION packets are permitted only in the extended format. When present, these field lengths must be zero unless the called line address modified notification facility is used in clearing, in response to an incoming call or call request packet.
- The extended format for CLEAR CONFIRMATION packets may be used only by the DCE in conjunction with the charging information facility.
- Frame-level modulo 128 operation is optional.
- Multilink procedure (MLP) operation is optional.
- The following optional user facilities (not supported in CCITT X.25 1980) are added for CCITT X.25 1984:

    1. On-line facilities registration.
    2. Local charging prevention.
    3. Network user identification.
    4. Charging information.
    5. Hunt group.
    6. Call redirection.

7. Called line address modified notification.
8. Call redirection notification.
9. Transit delay selection and indication.
10. Extended format CUG selection facility.
11. Closed user group with outgoing access (CUG/OA) selection facility.
12. User data field in CLEAR REQUEST and CLEAR INDICATION packets after acceptance of an unrestricted fast select call.
13. Extended-format Recognized Private Operating Agency (RPOA) selection facility.
14. CCITT-specified DTE facilities to support the OSI Network Service.

3.6.16.4 ISO 8208 X.25 Profile

Selection of the ISO 8208 X.25 profile enables the following features specific to ISO 8208, in addition to those supported for CCITT X.25 1984:

- T24 window status transmission timer.
- T25 window rotation timer and associated R25 retry limit.
- T26 interrupt response timer.
- T27 reject packet response timer and associated R27 retry limit (supported only when REJ support is configured, or is negotiated through on-line facilities registration with the network DCE).

3.6.16.5 CCITT X.25 1988 Profile

Selection of the CCITT 1988 X.25 profile enables the following features in addition to all features available to CCITT X.25 1984:

- Extended DTE address support for type-of-address (TOA) numbering-plan identification (NPI) address formats
- Call deflection selection facilities
- Facility for 64,000 b/s throughput class
- Enhanced call redirection or deflection notification

3.6.17 Local DTE Address Length (**HF_ADDR_LEN**)

The typical X.25 DTE address follows the CCITT X.121 recommendation. The X.121 recommendation specifies that a DTE address is formed by concatenating address subfields in the order shown in Table 3–1.

Table 3–1: CCITT X.121 DTE Address Fields

Name	Digits	Description
Prefix	1	(Optional)
DNIC	4	Data network identification code
NTN	10	National terminal number

Many packet-switched public data networks (PDNs) use only the first 8 digits on the NTN to identify the DTE/DCE interface on the network. In these cases, the last two digits of the NTN may be used as an optional DTE subaddress. The DTE subaddress may be used to identify a device, application process, or local DTE not known to the PDN, but known to the DTE actually attached to the PDN.

The local DTE address length is the number of digits in the main portion of the DTE address, excluding the local DTE subaddress field at the end of the NTN. The local DTE address length must be specified separately for each Freeway X.25 network connection. This parameter must be specified correctly for the attached X.25 network to ensure correct operation of the cs_listen request when lowest and highest local DTE subaddress values are specified in the qos parameter for the cs_register request.

3.6.18 Configure DTE Address Format (**HF_TOANPI**)

This function code is used in the call service configuration packet to select the X.25 DTE address format. This function is supported only when the X.25 operation profile selected is 1988 or is unrestricted.

Two DTE address formats are supported: normal address format and type-of-address (TOA) numbering-plan identification (NPI) format. Each X.25 network connection supports one (but not both) of these DTE address formats.

The normal DTE address format limits the length of each DTE address to 15 digits. By default, Freeway supports normal DTE address format.

The TOA/NPI address format increases the maximum DTE address length to 17 digits. In this case, the first DTE address digit specifies the type of address (TOA), and the second DTE address digit gives the numbering-plan identification (NPI). The remaining 15 digits identify a specific DTE.

3.7 X.25 Station Resources (**HCONFIG**)

Freeway requires a local station resource for each active X.25 virtual circuit it manages. The maximum number of station resources is equal to the configured maximum number of virtual circuits set during Freeway buffer configuration procedures (Section 3.2).

There are only 8–16 data links per ICP on Freeway, but there can be many station resources configured for those links. All station resources may be configured for the same link, or they may be distributed in any fashion to one or more links on the same ICP. However, no station resource may be associated with more than one link simultaneously. A station resource configured for a specific data link supports one virtual circuit on that link only.

The user is not required to configure all available station resources on an ICP. If a station resource is not explicitly configured for a data link, it becomes an available resource for SVC operations on any data link on the ICP.

Any station resource configured for an SLP under MLP control is automatically associated with the single logical data link interface represented by the MLP.

3.7.1 X.25 Virtual Circuits — PVCs and SVCs

X.25 defines two different types of virtual circuits: the permanent virtual circuit (PVC) and the switched virtual circuit (SVC). They differ in several ways, though data transfer is the same for both.

- A PVC is analogous to a leased phone line in that it is a permanent point-to-point connection between two DTEs. There is no way for it to connect to any other DTE.
- An SVC is analogous to a dialed phone connection in that it is temporary and switched.
- PVCs are common in applications using X.25 point-to-point communications, but may also be defined on a network.
- SVCs are common in applications that use a network to provide local access to data at several remote locations.
- PVC station resources must be configured.
- Configuration of SVC station resources is optional.

- An SVC requires call setup and clearing procedures by the USER application; a PVC does not.

When a USER application places or receives an X.25 call, the virtual circuit associated with the call is considered to be active, and Freeway associates a station resource with the application for the duration of the X.25 virtual circuit. Freeway selects a configured station resource, if one exists; otherwise, Freeway dynamically configures an available station resource for the job.

3.7.2 Configured Station Resources

Freeway requires that PVC station resources be configured by selecting a station ID, logical channel number (LCN) and logical channel group number (LCGN). Configuring of SVC station resources is optional and requires selection of only the station ID and LCGN; the LCN is selected by Freeway when the USER application places a call.

The advantage to configuring station resources is that the distribution of their use is controlled by the configuration. This may be of importance to application environments that require predictable availability of X.25 SVC access.

Station resource configuration includes the following parameters:

Station ID This parameter identifies the specific station resource being configured to support the associated virtual circuit. The valid values are 1 to the configured virtual circuit maximum (256 by default). All station identifiers for an ICP must be unique on that ICP. The station identifier is only for coordination between the host and Freeway; it is not used on the communications line.

PVC LCN This parameter selects the least-significant 8-bit logical channel number (LCN) portion of the composite 12-bit LCGN/LCN X.25 channel number. If the LCGN is 0, valid values for the LCN are 1– 255. If the LCGN is non-zero, the LCN may be in the range 0–255. For a PVC, the LCGN/LCN must be the same at each end of the DTE/DCE interface. No LCGN/LCN may be assigned twice on the same Freeway X.25 network connection.

PVC/SVC LCGN This parameter represents a group of LCNs designated for a particular type of access to the network. It forms the most significant 4 bits of the 12-bit LCGN/LCN X.25 channel number.

Packet Window Size This parameter controls how many data packets may be sent to the network by a station. The default packet window size is 2, but may be overridden on Freeway by specifying this parameter for the affected station. The packet window size can also be set dynamically either through flow control negotiation[1] (Section 3.6.10) or through facilities registration (Section 4.3.10 on page 93).

3.7.3 Dynamic Station Resources for SVCs

When a USER application places an SVC call and any configured station resources for the data link are currently in use, Freeway supports the use of dynamic station resources. Freeway selects an available non-configured station resource and assigns the station ID, LCN and LCGN.

Non-configured station resources may be used for SVC operations on any data link on the same ICP. Failure to configure station resources on an ICP allows Freeway complete freedom to respond to USER application demands for X.25 SVC access. It also permits commitment of all available station resources to manage X.25 SVCs on a single data link on that ICP, leaving no station resources available for X.25 SVCs on any other link until one of the active SVCs terminates.

1. Use the qos parameter in the cs_connect request to specify the packet window size facility.

Chapter 4

On-line Facilities Registration (HREGRQ and IREGCON)

This chapter describes optional procedures for X.25 networks that support on-line facilities registration (packet types HREGRQ and IREGCON). These procedures normally follow successful link activation, and precede virtual circuit access by USER applications. However, the facilities listed in Section 4.2 may be registered regardless of virtual circuit activity.

Following successful link activation, the X.25 MANAGER application uses the following general procedure for on-line facilities registration. Each X.25 network connection has its own unique facilities registration.

1. After successful link activation, the X.25 MANAGER application issues a host facilities registration request packet (HREGRQ), without data, to Freeway.
2. Freeway responds with a facilities registration confirmation packet (IREGCON). The data area indicates the available facilities supported by the network DCE.
3. The X.25 MANAGER application issues another facilities registration request packet (HREGRQ). The data area indicates the desired facilities to be enabled or disabled.
4. Freeway responds with a facilities registration confirmation packet (IREGCON). The data area indicates the updated status of all available facilities.

Note

The values reported by the network DCE through the facilities registration confirmation packet (IREGCON) override any previous values configured on Freeway.

Protogate's X.25 product supports use of the registration packets described in the CCITT X.25 1984 and 1988 recommendations. The function codes are listed in Table 4–1. Most of the facilities may appear in either host facilities registration request packets (HREGRQ) or Freeway facilities registration confirmation packets (IREGCON). However, the *availability of facilities* and *non-negotiable facilities values* classes of facilities cannot be specified in host facilities registration packets.

Section 10.3.15 on page 174 shows the format of the data areas and explains how to use the Protogate CS API to write an application program to perform facilities registration. Potential conflicts between facilities registration and call service are discussed in Chapter 5.

Section 4.1 through Section 4.8 describe the function codes used in the facilities registration packets, arranged in ascending numerical order.

Table 4–1: Function Codes for Facilities Registration Packets

Code Symbol	Code Number	Function	Allowed Packet Type
HF_NEGP1	128	Facilities negotiable in state *p1*	HREGRQ or IREGCON
HF_NEGANY	129	Facilities negotiable in any state	HREGRQ or IREGCON
HF_AVAIL	130	Availability of facilities	IREGCON only
HF_NON_NEG	131	Non-negotiable facilities	IREGCON only
HF_DFTHRU	132	Default throughput classes assignment	HREGRQ or IREGCON
HF_NSPACK	133	Non-standard default packet data sizes	HREGRQ or IREGCON
HF_NSWIN	134	Non-standard default packet window sizes	HREGRQ or IREGCON
HF_LOGCHAN	135	Logical channel types ranges	HREGRQ or IREGCON

4.1 Facilities Negotiable in State *p1* (**HF_NEGP1**)

This class of facilities affects operation of all logical channels at the DTE/DCE interface. All logical channels used for SVC calls must be in the *p1* state when these facilities are specified in a host facilities registration request packet. The *p1* state is a "ready" state in which the LCN/LCGN that identifies a given logical channel is not currently assigned to a virtual circuit (that is, no SVC call has been placed or received).

4.1.1 Extended Packet Sequence Numbering Facility

When the *extended packet sequence numbering* facility is enabled, modulo 128 packet sequence numbers are used. When this facility is disabled, modulo 8 packet sequence numbers are used. This facility setting should be compatible with the packet window size.[1]

This facility is normally disabled, unless modulo 128 sequence numbers are used at the frame level as well.

4.1.2 REJ — Packet Retransmission Facility

When the *packet retransmission* facility is enabled, the DTE may use REJ procedures (Section 3.6.14 on page 76) to recover lost data packets. This facility is normally disabled, since frame-level operation includes a similar data recovery procedure.

4.1.3 Delivery Bit (D-bit) Modification Facility

When the *D-bit modification* facility is enabled, the DCE ensures that end-to-end acknowledgment is used for data sent to other DTEs. This facility is normally disabled, since normal D-bit procedures allow the local DTE selective control over the use of end-to-end data acknowledgment.

1. Packet window size can be set at the station configuration level (Section 3.7 on page 82), through facilities registration (Section 4.3.10), or through flow control negotiation facilities using the qos parameter of the CS API cs_connect request.

4.2 Facilities Negotiable in any State (**HF_NEGANY**)

This class of facilities affects the validity of selected call service facilities during normal operation. These facilities can be enabled or disabled at any time.

When any of the facilities in Section 4.2.3 through Section 4.2.7 is enabled, the `USER` application uses the CS API `qos` parameter to specify or receive the call service facility information. Refer to the *X.25 Call Service API Guide*.

4.2.1 Incoming Calls Barred Facility

When the *incoming calls barred* facility is enabled, the DCE intercepts and clears all incoming calls. This facility differs from the *configure incoming calls* function described in Section 3.6.4 on page 68; the latter affects Freeway operation only.

4.2.2 Outgoing Calls Barred Facility

When the *outgoing calls barred* facility is enabled, the DCE intercepts and clears all outgoing calls.

4.2.3 Fast Select Acceptance Facility

When the *fast select acceptance* facility is enabled, the DCE is permitted to transmit to the DTE incoming calls which request the fast select facility. When the *fast select acceptance* facility is disabled, the DCE is not permitted to transmit to the DTE incoming calls which request the fast select facility.

4.2.4 Reverse Charging Acceptance Facility

When the *reverse charging acceptance* facility is enabled, the DCE is permitted to transmit to the DTE incoming calls which request the reverse charging facility. When the *reverse charging acceptance* facility is disabled, the DCE is not permitted to transmit to the DTE incoming calls which request the reverse charging facility.

4.2.5 Flow Control Negotiation Facility

When the *flow control negotiation* facility is enabled, both the DTE and DCE are permitted to specify flow control facilities (packet data size and packet window size) when establishing an SVC connection. When this facility is disabled, flow control facilities are not permitted.

4.2.6 Default Throughput Class Negotiation Facility

When the *default throughput class negotiation* facility is enabled, both the DTE and DCE are permitted to specify throughput class facilities when establishing an SVC connection. When this facility is disabled, throughput class facilities are not permitted.

4.2.7 Charging Information Facility

When the *charging information* facility is enabled, the DCE automatically provides charging information in each clear indication packet and each clear confirmation packet. When the *charging information* facility is disabled, the DCE provides charging information only if the DTE includes a request for charging information in its call request packet or its call accept packet when the virtual circuit is established.

4.3 Availability of Facilities (**HF_AVAIL**)

This class of facilities appears only in the Freeway registration confirmation packet (IREGCON). The network DCE notifies the DTE which facilities are available. Facilities that the DCE indicates are not available cannot be requested by the DTE.

The data area of the confirmation packet lists the facilities as a series of bytes in the order shown in Table 4–2. A byte value of “0” means the facility is not available; a “1” means it is available. Use a host facilities registration packet (HREGRQ) and the function codes listed to enable the desired facilities that are available. For function codes listed as “qos,” use the qos parameter of the CS API requests to specify those facilities. Refer to the *X.25 Call Service API Guide*.

Table 4–2: Order of Facilities in Confirmation Packet (IREGCON)

Facility	Code Symbol	Code Number
Extended packet sequence numbering facility	HF_NEGP1	128
Packet retransmission facility	HF_NEGP1	128
D-bit modification facility	HF_NEGP1	128
Called line address modified facility	HF_CLDADMOD	qos
Charging information (per interface) facility	HF_NEGANY	129
Charging information (per call) facility	HF_RQCRGIN	qos
Reverse charging acceptance facility	HF_NEGANY	129
Reverse charging facility	HF_RVFC	qos
Default throughput classes registration	HF_DFTHRU	132
Non-standard default window sizes registration	HF_NSWIN	134
Non-standard default packet sizes registration	HF_NSPACK	133
Logical channel types ranges registration	HF_LOGCHAN	135
RPOA selection (per call) facility	HF_RPOA	qos

4.3.1 Extended Packet Sequence Numbering Facility

If the *extended packet sequence numbering* facility is available, use the "Facilities Negotiable in State *p1*" (HF_NEGP1) function code to enable it.

4.3.2 REJ — Packet Retransmission Facility

If the *packet retransmission* facility is available, use the "Facilities Negotiable in State *p1*" (HF_NEGP1) function code to enable it.

4.3.3 D-bit Modification Facility

If the *D-bit modification* facility is available, use the "Facilities Negotiable in State *p1*" (HF_NEGP1) function code to enable it.

4.3.4 Called Line Address Modified Facility

If the *called line address modified* facility is available, use the CS API `qos` parameter to specify it.

4.3.5 Charging Information (per interface) Facility

If the *charging information (per interface)* facility is available, use the "Facilities Negotiable in any State" (`HF_NEGANY`) function code to enable it.

4.3.6 Charging Information (per call) Facility

If the *charging information (per call)* facility is available, use the CS API `qos` parameter to specify it.

4.3.7 Reverse Charging Acceptance Facility

If the *reverse charging acceptance* facility is available, use the "Facilities Negotiable in any State" (`HF_NEGANY`) function code to enable it.

4.3.8 Reverse Charging Facility

If the *reverse charging* facility is available, use the CS API `qos` parameter to specify it.

4.3.9 Default Throughput Classes Registration Facility

If the *default throughput classes registration* facility is available, use the "Default Throughput Classes Assignment" (`HF_DFTHRU`) function code to enable it.

4.3.10 Non-standard Default Packet Window Sizes Registration

If the *non-standard default packet window sizes* registration is available, use the "Non-standard Default Packet Window Sizes" (`HF_NSWIN`) function code to enable it.

4.3.11 Non-standard Default Packet Data Sizes Registration

If the *non-standard default packet data sizes* registration is available, use the "Non-standard Default Packet Data Sizes" (HF_NSPACK) function code to enable it.

4.3.12 Logical Channel Types Ranges Registration

If the *logical channel types ranges* registration is available, use the "Logical Channel Types Ranges" (HF_LOGCHAN) function code to enable it.

4.3.13 RPOA Selection (per call) Facility

If the *RPOA selection (per call)* facility is available, use the CS API qos parameter to specify it.

4.4 Non-negotiable Facilities (HF_NON_NEG)

This class of facilities may appear only in the Freeway registration confirmation packet (IREGCON). *Local charging prevention* is the only facility in this class. If the non-negotiable class of facilities is present, it indicates whether *local charging prevention* is enabled or disabled.

4.5 Default Throughput Classes Assignment (HF_DFTHRU)

This facility is valid in a host facilities registration packet (HREGRQ) only if the "Availability of Facilities" (HF_AVAIL) indicated by the network DCE specifies that *default throughput classes* registration is supported.

4.6 Non-standard Default Packet Data Sizes (HF_NSPACK)

This facility is valid in a host facilities registration packet (HREGRQ) only if the "Availability of Facilities" (HF_AVAIL) indicated by the network DCE specifies that *non-standard default packet data sizes* registration is supported.

4.7 Non-standard Default Packet Window Sizes (**HF_NSWIN**)

This facility is valid in a host facilities registration packet (HREGRQ) only if the "Availability of Facilities" (HF_AVAIL) indicated by the network DCE specifies that *non-standard default packet window sizes* registration is supported. If the "Facilities Negotiable in State *p1*" (HF_NEGP1) function code is used to enable *extended packet sequence numbering*, then packet window size values 1–127 are valid; otherwise, only window sizes 1–7 are valid.

4.8 Logical Channel Types Ranges (**HF_LOGCHAN**)

The logical channel group number and the logical channel number together form a unique 12-bit channel number at the DTE/DCE interface. The host facilities registration packet (HREGRQ) uses this facility to identify the following valid 12-bit channel number ranges:

- Lowest incoming channel (LIC)
- Highest incoming channel (HIC)
- Lowest two-way channel (LTC)
- Highest two-way channel (HTC)
- Lowest outgoing channel (LOC)
- Highest outgoing channel (HOC)

The ranges should progress from lower numbers to higher numbers and must not overlap. The highest valid channel number for a PVC is one lower than that specified by the LIC parameter. Channels in the range LIC through HIC are available only to incoming calls. Channels in the range LTC through HTC are available to either incoming or outgoing calls. Channels in the range LOC through HOC are available only to outgoing calls. The *one-way* restriction applies only to the SVC calls; once an SVC is connected, two-way data traffic is permitted.

To exclude all calls in a specific category, specify both the lowest and highest channels to be zero. For example, to exclude the two-way channel category, specify both LTC and HTC to be zero. In all other cases, channel numbers must be from 1 through 4095.

This facility differs from the call service *configure LCN bounds* parameter described in Section 3.6.8 on page 72; the latter affects Freeway operation only.

Chapter

5

Call Service Configuration vs. On-line Facilities Registration

The following facilities are available through either Freeway call service configuration or on-line facilities registration:

- Extended packet sequence numbering
- Flow control negotiation
- Packet retransmission
- Logical channel type ranges

If the network to which the DTE is connected does *not* support on-line facilities registration, there is no potential conflict situation. In this case, use Freeway call service configuration (Section 3.6 on page 66) to enable these facilities.

However, when the network does support on-line facilities registration, a potential conflict may arise. To resolve conflicts for these facilities, the values reported by the network through the Freeway facilities registration confirmation packet (IREGCON) override any previous values configured on Freeway, and any facilities not available through the network are disabled on Freeway.

The following example illustrates a potential conflict and how to properly use the network-provided registration procedure. Although this example uses extended sequence numbering, the same procedure applies to flow control negotiation, packet retransmission, and logical channel type ranges. A facility does not take effect until a Freeway registration confirmation packet (IREGCON) is received showing it is enabled.

1. The host enables extended sequence numbering using call service configuration (packet type HCSCON). Typically, call service is configured prior to enabling the data link.

2. The host enables the data link (packet type HENABLE).

3. The host issues a facilities registration request packet (type HREGRQ without any data) to determine which facilities are available through the network.

4. The host receives a facilities registration confirmation packet (type IREGCON) indicating the availability of facilities (function code HF_AVAIL) through the network. The packet may also include other function codes (Table 4–1 on page 88) indicating the current status of each facility (enabled or disabled).

5. The next step depends on the information in the confirmation packet.

   - If the confirmation packet indicates that extended sequence numbering is not available, Freeway call service configuration (from step 1) of that facility is disabled. Because extended sequence numbering is not supported by the network, this facility may not be used at all.

   - If the confirmation packet indicates extended sequence numbering is available, but not enabled, the host must issue another facilities registration request packet to enable extended sequence numbering.

   - If the confirmation packet indicates that extended sequence numbering is available and enabled, the host takes no action.

Table 5–1 and Table 5–2 give an overview of the required actions depending upon whether on-line facilities registration is supported by the network.

Table 5–1: Network Not Supporting Facilities Registration

	Action Required to Enable Facility
Facility[a]	Issue configure call service packet

[a] The facility may be extended sequence numbering, flow control negotiation, packet retransmission, and logical channel type ranges.

Table 5–2: Network Supporting Facilities Registration

	Registration Confirmation Packet Indicates	**Action Required to Enable Facility**
	Unavailable[a]	Cannot be enabled
Facility[b]	Available and disabled	Issue registration request packet and wait for registration confirmation packet
	Available and enabled	Facility already enabled

[a] Not applicable to the flow control negotiation facility

[b] The facility may be extended sequence numbering, flow control negotiation, packet retransmission, and logical channel type ranges.

Chapter 6 Freeway Operation Management

This chapter describes how to manage basic Freeway operations to support USER applications for virtual circuit access and data transfer. Freeway operation management operations do not themselves access virtual circuits.

6.1 Data Link Connectivity

Before any USER application may access Freeway X.25 services for virtual circuit operations, the underlying connection to the network DCE must be active. For X.25 operation, it is the MANAGER application's responsibility to ensure that Freeway is properly configured and that each data link is enabled. For HDLC, links are automatically enabled when the USER application issues a cs_connect request.

During normal operations, Freeway reports data link failures and/or data link timeouts. For X.25 data links, Freeway sends these reports to the MANAGER application currently bound to the X.25 service access point (SAP); if no MANAGER application exists, no such notification occurs. For HDLC data links, the CS API notifies the USER application by returning a CS_NOCONN error status.

The MANAGER application may also disable any X.25 data link requiring maintenance operations on the physical connection to the network DCE. When X.25 operates over a single HDLC LAPB data link, all X.25 virtual circuit operations terminate immediately when the data link is disabled.

When X.25 operates over an MLP controlling multiple data links, disabling any single data link under the MLP merely causes traffic load-sharing adjustments among the remaining active data links. X.25 virtual circuit services over the MLP continue unaffected unless all data links under control of the MLP are disabled.

6.2 Modem Control Signal Monitoring

Freeway X.25 call service configuration permits the MANAGER application to monitor the data-carrier-detect (DCD) and/or clear-to-send (CTS) modem signals. Each of these signals is supplied by the DCE to the DTE. Monitoring may be achieved in either of two ways.

Monitor Transitions The MANAGER application may request Freeway to debounce[1] unstable transitions on specified modem control line(s) (Section 3.6.11 on page 75) and report only stable transitions. The debounce period is configurable, and may be changed at any time (Section 3.6.12 on page 76).

Read Control Line The MANAGER application may request Freeway to report the current value of either DCD or CTS. The value represents an *instantaneous* value, in that unstable transitions on the modem control line are not debounced when read in this manner. See Section 10.3.14 on page 173 and Section 10.4.11 on page 187.

6.3 X.25 Diagnostic Packets

Under rare circumstances, the network DCE may transmit an X.25 diagnostic packet to the DTE. Diagnostic packets are not associated with any specific virtual circuit, but provide information about network-specific problems. Freeway sends diagnostic packet reports to the MANAGER application currently bound to the X.25 SAP. If no MANAGER application exists, no such notification occurs.

1. The term *debounce* is used to describe the process of deciding whether a signal is ON or OFF during a period of unstable oscillations on the signal input. The debounce period is the length of time during which the signal must remain either ON or OFF to determine that a stable reading has been achieved.

6.4 Statistics Maintenance

Freeway maintains statistics for X.25 data link operations. The MANAGER application may request Freeway to perform any of the following three statistics maintenance operations. Chapter 9 and Chapter 10 explain how to request the statistics from Freeway.

Clear Statistics Freeway responds to this request by zeroing all statistics for the specified data link.

Read Statistics Freeway responds to this request by reporting the current statistics for the specified data link and then clearing statistics for that data link.

Sample Statistics Freeway responds to this request by reporting the current statistics for the specified data link. Freeway continues to maintain link statistics without clearing them.

Data link statistics count received and transmitted frames, occurrences of error conditions, the number of X.25 restarts and X.25 LCN usage. Available link statistics include the following:

Receive FCS errors This is the number of frame check sequence errors detected on the line. A high FCS error rate usually indicates a physical layer problem due to clocking or cabling problems.

Receive I-frames too long This is the number of I-frames received with an information field of excessive length. This may indicate that the configured frame data size is too small to contain the maximum data field transmitted by the network DCE.

Receive overrun errors This is the number of frames received too quickly for Freeway to keep up. This may indicate an excessive receive data rate, or may occur if the spacing between frames from the DCE to the DTE is too small for the current receive data rate.

Transmit underrun errors This is the number of frames transmitted too quickly for Freeway to keep up. This may indicate an excessive transmit data rate.

Transmit watchdog errors This is the number of frames transmitted for which the transmission did not complete within the expected time. This may indicate a transmit clock or cabling problem.

Unrecognized frames received This is the number of frames received that are not appropriate to HDLC operations.

I-frames received This is the number of I-frames received. The count is limited to 16-bits, and the actual count may exceed the reported value due to counter rollover.

I-frames sent This is the number of I-frames transmitted. The count is limited to 16-bits, and the actual count may exceed the reported value due to counter rollover.

FRMR frames received This is the number of frame reject (FRMR) frames received.

FRMR frames sent This is the number of FRMR frames transmitted.

REJ frames received This is the number of REJ frames received. REJ frames should not be confused with REJ packets carried within an I-frame information field. If SREJ selective recovery is enabled (Section 11.2 on page 192), this field also counts SREJ frames received.

REJ frames sent This is the number of REJ frames transmitted. REJ frames should not be confused with REJ packets carried within an I-frame information field. If SREJ selective recovery is enabled (Section 11.2 on page 192), this field also counts SREJ frames transmitted.

SABM frames received This is the number of SABM frames received.

SABM frames sent This is the number of SABM frames transmitted.

Restart packets received This is the number of X.25 restart packets received.

Restart packets sent This is the number of X.25 restart packets transmitted.

LCNs currently in use This is the number of virtual circuits currently in use on the X.25 network connection.

LCN usage high-water mark This is the maximum number of virtual circuits ever used on the X.25 network connection.

Note

Freeway does not report LCN statistics for the HDLC protocol service.

Chapter 7 OSI Network Service Support

Protogate's X.25 software supports CCITT-specified DTE facilities for end-to-end signalling required by the open systems interconnect (OSI) network service. These non-standard facilities follow a two-byte facility marker in which the code and parameter bytes are 0 and 15, respectively. Refer to the *X.25 Call Service API Guide* regarding the use of non-standard user facilities in the qos parameter of CS API requests.

Each actual facility is coded as described in ANNEX G of the CCITT X.25 recommendation. See the list of references in the *Preface* to this manual on page 19.

Chapter 8

X.25 Certification

Administrators of non-public X.25 networks (financial or military for example) might require that DTE equipment be certified prior to permitting its use on their network. In this case, you might need the assistance of an X.25 expert to assist in the certification process, and to discuss test results with the certification engineer representing the network provider.

8.1 DCE Emulator Test Equipment

In Protogate's experience, DCE emulator equipment used to certify DTE X.25 operation is typically limited in its capacity to recognize valid X.25 protocol behavior that deviates from expected testable behavior. Consequently, Protogate provides an optional certification mode configuration parameter (described in Section 10.3.7 on page 164) to inform Freeway whether or not it is connected to DCE emulator test equipment for certification so Freeway can accommodate typical limitations in the DCE emulator test equipment. Although certification mode is primarily intended for use during certification of X.25 operations, you can also use it during normal operations.

DCE emulator test equipment might also be sensitive to the configured value of other normal operational parameters. In particular, the following parameters might be critical to obtaining successful test results. Additional details regarding each parameter can be found by referring to this manual's index.

8.1.1 Buffer Configuration Parameters

Buffer configuration parameters that might affect X.25 certification results are as follows:

Segmentation buffers These should be configured so Freeway can provide maximum flexibility when flow-control negotiation procedures are tested.

Communication buffers These must be large enough to accommodate the configured value for N1 maximum frame data size.

Virtual Circuit Maximum X.25 station resources do not need to be explicitly configured, but the maximum number of virtual circuits declared during buffer configuration must be adequate to ensure availability of at least one SVC station resource for each logical channel group number (LCGN) used by the DCE emulator test equipment.

8.1.2 Data Link Configuration Parameters

Data link configuration parameters that might affect X.25 certification results are as follows:

Clock Source This should be set to external, since the ICP hardware is set for external clock. The DCE emulator must supply the clock.

Frame Modulus This must exactly match the modulus (8 or 128) for which the DCE emulator is configured. This setting determines whether SABM or SABME is used to initialize the data link.

Frame Transmit Window Size This must exactly match the maximum number of outstanding I-frames (k) for which the DCE emulator is configured.

N1 Maximum Frame Data Size Since the DCE emulator might test the maximum information frame length, the N1 parameter on Freeway must be set to the maximum number of bytes in the data field of an X.25 data packet. Freeway automatically adjusts for the additional bytes required to accommodate the X.25 and HDLC LAPB protocol headers.

T1 CCITT/ISO Retry Timer If the T1 timer is set too short, then the DTE might transmit a frame with the P-bit set (due to a T1 timeout) when the DCE emulator is expecting a response to a supervisory REJ frame. The DCE emulator test equipment might then report the receipt of an unexpected frame.

T2 CCITT/ISO Acknowledgment Delay Timer If the T2 timer is set too long, then the DTE might not transmit acknowledgment within the time frame expected by the DCE emulator equipment.

T3 ISO Idle Link Timer This timer should not be used when certifying CCITT X.25 operation.

T4 ISO Link Integrity (Keep Alive) Timer This timer should not be used when certifying CCITT X.25 operation.

8.1.3 Multilink Procedures Configuration Parameters

Do not configure MLP unless the DCE emulator expects to see the MLP protocol layer during testing. Configuration of MLP results in the use of HDLC LAPB frame address values that are incompatible with non-MLP operation and testing.

8.1.4 Call Service Configuration Parameters

Call service configuration parameters that might affect X.25 certification results are as follows:

T2X Timers These timers must exactly match the values for which the DCE emulator is configured.

R2X Retry Limits These retry limits must exactly match the values for which the DCE emulator is configured.

LCN Bounds These must exactly match the LCN ranges for which the DCE emulator is configured.

Flow Control Negotiation This should be enabled only if the DCE emulator supports and tests flow control negotiation.

REJ Packet Retransmission Support This should not be used unless the DCE emulator specifically tests DTE use of the REJ packet (not to be confused with REJ frames).

Restarts DTE restarts should be disabled during testing since the transmission of an I-frame (containing a DTE restart request) immediately following each SABM/UA exchange might interfere with testing of the HDLC LAPB frame level.

Extended Packet Sequence Numbering This should not be used unless the DCE emulator specifically tests X.25 packet level modulo 128 operation.

X.25 Operation Profile This must correctly identify the specification to which the DCE emulator expects X.25 operations to conform.

DTE Address Format This must not be configured for TOA/NPI format unless the DCE emulation specifically tests the X.25 extended DTE addressing.

8.2 Client Software Requirements

Certification of the HDLC LAPB data link layer of X.25 can most often be completed without the use of client software other than the x25_manager program. However, successful certification of the X.25 packet layer requires the user to provide a CS API client program capable of handling the following X.25 processing requirements:

DCE Call Indication The CS API client program must use the cs_register request to register a permanent incoming call handler, must issue the cs_listen request to receive notification of each incoming call, and must issue the cs_accept request to accept each incoming call.

DCE Interrupt Indication The CS API client program must detect and process the CS_INDX25OOB indication.

DCE Reset Indication The CS API client program must detect and process the CS_INDX25RSET indication.

DCE Clear Indication The CS API client program must detect and process the CS_NOCONN indication, then issue another cs_listen request to receive notification of the next incoming call.

Chapter 9

X.25 **MANAGER** Configuration Utility

After installing the Freeway hardware (described in the installation guide for your particular hardware) and software (described in the *Freeway Server User's Guide*), the system administrator can use the x25_manager utility to download the X.25/HDLC software to Freeway and perform configuration and startup in the order shown in Table 9–1.

Table 9–1: X.25 Configuration and Startup Steps

Step	Action	Reference Section(s)
1	Download X.25/HDLC software to Freeway	Section 9.1
2	Configure buffer and station resource limits	Section 9.3.2
3	Configure data links	Section 9.3.3 and Section 9.5
4	Configure X.25 multilink procedures (optional)	Section 9.3.4
5	Configure X.25 call service (optional)	Section 9.3.5
6	Configure X.25 stations for each data link (optional)	Section 9.3.6 and Section 9.3.7
7	Enable data links	Section 9.3.8

Note

For the HDLC MANAGER application, x25_manager supports only step 3. See Section 9.5.

Note

The x25_manager utility does not support all Freeway commands. For example, you cannot perform call-service modem-control-signal configurations or on-line X.25 facilities registration.

The x25_manager utility uses the CS API to attach and bind to Freeway, and uses standard terminal and file input/output facilities to provide an interactive user interface. The x25_manager utility accepts free-form textual commands from the operator's terminal, workstation, or a pre-edited text file to configure characteristics of Freeway data links immediately after the X.25 software has been downloaded to Freeway. The command syntax uses specific keywords followed by a specification list enclosed in matching left and right brackets, braces, or parentheses. In some cases, a specification may itself require an additional specification list.

Four sample configuration command files are provided to show the command syntax accepted by the program. These programs are located in the freeway/client/ test/x25mgr directory. Use the svc.setup file (Figure 9–2) before running the x25_svc test program to verify correct installation of X.25 on Freeway. Figure 9–3 shows the output from running the svc.setup file. Use the hdlc.setup file (Figure 9–4) before running the hdlc_user test program to verify correct installation of HDLC on Freeway. Chapter 2 describes how to use the x25_svc and hdlc_user test programs.

When using the x25_manager utility, keep the following points in mind:

- X25_manager implements a simple on-line help utility in the form of printed feedback when it encounters unexpected input.
- Type a question mark followed by a carriage return to get a list of the expected commands and symbols for the current context.
- You do not need to enter the entire command name; enter just enough letters to make it unique.

- Freely use commas, spaces, and carriage returns to separate individual command elements or specifications.
- Add comments to a command file as shown in Figure 9–2.
- Terminate x25_manager at any time by entering the command quit or exit, or by holding down the CTRL key and typing C.
- Omit the closing brace, bracket or parenthesis to leave the current command level open for further specifications.
- The SLP command cancels the previous link configurations, as well as any station assignments for the link. Therefore, this command must include all the specifications you wish to configure in one single SLP command, and you must reissue the PVC or SVC commands associated with that link.
- Similar to the previous item, each MLP, PVC or SVC command should include all the desired specifications.
- After you first use a third-level LINKS command, x25_manager uses those specified links for any subsequent commands (at any level) that require a link specification. Issue another LINKS command to change the current list of links.
- The most common error reported by x25_manager is CS_SVRERR, which usually indicates a rejection of the command by Freeway. Normally this error is due to issuing commands in the wrong order or supplying incomplete or invalid specifications.
- Due to keyboard I/O restrictions on VMS machines, the user must not be connected to the host by means of the VMS sethost command.

- Figure 9–1 shows how to invoke the help feature of the x25_manager test program.

```
x25_manager ?

SIMPACT X.25 MANAGER UTILITY
VI-200-3109: X25CFW 2.2-2 Apr 16 2004
----------------------------
SYNTAX:
        x25_manager [config|?] [dbg] [mgr] [setup]

WHERE:
        [?]       == display this help text
        [config]  == replacement for cs_config    (default == cs_config)
        [dbg]     == debuglog flag 1=yes, 0=no    (default == 0)
        [mgr]     == manager session in [config]  (default == mgr)
        [setup]   == setup command file           (NO DEFAULT)

EXAMPLES:
        x25_manager
        x25_manager  ?
        x25_manager  cs_config
        x25_manager  cs_config  1
        x25_manager  cs_config  0  mgr
        x25_manager  cs_config  0  mgr  svc.setup
```

Figure 9–1: Help Feature of x25_manager Test Program

When you type a question mark for help immediately after accessing x25_manager, the following primary commands appear:

```
COMMENT
DOWNLOAD
FILE
SAPX25
SAPMLP
SAPSLP
MONITOR
```

A COMMENT is normally used in a command file as shown in Figure 9–2. Section 9.1 through Section 9.6 discuss the other primary commands.

The following command syntax example opens access to the X.25 protocol service on Freeway, requests software version data, and leaves access to the X.25 service open:

```
SAPX25 { VERSION,
```

Another example shows the use of second- and third-level commands. Under the primary SAPX25 command, the second-level BUFFERS command supports its own set of three third-level commands. After the above command syntax has been executed, the following command syntax configures buffer and virtual circuit resource limits on Freeway. Note that the closing bracket (]) ends the second-level BUFFERS command, but the primary SAPX25 command is still open for further specifications.

```
BUFFERS [ BIG(1024), SMALL(256), CIRCUITS(256) ],
```

```
COMMENT
  (************************************************************
  The following command file text may be fed to the X25_MANAGER
  sample program to configure X.25 on the Freeway ICP for loopback
  testing between odd and even ports.

  NOTE: for use with the "x25_svc" program

  The configuration may be summarized as follows:

    X.25        all even numbered links DTE
    X.25        all odd numbered links DCE

  ************************************************************)

SAPX25
  {                     COMMENT(BEGIN X.25 SERVICE CONFIGURATION)
  VERSION,              comment(report X.25 software version data)
  BUFFERS
    [                   COMMENT(CONFIGURE Freeway ICP BUFFERS),
    BIG(1024),          comment(segmentation buffer size in bytes),
    SMALL(512),         comment(communication buffer size in bytes),
    CIRCUITS(256),      comment(maximum number of virtual circuits),
    ],

  COMMENT
  (*****************************************************
  *     CONFIGURE EVEN LINKS as DTE under X.25          *
  *****************************************************)
  SLP [                 COMMENT(CONFIGURE HDLC LAPB DATA LINKS),
    LINKS(0),           comment(links for following configuration),
    DXE(DTE),           comment(DTE or DCE),
    EIA(232),           comment(232, 449, 530, V35, 188C),
    CLOCK(EXTERNAL),    comment(INTERNAL, EXTERNAL or X21V11),
    MODULUS(8),         comment(frame modulus 8 or 128),
    WINDOW(7),          comment(frame window 1 to modulus-1),
    T1(2.0),            comment(0.1 to 255.9 seconds),
    T2(0.1),            comment(0.1 to 255.9 seconds),
    N2(5),              comment(1 to 255 retries),
    RATE(19200),        comment(300 to 128000 baud),
    ],
```

Figure 9–2: SVC.SETUP File

```
CALLSERVICE
  [
  DTECALLING(123456789012345), comment(local DTE address),
  FASTSELECT(NOTIFY), comment(BAR or NOTIFY),
  REVERSE(ACCEPT),    comment(BAR or ACCEPT or NOTIFY),
  INCOMINGCALLS(NOTIFY), comment(BAR or ACCEPT or NOTIFY),
  T20(180),           comment(1 to 255 seconds),
  T21(200),           comment(1 to 255 seconds),
  T22(180),           comment(1 to 255 seconds),
  T23(180),           comment(1 to 255 seconds),
  R20(2),             comment(1 to 255 retries),
  R22(2),             comment(1 to 255 retries),
  R23(2),             comment(1 to 255 retries),
  TL1(60),            comment(1 to 255 seconds),
  LCNBOUNDS(0,0,1,255,0,0),  comment(LIC, HIC, LTC, HTC, LOC, HOC),
  FLOWNEGOTIATION(ACCEPT),   comment(BAR or ACCEPT),
  RESTARTS(YES),      comment(restart on SLP reset NO or YES),
  REJ(NO),            comment(REJ packet support NO or YES),
  MODULUS(8),         comment(packet modulus 8 or 128),
  X25PROFILE(CCITT1984), comment(CCITT1980,CCITT1984,CCITT1988 or ISO8208),
  ],

COMMENT
(******************************************************
*     CONFIGURE ODD LINKS as DCE under X.25          *
******************************************************)
SLP [                 COMMENT(CONFIGURE HDLC LAPB DATA LINKS),
  LINKS(1),           comment(links for following configuration),
  DXE(DCE),           comment(DTE or DCE),
  EIA(232),           comment(232, 449, 530, V35, 188C),
  CLOCK(EXTERNAL),    comment(INTERNAL, EXTERNAL or X21V11),
  MODULUS(8),         comment(frame modulus 8 or 128),
  WINDOW(7),          comment(frame window 1 to modulus-1),
  T1(2.0),            comment(0.1 to 255.9 seconds),
  T2(0.1),            comment(0.1 to 255.9 seconds),
  N2(5),              comment(1 to 255 retries),
  RATE(19200),        comment(300 to 128000 baud),
  ],
```

Figure 9–2: SVC.SETUP File *(Cont'd)*

```
CALLSERVICE
   [
   DTECALLING(123456789012345), comment(local DTE address),
   FASTSELECT(NOTIFY), comment(BAR or NOTIFY),
   REVERSE(ACCEPT),    comment(BAR or ACCEPT or NOTIFY),
   INCOMINGCALLS(NOTIFY), comment(BAR or ACCEPT or NOTIFY),
   T20(180),           comment(1 to 255 seconds),
   T21(200),           comment(1 to 255 seconds),
   T22(180),           comment(1 to 255 seconds),
   T23(180),           comment(1 to 255 seconds),
   R20(2),             comment(1 to 255 retries),
   R22(2),             comment(1 to 255 retries),
   R23(2),             comment(1 to 255 retries),
   TL1(60),            comment(1 to 255 seconds),
   LCNBOUNDS(0,0,1,255,0,0),  comment(LIC, HIC, LTC, HTC, LOC, HOC),
   FLOWNEGOTIATION(ACCEPT),   comment(BAR or ACCEPT),
   RESTARTS(YES),      comment(restart on SLP reset NO or YES),
   REJ(NO),            comment(REJ packet support NO or YES),
   MODULUS(8),         comment(packet modulus 8 or 128),
   X25PROFILE(CCITT1984), comment(CCITT1980,CCITT1984,CCITT1988 or ISO8208),
   ],
                       COMMENT(END X.25 SERVICE CONFIGURATION)

 REQUEST
   [                   COMMENT(ISSUE LINK CONTROL REQUESTS),
   LINKS(0,1),
   ENABLE,

 COMMENT(LEAVE SAPX25 REQUEST OPEN TO REPORT LINK ACTIVATION EVENTS)
```

Figure 9–2: SVC.SETUP File *(Cont'd)*

```
SIMPACT Freeway X.25 MANAGER
-----------------------------

:  file(svc.setup)
SAPX25{:  ICP 6000/9000 COMMUNICATIONS FRONT END PROCESSOR - V1.5
SAPX25{:  CCITT/ISO 1984/1988 X.25 SERVICE/XIO 04-JAN-1995 - 3.1.2
SAPX25{BUFFERS[:  Configuring buffers.
SAPX25{BUFFERS[:  Configured 12 BIG buffers 1024 bytes each.
SAPX25{BUFFERS[:  Configured 693 SMALL buffers 512 bytes each.
SAPX25{BUFFERS[:  Configured 112 virtual circuit maximum.
SAPX25{SLP[:  Configuring SLP 0.
SAPX25{CALLSERVICE[:  Configuring CALLSERVICE on SLP 0.
SAPX25{SLP[:  Configuring SLP 1.
SAPX25{CALLSERVICE[:  Configuring CALLSERVICE on SLP 1.
SAPX25{REQUEST[:  Enabling link 0.
SAPX25{REQUEST[:  Enabling link 1.

freeway1:  Link 0 ONLINE.
freeway1:  Link 1 ONLINE.
SAPX25{:  exit
```

Figure 9–3: Output from file(SVC.SETUP) Command

```
COMMENT
  (************************************************************
  The following command file text may be fed to the X25_MANAGER
  sample program to configure HDLC on the Freeway ICP for loopback
  testing between odd and even ports.

  NOTE: for use with the "hdlc_user" program

  The configuration may be summarized as follows:

    HDLC        links 0, 2, 4, and 6 DTE
    HDLC        links 1, 3, 5, and 7 DCE

  ************************************************************)

SAPX25
  {
  VERSION,                comment(report X.25 software version data)
  BUFFERS
    [                     COMMENT(CONFIGURE Freeway ICP BUFFERS),
    BIG(0),               comment(segmentation buffer size in bytes),
    SMALL(1024),          comment(communication buffer size in bytes),
    ]
  }
SAPSLP
  {                       COMMENT(BEGIN HDLC SERVICE CONFIGURATION)
  COMMENT
  (*****************************************************
  *     CONFIGURE EVEN LINKS as DTE under HDLC          *
  *****************************************************)
  SLP [                   COMMENT(CONFIGURE HDLC LAPB DATA LINKS),
    LINKS(0),             comment(links for following configuration),
    DXE(DTE),             comment(DTE or DCE),
    EIA(232),             comment(232, 449, 530, V35, 188C),
    CLOCK(EXTERNAL),      comment(INTERNAL, EXTERNAL or X21V11),
    MODULUS(8),           comment(frame modulus 8 or 128),
    WINDOW(7),            comment(frame window 1 to modulus-1),
    T1(2.0),              comment(0.1 to 255.9 seconds),
    T2(0.1),              comment(0.1 to 255.9 seconds),
    N2(5),                comment(1 to 255 retries),
    RATE(19200),          comment(300 to 128000 baud),
    ],
```

Figure 9–4: HDLC.SETUP File

```
 COMMENT
(****************************************************
*     CONFIGURE ODD LINKS as DCE under HDLC          *
****************************************************)
SLP [                  COMMENT(CONFIGURE HDLC LAPB DATA LINKS),
  LINKS(1),            comment(links for following configuration),
  DXE(DCE),            comment(DTE or DCE),
  EIA(232),            comment(232, 449, 530, V35, 188C),
  CLOCK(EXTERNAL),     comment(INTERNAL, EXTERNAL or X21V11),
  MODULUS(8),          comment(frame modulus 8 or 128),
  WINDOW(7),           comment(frame window 1 to modulus-1),
  T1(2.0),             comment(0.1 to 255.9 seconds),
  T2(0.1),             comment(0.1 to 255.9 seconds),
  N2(5),               comment(1 to 255 retries),
  RATE(19200),         comment(300 to 128000 baud),
  ],
}                      COMMENT(END HDLC SERVICE CONFIGURATION)
```

Figure 9–4: HDLC.SETUP File *(Cont'd)*

9.1 **DOWNLOAD** — Download X.25/HDLC Software

The primary DOWNLOAD[1] command requests Freeway to download fresh software. This erases the current configuration and returns Freeway to a known state. At the same time, all attached application processes are notified via TCP/IP socket failure that access to Freeway is terminated. Application processes may re-attach to Freeway after the download operation completes.

9.2 **FILE** — Execute Configuration Command File

The primary FILE command requests x25_manager to read commands from a specified ASCII text file. An example of the command syntax is:

```
FILE (SVC.SETUP)
EXIT Comment(Wait until file completes before exiting)
```

Figure 9–2 on page 120 shows the svc.setup file which is provided with the Freeway product. Figure 9–3 on page 123 shows the output from executing the FILE(SVC.SETUP) command.

9.3 **SAPX25** — X.25 Service Access Point

The primary SAPX25 command gains MANAGER access to Freeway X.25 protocol services on the current ICP. After SAPX25 access is open, second-level commands configure X.25 services and all underlying MLP and/or SLP services for USER application process use under CS API control.

The SAPX25 command provides the following help information when you type a question mark:

1. The current release of Freeway X.25 does not support the x25_manager DOWNLOAD command. Instead, refer to the *Freeway Server User's Guide* for instructions on downloading.

```
SAPX25 {
  COMMENT
  VERSION
  BUFFERS
  SLP
  MLP
  CALLSERVICE
  PVC
  SVC
  REQUEST
  }
```

Each of the following subsections describes the second- and third-level commands supported by x25_manager within the context of the primary SAPX25 command. The command and response packet types are shown in parentheses to help cross reference to other chapters.

9.3.1 VERSION — Report Software Version Data (HVERSION and IVERSION)

The second-level VERSION command displays the X.25 software version information. An example of the command syntax is:

```
SAPX25 { VERSION }
```

9.3.2 BUFFERS — Configure Buffer and Station Resource Limits (HBUFI and IBUFIC)

Immediately after downloading the X.25 software to the current ICP on Freeway, the second-level BUFFERS command configures segmentation buffers, communication buffers, and the maximum number of virtual circuits.

Type a question mark at the BUFFERS command level to display the following help information:

```
BUFFERS [
  COMMENT
  BIG
  SMALL
  CIRCUITS
  ]
```

The complete BUFFER command syntax is:

```
SAPX25 { BUFFERS [ BIG(1024), SMALL(256), CIRCUITS(256) ] }
```

9.3.2.1 BIG — Segmentation Buffer Size

The allowed value for the BIG command is 0–8192 bytes and must be a multiple of 64. The default is 0 which disables segmentation.

9.3.2.2 CIRCUITS — Maximum Number of Virtual Circuits

The allowed value for the CIRCUITS command is 1–1024. The default is 256.

9.3.2.3 SMALL — Communication Buffer Size

The allowed value for the SMALL command is 64– 8192[1] bytes, and must be a multiple of 64. The default is 256 bytes.

9.3.3 SLP — Configure SLP Data Links (HCONFIG)

The second-level SLP command configures all data links specified by the latest LINKS command.

Type a question mark at the SLP command level to display the following help information:

```
SLP [
  COMMENT
  LINKS
  DXE
  CLOCK
  MODULUS
  WINDOW
  SIZE
  T1
```

1. The communication buffer size must not exceed the segmentation buffer size when segmentation is enabled.

```
T2
T3
T4
N2
RATE
GAP
RAW_HDLC
SREJ
EIA
CUSTOMADDRESS
]
```

An example of the SLP command syntax is:

```
SAPX25 { SLP [ LINKS(0,2,4,6), DXE(DTE), CLOCK(EXTERNAL),
               MODULUS(8), WINDOW(7), SIZE(256), T1(2.0),
               T2(0.1), N2(5), RATE(64000) ] }
```

Note

Because the SLP command cancels any previous link configurations, it must always be issued as a complete command with all desired specifications.

9.3.3.1 **CLOCK** — Clock Source

The allowed value for the CLOCK command is INTERNAL, EXTERNAL, or X21V11. The clock source must be specified, and there is no default.

Note

The Freeway hardware is default configured for external clock. If you need to set internal clock, call the Protogate customer support number given in the *Preface* on page 24.

9.3.3.2 **CUSTOMADDRESS** — HDLC Custom Addressing Mode

In the atypical situation where the default addresses (3,1) are not appropriate, the CUSTOMADDRESS command specifies the remote address and the local address, in that order.

9.3.3.3 **DXE** — HDLC Addressing Mode

The allowed value for the DXE command is DTE or DCE. The default is DTE.

9.3.3.4 **EIA** — Electrical Interface

The allowed value for the EIA command is 232, 449, 530, V35, or 188C. There is no default. Software-selectable EIA configuration is supported on the ICP2424 and ICP2432 only. The ICP6000 disregards this option because EIA is determined by the hardware.

9.3.3.5 **GAP** — Interframe Gap

The allowed value for the GAP command is 0–255. The default is 0. The specification configures the minimum number of flags between frames on the data link. This command is only supported on high-speed ICPs such as the ICP2424 and ICP2432.

9.3.3.6 **LINKS** — Data Link IDs

The LINKS command specifies a list of data links to be used by all subsequent commands that require a link specification, until the LINKS command is reissued. The allowed values are 0 through *n*–1, where *n* is the number of links on the current ICP.

9.3.3.7 **MODULUS** — SLP Frame Modulus

The allowed value for the MODULUS command is 8 or 128. The default is 8.

9.3.3.8 **N2** — Retry Limit (for T1 Timer)

The allowed value for the N2 command is 1–255. The default is 10.

9.3.3.9 RATE — Data Rate

The standard values for the RATE command are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 56000, 57600, or 64000. A custom data rate may be specified; however, Freeway cannot guarantee the accuracy of non-standard data rates. See Section 3.4.3 on page 54.

The data rate *must* be specified (even if the configured clock source is EXTERNAL), and there is no default.

9.3.3.10 RAW_HDLC — Raw HDLC Option

The allowed values for the RAW_HDLC command are YES or NO. The default is NO. See Section 11.2 on page 192 for information on this non-standard HDLC option.

9.3.3.11 SIZE — Frame Data Size

The allowed value for the SIZE command ranges from 64 bytes up to the communication buffer size. The default is the communication buffer size.

9.3.3.12 SREJ — Selective Reject Option

The allowed values for the SREJ command are YES or NO. The default is NO. See Section 11.2 on page 192 for information on this non-standard HDLC option.

9.3.3.13 T1 — CCITT/ISO Retry Timer

The allowed value for the T1 command is 0.1–255.9 seconds. The default is 2.0 seconds.

9.3.3.14 T2 — CCITT/ISO Acknowledgment Delay Timer

The allowed value for the T2 command is 0.0–255.9 seconds. The default is 0.1 seconds.

9.3.3.15 T3 — ISO Idle Link Timer

The allowed value for the T3 command is 0.0–255.9 seconds. The default is 0.0 (no timer active).

9.3.3.16 T4 — ISO Link Integrity (Keep Alive) Timer

The allowed value for the T4 command is 0.0–255.9 seconds. The default is 0.0 (no timer active).

9.3.3.17 WINDOW — Frame Transmit Window

The allowed value for the WINDOW command is 1–7 if the frame modulus is 8, or 1–127 if the frame modulus is 128. The default is 7.

9.3.4 MLP — Configure Multilink Procedures Over Data Link(s) (HCONMLP)

The second-level MLP command configures a multilink procedure to control all data links specified by the previous SLP[LINKS] command.

Type a question mark at the MLP command level to display the following help information:

```
MLP [
  COMMENT
  MT1
  MT2
  MT3
  MW
  MX
  ]
```

Note

The MLP command should be issued as a complete command with all desired specifications.

An example of the complete MLP command syntax is:

```
SAPX25 { MLP [ MT1(60), MT2(60), MT3(15), MW(200), MX(200) ] }
```

9.3.4.1 **MT1** — Lost Frame Timer

The allowed value for the MT1 command is 1–255 seconds.

9.3.4.2 **MT2** — Group Busy Timer

The allowed value for the MT2 command is 1–255 seconds.

9.3.4.3 **MT3** — Reset Confirmation Timer

The allowed value for the MT3 command is 1–255 seconds.

9.3.4.4 **MW** — Multilink Window Size

The allowed value for the MW command is 1–2048. The MW value must be the same for both the DTE and the DCE. It should be larger than the product of the number of data links and the configured frame transmit window size. See Section 3.5.4 on page 65.

9.3.4.5 **MX** — Receive Window Guard Region Size

The allowed value for the MX command is 1 to 2048 minus MW. The value for MX should not exceed the value for MW, and the sum of MX and MW cannot exceed 4095. See Section 3.5.5 on page 65.

9.3.5 **CALLSERVICE** — Configure X.25 Call Service(**HCSCON**)

The second-level CALLSERVICE command configures call service parameters for all data links specified by the latest LINKS command.

Type a question mark at the CALLSERVICE command level to display the following help information:

```
CALLSERVICE [
  COMMENT
  DTECALLING
  FASTSELECT
  REVERSE
  INCOMINGCALLS
  T20
  T21
  T22
  T23
  T24
  T25
  T26
  T27
  T28
  R20
  R22
  R23
  R25
  R27
  R28
  TL1
  LCNBOUNDS
  FLOWNEGOTIATION
  RESTARTS
  REJ
  MODULUS
  X25PROFILE
  DTEADDRESSLENGTH
  CERTMODE
  TOANPIDTEADDRESSFORMAT ]
```

An example of the CALLSERVICE command syntax is:

```
SAPX25 { CALLSERVICE [ DTECALLING(123456789012345),
FASTSELECT(NOTIFY), FLOWNEGOTIATION(ACCEPT),
INCOMINGCALLS(NOTIFY), LCNBOUNDS(0,0,1,255,0,0),
MODULUS(8), R20(2), R22(2), R23(2), R28(2), REJ(NO),
RESTARTS(YES), REVERSE(ACCEPT), T20(180), T21(200),
T22(180), T23(180), T28(50), TL1(60),
X25PROFILE(CCITT1984) ] }
```

Note

Unlike some other commands, the CALLSERVICE command does not have to be issued as a complete single command, and it does not cancel previous call service configurations. You can change individual specifications dynamically.

9.3.5.1 DTECALLING — Calling DTE Address

The allowed value for the DTECALLING command is an ASCII string 1–15 characters long.

9.3.5.2 FASTSELECT — Fast Select

The allowed value for the FASTSELECT command is BAR or NOTIFY. The default is NOTIFY.

9.3.5.3 FLOWNEGOTIATION — Flow Control Negotiation

The allowed value for the FLOWNEGOTIATION command is BAR or ACCEPT. The default is BAR.

9.3.5.4 INCOMINGCALLS — Incoming Calls

The allowed value for the INCOMINGCALLS command is BAR, ACCEPT or NOTIFY. The default is ACCEPT.

9.3.5.5 **LCNBOUNDS** — Logical Channel Types Ranges

The LCNBOUNDS command has six specifications in the order of LIC, HIC, LTC, HTC, LOC and HOC. See Section 3.6.8 on page 72 for details. The defaults are 0, 0, 1, 4095, 0 and 0, respectively.

9.3.5.6 **MODULUS** — Packet Modulus

The allowed value for the MODULUS command is 8 or 128. The default is 8. This command configures *extended packet sequence numbering*.

9.3.5.7 **R20** — Retry Limit for T20 Timer

The allowed value for the R20 command is 1–255. The default is 2.

9.3.5.8 **R22** — Retry Limit for T22 Timer

The allowed value for the R22 command is 1–255. The default is 2.

9.3.5.9 **R23** — Retry Limit for T23 Timer

The allowed value for the R23 command is 1–255. The default is 2.

9.3.5.10 **R25** — Retry Limit for T25 Timer

The allowed value for the R25 command (if supported) is 1–255. The default is 1.

9.3.5.11 **R27** — Retry Limit for T27 Timer

The allowed value for the R27 command (if supported) is 1–255. The default is 1.

9.3.5.12 **R28** — Retry Limit for T28 Timer

The allowed value for the R28 command (if supported) is 1–255. The default is 2.

9.3.5.13 REJ — DTE REJ Packet Support

The allowed value for the REJ command is YES or NO. The default is NO.

9.3.5.14 RESTARTS — Restart on SLP/MLP Initialization

The allowed value for the RESTARTS command is YES or NO. The default is NO.

9.3.5.15 REVERSE — Reverse Charge

The allowed value for the REVERSE command is BAR, ACCEPT or NOTIFY. The default is ACCEPT.

9.3.5.16 T20 — CCITT/ISO Restart Request Timer

The allowed value for the T20 command is 1–255 seconds. The default is 180.

9.3.5.17 T21 — CCITT/ISO Call Request Timer

The allowed value for the T21 command is 1–255 seconds. The default is 200.

9.3.5.18 T22 — CCITT/ISO Reset Request Timer

The allowed value for the T22 command is 1–255 seconds. The default is 180.

9.3.5.19 T23 — CCITT/ISO Clear Request Timer

The allowed value for the T23 command is 1–255 seconds. The default is 180.

9.3.5.20 T24 — ISO Window Status Transmission Timer

The allowed value for the T24 command (if supported) is 1–255 seconds. By default the T24 timer is disabled.

9.3.5.21 T25 — ISO Window Rotation Timer

The allowed value for the T25 command (if supported) is 1–255 seconds. By default the T25 timer is disabled.

9.3.5.22 T26 — ISO Interrupt Response Timer

The allowed value for the T26 command (if supported) is 1–255 seconds. By default the T26 timer is disabled.

9.3.5.23 T27 — ISO Reject Response Timer

The allowed value for the T27 command (if supported) is 1–255 seconds. By default the T27 timer is disabled.

9.3.5.24 T28 — CCITT/ISO Registration Request Timer

The allowed value for the T28 command (if supported) is 0.1–25.5 minutes. The default is 5.0.

9.3.5.25 TL1 — Link Activation Timer

The allowed value for the TL1 command is 1–255 seconds. The default is 180.

9.3.5.26 X25PROFILE — X.25 Operation Profile

The allowed value for the X25PROFILE command is CCITT1980, CCITT1984, CCITT1988, or ISO8208. The default is CCITT1984. The UNRESTRICTED profile is not supported by x25_manager.

9.3.5.27 DTEADDRESSLENGTH — Local DTE Address Length

The DTEADDRESSLENGTH command specifies the length of the portion of the local DTE address that excludes the DTE subaddress field. The allowed value is 0–15. The default is 0.

9.3.5.28 **CERTMODE** — Certification Mode

The value for the CERTMODE command is YES or NO. The default is NO.

9.3.5.29 **TOANPIDTEADDRESSFORMAT** — DTE Address Format

The TOANPIDTEADDRESSFORMAT command specifies whether or not the type of address (TOA) numbering plan identification (NPI) DTE address format is supported. The value for this command is YES or NO. The default is NO.

9.3.6 **PVC** — Configure X.25 PVC Station (**HCONFIG**)

The second-level PVC command configures station parameters over an MLP (if one was configured) or over the first link specified by the previous SLP[LINKS] command.

If you are configuring an MLP, one PVC command is sufficient to configure station parameters for the first link specified by the previous SLP[LINKS] command.

If you are configuring station parameters for multiple SLPs, configure each SLP separately with the SLP[LINKS(*n*),...] command, followed by a PVC command for that link.

Type a question mark at the PVC command level to display the following help information:

```
PVC [
  COMMENT
  STATION
  WINDOW
  LCN
  ]
```

Note

The PVC command should be issued as a complete command with all desired specifications.

An example of a complete PVC command syntax is:

```
SAPX25 { PVC [ STATION(1), WINDOW(7), LCN(1) ] }
```

9.3.6.1 **STATION** — Station Identifier

The allowed value for the STATION command is 1–*n*, where *n* is the configured virtual circuit maximum (Section 9.3.2.2).

9.3.6.2 **WINDOW** — Packet Window Size

The allowed value for the WINDOW command is 1–7 (if the packet MODULUS is 8) or 1–127 (if the packet MODULUS is 128). The default is 2. See Section 9.3.5.6 for the entry range and default of Packet Modulus.

9.3.6.3 **LCN** — PVC Logical Channel Number

The allowed value for the LCN command is 1–4095, which is the composite LCN/LCGN value.

9.3.7 **SVC** — Configure X.25 SVC Station (**HCONFIG**)

The second-level SVC command configures station parameters for the first link specified by the previous SLP[LINKS] command.

If you are configuring an MLP, one SVC command is sufficient to configure station parameters for the first link specified by the previous SLP[LINKS] command.

If you are configuring station parameters for multiple SLPs, configure each SLP separately with the SLP[LINKS(*n*),...] command, followed by an SVC command for that link.

Type a question mark at the SVC command level to display the following help information:

```
SVC [
  COMMENT
  STATION
  WINDOW
  LCGN
  ]
```

Note

The SVC command should be issued as a complete command with all desired specifications.

An example of a complete SVC command syntax is:

```
SAPX25 { SVC [ STATION(32), WINDOW(7), LCGN(0) ] }
```

9.3.7.1 **STATION** — Station Identifier

The allowed value for the STATION command is 1–*n*, where *n* is the configured virtual circuit maximum (Section 9.3.2.2).

9.3.7.2 **WINDOW** — Packet Window Size

The allowed value for the WINDOW command is 1–7 (if the packet MODULUS is 8) or 1–127 (if the packet MODULUS is 128). The default is 2. See Section 9.3.5.6.

9.3.7.3 **LCGN** — SVC Logical Channel Group Number

The allowed value for the LCGN command is 0–15.

9.3.8 **REQUEST** — Request Link Control Operation

The second-level REQUEST command enables, disables or displays statistics for the data links specified by the latest LINKS command.

Type a question mark at the REQUEST command level to display the following help information:

```
REQUEST [
  COMMENT
  LINKS
  ENABLE
  DISABLE
  SAMPLESTATISTICS
  READSTATISTICS
  CLEARSTATISTICS
  LSAMPLESTATISTICS
  LREADSTATISTICS
  ]
```

An example of a REQUEST command syntax is:

```
SAPX25 { REQUEST [ LINKS(0,1,2,3,4,5,6,7), ENABLE ] }
```

9.3.8.1 **ENABLE** — Enable SLP Data Link(s) (**HENABLE** and **IENABLE**)

The third-level ENABLE command enables all data links specified by the latest LINKS command. This command is available only for SAPX25.

9.3.8.2 **DISABLE** — Disable SLP Data Link(s) (**HDISABLE** and **IDISABLE**)

The third-level DISABLE command disables all data links specified by the latest LINKS command.This command is available only for SAPX25.

9.3.8.3 **SAMPLESTATISTICS** — Sample SLP Data Link(s) Statistics (**HSTATS_SAMPLE** and **ISTATS**)

The third-level SAMPLESTATISTICS command generates a report of the current statistics for all data links specified by the latest LINKS command. Freeway does not clear the statistics.

9.3.8.4 **READSTATISTICS** — Read/Clear SLP Data Link(s) Statistics (**HSTATS** and **ISTATS**)

The third-level READSTATISTICS command generates a report of the current statistics for all data links specified by the latest LINKS command. Freeway then clears the statistics.

9.3.8.5 CLEARSTATISTICS — Clear SLP Data Link(s) Statistics (HSTATS_CLEAR)

The third-level CLEARSTATISTICS command clears the current statistics for all data links specified by the latest LINKS command, but Freeway does not report the statistics.

9.3.8.6 LSAMPLESTATISTICS — Sample 32-bit SLP Data Link(s) Statistics (HSTATS_32BIT_SAMPLE and ISTATS_32BIT)

The third-level LSAMPLESTATISTICS command generates a report of the current 32-bit statistics for all data links specified by the latest LINKS command. Freeway does not clear the statistics.

9.3.8.7 LREADSTATISTICS — Read/Clear 32-bit SLP Data Link(s) Statistics (HSTATS_32BIT and ISTATS_32BIT)

The third-level LREADSTATISTICS command generates a report of the current 32-bit statistics for all data links specified by the latest LINKS command. Freeway then clears the statistics.

9.4 SAPMLP — Multilink Procedure Service Access Point

The primary SAPMLP command gains MANAGER application access to the Freeway MLP protocol services directly rather than through the X.25 SAPX25 command. Since Protogate currently provides CS API support for X.25 and HDLC only, this command should not be used. If MLP support *under* X.25 is desired, the MLP should be configured after using the SAPX25 command to access Freeway X.25 protocol services.

9.5 SAPSLP — HDLC LAPB Service Access Point

The primary SAPSLP command gains MANAGER application access to the Freeway HDLC LAPB single link procedure (SLP) protocol services directly rather than through the X.25 SAPX25 and/or SAPMLP commands. After SAPSLP access is open, second-level commands configure individual HDLC data links for USER application process use under CS API control.

The SAPSLP command provides the following help information when you type a question mark:

```
SAPSLP {
  COMMENT
  SLP
  REQUEST
  }
```

The second-level SLP command is identical to the corresponding SAPX25 SLP command (Section 9.3.3). The REQUEST command provides the following help information when you type a question mark:

```
REQUEST [
  COMMENT
  LINKS
  SAMPLESTATISTICS
  READSTATISTICS
  CLEARSTATISTICS
  LSAMPLESTATISTICS
  LREADSTATISTICS
  ]
```

These third-level commands are identical to the corresponding SAPX25 REQUEST commands (Section 9.3.8).

Note

The HDLC MANAGER application cannot enable or disable data links. Instead, the HDLC USER application enables a data link by issuing a cs_connect request, and disables a data link by issuing a cs_disconnect request.

9.6 **MONITOR** — X.25 HDLC Data Link Monitor

The primary MONITOR command gains MANAGER access to the Freeway diagnostic service-access point to prepare for monitoring protocol operation on a specified data link.

The MONITOR command provides the following help information when you type a question mark:

```
MONITOR {
  LINKS
  BRIEF
  FULL
  EXCEPTIONS
  }
```

An example of the MONITOR command syntax is:

```
MONITOR { LINKS(0), BRIEF
```

Note that the closing brace is omitted. This is because specification of a closing brace would terminate the MONITOR command, stopping all data link monitoring immediately.

Figure 9–5 shows a sample of MONITOR command report data. The report includes time-stamped reports of monitoring ON/OFF events, modem signal ON/OFF transitions, frames and packets sent by the DTE, frames and packets received from the DCE, and frame transfer error status. The reports are designed to show clearly the contents of each X.25 frame and packet header field. Data fields (when present) are shown in both hexadecimal and ASCII formats.

```
  TIME-STAMP LINK    FRAME   NS NR  MLP MOD QDM LCN PACKET    PS PR ERR

     104.150 ***0 ON
     123.900 DTR0 ON
     123.903 DSR0 ON
     123.907 DCD0 ON
     123.913 DCE0  1 DM
     124.003 RTS0 ON
     124.003 CTS0 ON
     124.006 DTE0  1 SABM  P
     124.015 DCE0  1 UA    F
     124.045 DCE0  3 I        0  0        8     001 CALL
0000: 11 19 00                                       ...
     124.055 DCE0  3 I        1  0        8     002 CALL
0000: 11 19 00                                       ...
     124.057 DTE0  1 I        0  1        8     001 CONNECT
0000: 00 00                                          ..
     124.064 DCE0  3 I        2  0        8     003 CALL
0000: 11 19 00                                       ...
     124.066 DTE0  1 I        1  2        8     002 CONNECT
0000: 00 00                                          ..
     124.080 DTE0  1 I        2  3        8     003 CONNECT
0000: 00 00                                          ..
     124.156 DCE0  1 RR          3
     125.041 DTE0  1 I        3  3        8     001 DATA  512  0  0
     125.051 DCE0  3 I        3  3        8     001 DATA  512  0  0
     125.474 DTE0  1 I        4  3        8     002 DATA  512  0  0
     125.485 DCE0  3 I        4  3        8     002 DATA  512  0  0
     125.908 DTE0  1 I        5  3        8     003 DATA  512  0  0
     125.918 DCE0  3 I        5  4        8     003 DATA  512  0  0
     126.341 DTE0  1 I        6  4        8     001 DATA  512  1  0
     126.351 DCE0  3 I        6  5        8     001 DATA  512  1  0
     126.774 DTE0  1 I        7  5        8     002 DATA  512  1  0
     126.785 DCE0  3 I        7  6        8     002 DATA  512  1  0
     127.208 DTE0  1 I        0  6        8     003 DATA  512  1  0
     127.218 DCE0  3 I        0  7        8     003 DATA  512  1  0
     127.641 DTE0  1 I        1  7        8     001 DATA  512  2  0
     127.652 DCE0  3 I        1  0        8     001 DATA  512  2  0
```

Figure 9–5: Sample MONITOR Report

The monitor output format contains 13 named display fields. Some named display fields contain unnamed display subfields. A description of each display field and subfield follows.

TIME-STAMP This field displays a 32-bit millisecond time stamp as seconds and milliseconds (ssssssss.mmm).

LINK This field contains two subfields showing the event type and link number. The link number appears as a digit following the event type. Event types appear as one of the following three-letter identifiers:

***	Transition on monitor function
CTS	Transition on clear to send
DCD	Transition on data carrier detect
DCE	Frame/packet received from DCE
DSR	Transition on data set ready
DTE	Frame/packet sent by DTE
DTR	Transition on data terminal ready
RTS	Transition on request to send

FRAME When the LINK event type is DCE or DTE, the FRAME field contains three subfields that show the frame address, frame type, and P/F bit state (the appropriate letter P or F appears when the P/F bit is set).

When the LINK event type is ***, CTS, DCD, DSR, DTR, or RTS, the FRAME field identifies whether the new transition state is ON or OFF. A transition of the monitor function to OFF indicates the start of a gap in reported data.

NS When the FRAME type is I (meaning I-frame), the NS field shows the send sequence number in the frame; otherwise the field is blank.

NR When the FRAME type is I, RR, RNR, REJ, or SREJ, the NR field shows the acknowledging receive sequence number in the frame; otherwise the field is blank.

MLP When MLP operations are enabled and an I-frame contains an MLP or X.25 packet, the MLP field contains a hexadecimal dump of the MLP protocol header; otherwise the field is blank.

MOD When an I-frame contains an X.25 packet, the MOD field shows the X.25 packet modulus value extracted from the X.25 packet header; otherwise the field is blank.

QDM When an I-frame contains an X.25 packet, the QDM field shows the X.25 packet A/Q-bit, D-bit, M-bit values extracted from the X.25 packet header. The indicator letters A, Q, D, or M are used in combination to show which (if any) of these bits are set in the X.25 packet header; otherwise the field is blank.

LCN When an I-frame contains an X.25 packet, the LCN field shows the hexadecimal LCGN/LCN value from the packet header; otherwise the field is blank.

PACKET When an I-frame contains an X.25 packet, the PACKET field show the packet type as CALL, CLEAR, CLEAR_C, CONNECT, DIAG, INT, INT_C, REJ, RESET, RESET_C, RGSTR, RGSTR_C, RNR, RR, RSTRT, RSTRT_C, or DATA*nnnn* (where "*nnnn*" is the number of bytes in the data field). Any unknown packet type is shown in hexadecimal.

PS When the PACKET type is DATA, the PS field shows the send sequence number in the packet; otherwise the field is blank.

PR When the PACKET type is DATA, RR, RNR, or REJ, the PR field shows the acknowledging receive sequence number in the packet; otherwise the field is blank.

ERR When the LINK event is DTE, this field is blank or reports an abnormal frame transmit status as follows:

WDT Transmit timeout

ABT Transmit abort

UNR Transmit underrun

When the LINK event is DCE, the ERR field is blank or reports an abnormal frame receive status as follows:

FCS Frame check sequence error

ABT Receive abort

OVR Receiver overrun

SIZ Received frame oversize

Packet data contents (when reported) appear on additional lines as 16 bytes per line, shown in hexadecimal and ASCII formats. In the ASCII printout, the high-order bit is ignored, and all non-printing ASCII characters except spaces are printed as periods.

If the monitor report data is output too slowly, it may not keep up with the actual Freeway data link operations. In this case, the report format indicates monitoring gaps by showing when monitoring is temporarily turned OFF then ON again.

Monitoring gaps may be reduced by monitoring only one link at a time and by redirecting monitor output to a file. Monitor data may be captured to a file by redirecting the standard error output device (stderr) to the desired file or by capturing workstation screen output to a log file.

9.6.1 LINKS — Select Monitored Data Links

The secondary LINKS command specifies a list of data links to be monitored. The allowed values are 0–7. Monitoring of more than one link at a time is not recommended.

9.6.2 BRIEF — Select Brief Monitoring Format

The secondary BRIEF command disables reporting of X.25 data packet data fields. The contents of X.25 data packet frame and packet headers, and the data fields for all other packets are still reported. This is the default format if no monitoring format specification is supplied.

9.6.3 FULL — Select Full Monitoring Format

The secondary FULL command enables reporting of X.25 data packet data fields. The contents of X.25 data packet frame and packet headers are also reported.

Since FULL format radically increases the volume of monitoring report output, it increases the likelihood that gaps will appear in the report data. The FULL format should only be used when knowledge of the data field contents in data packets is required.

9.6.4 EXCEPTIONS — Select Exception Event Monitoring

The secondary EXCEPTIONS command enables reporting of exception events only. Most normal events are screened out of the report stream on the ICP, so that only unusual events such as modem signal transitions, data link resets and I/O errors, and X.25 packet anomalies are reported.

Chapter 10

Freeway X.25 Call Service Application Program Interface

This chapter documents the MANAGER application access to Freeway using Protogate's Call Service Application Program Interface (CS API). Freeway supports two classes of application:

USER applications This class accesses Freeway X.25 virtual circuits for data transfer. Freeway supports multiple USER applications simultaneously. To implement the USER application data transfer functions, refer to the *X.25 Call Service API Guide*.

MANAGER application This class accesses Freeway X.25 or HDLC LAPB protocol services to exercise complete control over Freeway configuration and management options described in Chapter 3 through Chapter 6. Freeway permits a maximum of one MANAGER application per data link. Freeway also permits one MANAGER application to configure several data links, but protects against contention for control of links.

The application programmer can use Protogate's CS API to perform the MANAGER application configuration and startup steps (Table 10–1) prior to implementing USER application data transfer. Figure 10–1 illustrates the X.25 sequence. Figure 10–2 is the configuration sequence for HDLC.

Note

For the HDLC MANAGER application, only steps 2 and 4 are supported. Step 4 is limited to configuration of the TL1 timer and modem control signal options.

Table 10–1: X.25 MANAGER Application Configuration and Startup

Step	Action	Reference Section
1	Configure buffer and station resource limits	Section 10.3.6
2	Configure data links	Section 10.3.4.1
3	Configure X.25 multilink procedures (optional)	Section 10.3.8
4	Configure X.25 call service (optional)	Section 10.3.7
5	Configure X.25 stations for each data link (optional)	Section 10.3.4.2
6	Enable data links	Section 10.3.2
7	Register Facilities with the network DCE (optional)	Section 10.3.15

10.1 MANAGER Application CS API Usage

The MANAGER application must attach and bind to the X.25 or HDLC protocol service access point (SAP) on Freeway before it can issue configuration requests. Protogate's CS API provides cs_attach and cs_bind requests for this purpose. The access mode in the DLI configuration file must specify MGR. MANAGER application access to the SAP continues until the application issues a cs_unbind or cs_detach request, or terminates abnormally.

To send commands to Freeway, the MANAGER application issues cs_write requests specifying the header and data information described in each of the following sections. The cs_read request receives responses from Freeway.

The most common error response from the CS API is CS_SVRERR, which usually indicates a rejection of the packet by Freeway. Normally this response is due to incorrect operation of the host program, such as issuing commands in the wrong order or incorrectly specifying header or data information. The programmer should correct the situation that causes the rejection.

For details on the CS API requests and error codes, refer to the *X.25 Call Service API Guide*.

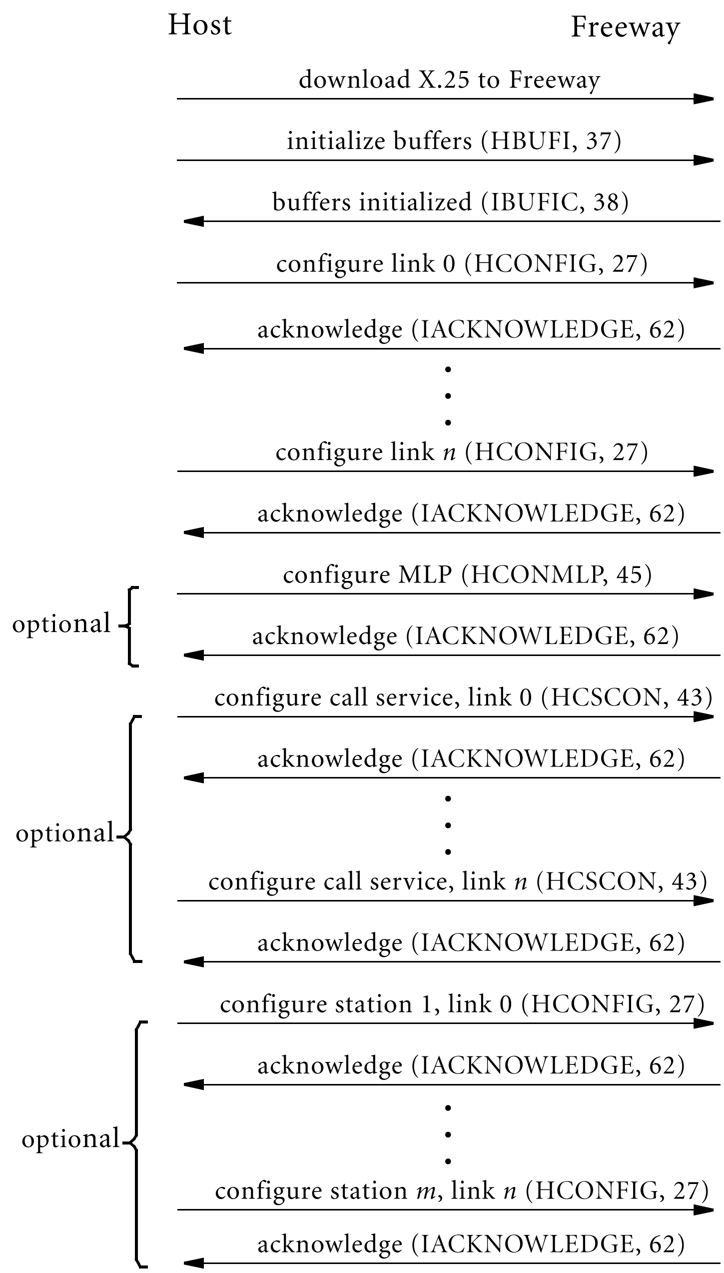

Figure 10–1: X.25 Startup Sequence

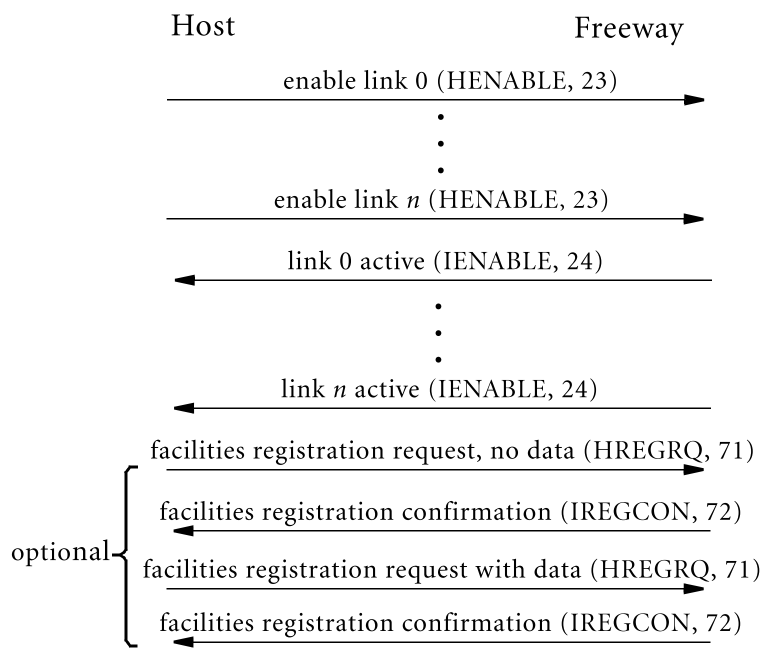

Figure 10–1: X.25 Startup Sequence *(Cont'd)*

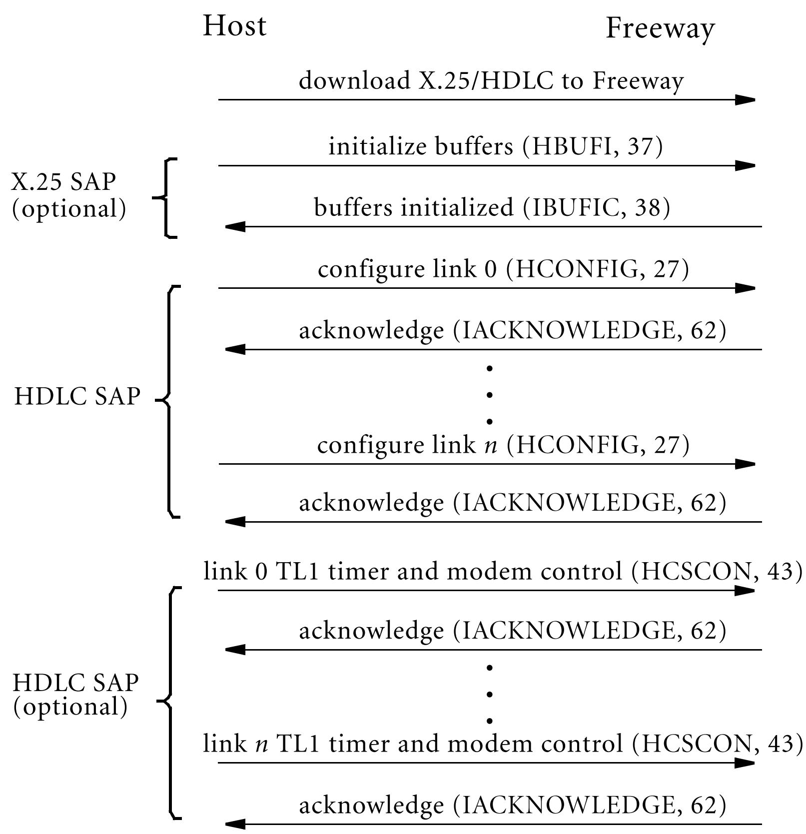

Figure 10–2: HDLC Configuration Sequence

10.2 Freeway Command or Response Packet Format

Freeway command or response packet contains 16 bytes of header information, referred to as the SAP header (see the CS API header file cs_struct.h), plus data of variable length.

command
modifier
link[1]
circuit
session
sequence
reserved1
reserved2

10.3 MANAGER Application Packets Sent to Freeway

To send command packets to Freeway, the MANAGER application uses the CS API cs_write request and sets the buf_length parameter to the total number of bytes, which includes the 16-byte SAP header plus the size of the data which is variable. Section 10.3.2 through Section 10.3.17 describe the format of the command packets.

10.3.1 HSTATS_32BIT_SAMPLE (15) — Sample Statistics

Use this command to request Freeway to report the current statistics for a specified link without altering them. To clear the statistics after reading them, use the HSTATS_32BIT (51) command. Freeway responds to a HSTATS_32BIT_SAMPLE command with an ISTATS_32BIT (16) packet.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HSTATS_32BIT_SAMPLE (15)
modifier	0

1. The link ranges from 0 through n-1, where n is the actual number of links supported by the ICP on Freeway. ICPs support either 8 or 16 data links each.

link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.2 HENABLE (23) — Host Enable Link

Use this command to enable an X.25 data link after you have configured the link, call service parameters, and associated stations. The expected Freeway response is an IENABLE (24) packet. The HDLC MANAGER application does not use this command.

Each link must be enabled separately. The application program must wait for the IENABLE confirmation packet from Freeway before the USER application can start data transfer or call placement on that link. When using an MLP, the application program must wait for the IENABLE confirmation for *at least one* of the MLP's SLPs before starting data transfer.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HENABLE (23)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.3 HDISABLE (25) — Host Disable Link

Use this command to disable an X.25 link. The expected Freeway response is an IDISABLE (26) packet. The HDLC MANAGER application does not use this command.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HDISABLE (25)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.4 HCONFIG (27) — Configure Link or Station

Use this command to configure either a data link, or an X.25 station resource for a particular data link. The expected Freeway response is an IACKNOWLEDGE (62) packet.

The two configuration methods are described in the following sections.

10.3.4.1 Configure Link

Use this command to configure an X.25 or HDLC data link. If you send a HCONFIG packet while the link is enabled, the CS API returns an error.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HCONFIG (27)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus the data size which is variable. The data format is as follows:

The first 16-bit word following the SAP header must contain the following specifications:

word 0:	Bits 0–3:	nominal data rate (see Table 10–2)
	Bit 4:	addressing (0 = DTE (default), 1 = DCE)
	Bit 5:	0
	Bit 6:	clock (1 = external (required))
	Bit 7:	0
	Bits 8–15:	0

Table 10–2: Nominal Data Rate

Value of bits 0–3	Data rate
0	Custom rate[a]
1	reserved
2	reserved
3	reserved
4	reserved
5	300
6	600
7	1200
8	2400
9	4800
10	9600
11	19200
12	38400
13	56000
14	57600
15	64000

[a] Other data rates may be specified by using the custom data rate function (6) in the packet data area.

In addition, the data area may contain the following optional information for setting link configuration parameters, listed in ascending function code order. Each optional specification consists of a set of two or three 16-bit word values.

word 0:	SFWSIZE[1] (1)
word 1:	Frame transmit window size (1–7 or 1–127 *extended*) (Default is 7)
word 0:	SDATSIZE (2)
word 1:	Maximum frame data size in bytes (64 through the configured communication buffer size) (Default is the comm. buffer size)
word 0:	ST1TIME[2] (3)
word 1:	T1 timer value, where bits 0–7 = seconds (0–255) Bits 8–15 = tenths (0–9) (Default is 2.0 seconds.)
word 0:	SN2 (4)
word 1:	N2 retry limit value (1–255) (Default is 10)
word 0:	ENCODING (5)
word 1:	Bit encoding format value (0 = NRZ (default), 1 = NRZI)
word 0:	DATARATE[3] (6)
words 1–2:	Custom data rate value (longword)
word 0:	ST2TIME[4] (7)
word 1:	T2 timer value, where bits 0–7 = seconds (0–255) Bits 8–15 = tenths (0–9) (Default is 0.1 seconds.)
word 0:	LAPB_MODULUS (8)
word 1:	Frame modulus value (0 = mod 8 (default) 1 = *extended* mod 128)

1. Frame transmit window size must be compatible with the frame modulus (function 8).

2. A T1 timer value of 2.0 seconds may be insufficient at data rates below 9.6 kb/s. Protogate recommends a T1 timer value of three to four times the transmission time of the longest packet.

3. Specify a custom data rate only when the nominal data rate is not indicated.

4. The T2 value for the DTE must be sufficiently less than the T1 value for the DCE to ensure that delaying DTE transmission of acknowledgments by T2 seconds will not cause a T1 timeout in the DCE

word 0: CUSTOM_ADDRESS (9)
word 1: Local SLP address
word 2: Remote SLP address

word 0: INTEGRITY_TIMER (10)
word 1: T4 integrity check timer value, where bits 0–7 = seconds (0–255)
Bits 8–15 = tenths (0–9) (Default is zero...no timer active)

word 0: IDLE_TIMER (11)
word 1: T3 idle link timer value, where bits 0–7 = seconds (0–255)
Bits 8–15 = tenths (0–9) (Default is zero...no timer active)

word 0: XMIT_CLOCK (12)
word 1: X.21/V.11 external transmit clock source selection
(0 = send timing (default), 1 = receive timing)

word 0: OPTION_SREJ[1] (13)
word 1: Data link SREJ option switch (0 = off, 1 = on) (Default is 0 (off))

word 0: OPTION_RAW[2] (14)
word 1: Raw HDLC option switch (0 = off, 1 = on) (Default is 0 (off))

word 0: EIA_TYPE[3] (15)
word 1: EIA selection indication (EIA_232 = 1, EIA_449 = 2, EIA_530 = 3, EIA_V35 = 4, MIL_188C = 5) (There is no default)

word 0: OPTION_UI[4] (16)
word 1: ISO HDLC Option 4 (UI frames) (0=off (default), 1=on)

word 0: OPTION_TEST[5] (17)
word 1: ISO HDLC Option 12 (TEST frames) (0=off (default), 1=on)

1. Neither CCITT X.25 nor ISO7776 permits the use of the SREJ option.
2. Applies only to SAP_SLP operation.
3. Software-selectable EIA configuration is supported on ICPs with the IUSC serial port controller.
4. Applies only to SAP_SLP operation.
5. Applies only to SAP_SLP operation.

10.3.4.2 Configure Station

After configuring the data links, use a separate HCONFIG command for each station associated with an X.25 data link. Multiple stations can be configured for each link. If you send a HCONFIG packet while the link is enabled, the CS API cs_write request returns an error. The HDLC MANAGER application does not use this command.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HCONFIG (27)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	Station ID (1–*n*) (*n* = virtual circuit maximum)
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus the data size which is variable. The data format is as follows:

word 0:	Bits 0–7:	LCN value (only for PVC) (0–255)
	Bits 8–11:	LCGN value (for PVC or SVC) (0–15)
	Bit 12:	Set to 1 for PVC and set to zero for SVC

In addition, the data area may contain the following word pair to set station packet window size:

word 0:	SPWSIZE (1)
word 1:	Packet window size (1–7 or 1–127 *extended*[1]) (Default is 2)

1. Before configuring stations with extended packet window sizes on a link, first send a configure call service packet (43) to enable extended packet sequence numbering on the link.

10.3.5 HSTATS (33) — Read and Clear Statistics

Use this command to clear the statistics on a link. Freeway sends the current statistics in a ISTATS (34) response packet and then clears the statistics.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HSTATS (33)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.6 HBUFI (37) — Configure Buffer and Station Resource Limits

Use this command to configure the segmentation buffer size, the communication buffer size, and the number of virtual circuits. The Freeway confirmation response is an IBUFIC (38) packet. If you send a HBUFI packet while any links are enabled, the CS API cs_write request returns an error. The HDLC MANAGER application does not use this command.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HBUFI (37)
modifier	0
link	0
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus the data size of 6. The information in the data area is as follows:

word 0:	Number of 64-byte pages in the segmentation buffers. Valid values are zero through 128. A value of zero implies segmentation is not used. The default is zero.
word 1:	Number of 64-byte pages in the communication buffers. Valid values[1] are 1 through 64. The default value is four pages (256 bytes).
word 2:	Number of virtual circuits (1–1024). The default is 256.

10.3.7 HCSCON (43) — Configure Call Service

Use this command to configure call service parameters for a data link. The expected Freeway response is an IACKNOWLEDGE (62) packet. Table 10–3 lists the function codes for call service configuration packets. The default configuration values, shown in the data descriptions below, apply if not overridden by the host.

If you send a HCSCON packet while the link is enabled, the CS API cs_write request returns an error.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HCSCON (43)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

1. You should analyze the SVC call request user data and fast select data requirements before configuring a communication buffer size of less than four pages (256 bytes).

Table 10–3: Function Codes for Configure Call Service Packets

Code Symbol	Code Number	Function	X.25/HDLC Support
HF_CLLNG	1	Calling DTE address	X.25
HF_FASCN	3	Fast select option	X.25
HF_RVCN	6	Reverse charge option	X.25
HF_INCM	8	Incoming calls option	X.25
HF_T2XCN	11	T2X timers	X.25
HF_R2XCN	12	R2X retry limits for T2X timers	X.25
HF_TLX	13	TL1 timer	X.25/HDLC
HF_LCN	17	LCN bounds	X.25
HF_CERT	18	X.25 Certification Mode	X.25
HF_FLOW	19	Flow control negotiation	X.25
HF_CLM	22	Modem Control Signal Monitoring	X.25/HDLC
HF_CLTMR	23	Modem Control Signal Debounce Time	X.25/HDLC
HF_RESTART	25	Restart on SLP/MLP initialization	X.25
HF_REJ	42	Packet retransmission support	X.25
HF_MOD128	43	Extended packet sequence numbering	X.25
HF_X25_PROFILE	44	X.25 operation profile	X.25
HF_ADDR_LEN	45	Local DTE address length	X.25
HF_TOANPI	47	DTE Address Format	X.25

The cs_write buf_length parameter = 16 (SAP header size) plus the data size which is variable. The call service configuration parameters are described below, arranged in ascending function code order.

Note

For some function codes, byte 1 is a fixed data length which is *not* variable. You must include all the data indicated.

Configure Calling DTE Address (1)

byte 0:	`HF_CLLNG` (1)
byte 1:	Calling DTE address length in bytes (0–15) (default=0)
bytes 2–*n*:	Calling DTE address (ASCII string)

Fast Select (3)

byte 0:	`HF_FASCN` (3)
byte 1:	0 = bar, 2 = notify (default)

Reverse Charge

byte 0:	`HF_RVCN` (6)
byte 1:	0 = bar, 1 = accept (default), 2 = notify

Incoming Calls (8)

byte 0:	`HF_INCM` (8)
byte 1:	0 = bar, 1 = accept (default), 2 = notify

T2X Timer (CCITT) (11)

byte 0:	`HF_T2XCN` (11)
byte 1:	Data length (4 or 5)
byte 2:	T20 timeout value (1–255 seconds) (default = 180)
byte 3:	T21 timeout value (1–255 seconds) (default = 200)
byte 4:	T22 timeout value (1–255 seconds) (default = 180)
byte 5:	T23 timeout value (1–255 seconds) (default = 180)
byte 6:	T28 timeout value (0.1–25.5 minutes) (default = 5.0 minutes) (CCITT 1984 and 1988)

T2X Timer (ISO 8208 or Unrestricted) (11)

byte 0:	`HF_T2XCN` (11)
byte 1:	Data length (9)
byte 2:	T20 timeout value (1–255 seconds) (default = 180)

byte 3:	T21 timeout value (1–255 seconds) (default = 200)
byte 4:	T22 timeout value (1–255 seconds) (default = 180)
byte 5:	T23 timeout value (1–255 seconds) (default = 180)
byte 6:	T24 timeout value (1–255 seconds) (default = disabled)
byte 7:	T25 timeout value (1–255 seconds) (default = disabled)
byte 8:	T26 timeout value (1–255 seconds) (default = disabled)
byte 9:	T27 timeout value (1–255 seconds) (default = disabled)
byte 10:	T28 timeout value (0.1–25.5 minutes) (default = 5.0 minutes)

Note

A T2X timer or R2X retry limit value of zero does not update the current setting.

R2X Retry Limits for T2X Timers (CCITT) (12)

byte 0:	`HF_R2XCN` (12)
byte 1:	Data length (4 or 5)
byte 2:	R20 retry limit value (1–255) (default = 2)
byte 3:	0
byte 4:	R22 retry limit value (1–255) (default = 2)
byte 5:	R23 retry limit value (1–255) (default = 2)
byte 6:	R28 retry limit value (1–255) (default = 2) (CCITT 1984 and 1988)

R2X Retry Limits for T2X Timers (ISO 8208 or Unrestricted) (12)

byte 0:	`HF_R2XCN` (12)
byte 1:	Data length (9)
byte 2:	R20 retry limit value (1–255) (default = 2)
byte 3:	0
byte 4:	R22 retry limit value (1–255) (default = 2)
byte 5:	R23 retry limit value (1–255) (default = 2)
byte 6:	0
byte 7:	R25 retry limit value (1–255) (default = 1)

byte 8:	0
byte 9:	R27 retry limit value (1–255) (default = 1)
byte 10:	R28 retry limit value (1–255) (default = 2)

TL1 Link Activation Timer (13)

byte 0:	HF_TLX (13)
byte 1:	Data length (1)
byte 2:	TL1 timer limit (1–255) (default = 180)

LCN Bounds (17)

byte 0:	HF_LCN (17)
byte 1:	Data length (12)
bytes 2, 3:	Lowest incoming channel (LIC) (default = 0)
bytes 4, 5:	Highest incoming channel (HIC) (default = 0)
bytes 6, 7:	Lowest two-way channel (LTC) (default = 1)
bytes 8, 9:	Highest two-way channel (HTC) (default = 4095)
bytes 10, 11:	Lowest outgoing channel (LOC) (default = 0)
bytes 12, 13:	Highest outgoing channel (HOC) (default = 0)

Certification Mode (18)

byte 0:	HF_CERT (18)
byte 1:	0 = no (default), 1 = yes

Flow Control Negotiation (19)

byte 0:	HF_FLOW (19)
byte 1:	0 = bar (default), 1 = accept

Modem Control Signal Monitoring (22)

byte 0:	HF_CLM (22)
byte 1:	Signal to be monitored (1 = CTS, 2 = DCD)
byte 2:	Status of monitoring (0 = stop (default), 1 = start)

Modem Control Signal Debounce Time (23)

byte 0: HF_CLTMR (23)
byte 1: Signal associated with timer (1 = CTS, 2 = DCD)
byte 2: Debounce time value (1–255 seconds) (default = 15)

X.25 Restart Following SLP/MLP Initialization (25)

byte 0: HF_RESTART (25)
byte 1: 0 = no (default), 1 = yes

REJ Packet Retransmission (42)

byte 0: HF_REJ (42)
byte 1: 0 = disable (default), 1 = enable

Extended Packet Sequence Numbering (43)

byte 0: HF_MOD128 (43)
byte 1: 0 = modulo 8 (default)1 = *extended* modulo 128

X.25 Operation Profile (44)

byte 0: HF_X25_PROFILE (44)
byte 1: X.25 standard selection option
0 = unrestricted
1 = reserved
2 = CCITT 1980
3 = CCITT 1984 (default)
4 = ISO 8208
5 = CCITT 1988

Local DTE Address Length (45)

byte 0: HF_ADDR_LEN (45)
byte 1: Address length value (1–15, or 3–17 TOA/NPI)

DTE Address Format (47)

byte 0:	HF_TOANPI (47)
byte 1:	0 = Normal (default), 1 = TOA/NPI

10.3.8 HCONMLP (45) — Configure Multilink Procedures

Use this command to assign one or more X.25 SLPs to a common MLP and configure the timer and window parameters. The expected Freeway response is an IACKNOWLEDGE (62) packet. The HDLC MANAGER application does not use this command.

If you send a HCONMLP packet while any of the SLPs are enabled, the CS API cs_write request returns an error.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HCONMLP (45)
modifier	0
link	0
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus the data size which is variable, depending upon the number of SLPs included. The data format is as follows:

word 0:	MT1 lost frame timer (1–255 seconds)
word 1:	MT2 group busy timer (1–255 seconds)
word 2:	MT3 reset confirmation timer (1–255 seconds)
word 3:	MW multilink window size parameter (1–2048)
word 4:	MX receive MLP window guard region parameter (1 to 2048–MW)
word 5:	First SLP link identification
word 6:	Second SLP link identification
etc.	

10.3.9 HSTATS_32BIT (51) — Read and Clear Statistics

Use this command to clear the statistics on a link. Freeway sends the current statistics in a ISTATS_32BIT (16) response packet and then clears the statistics.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HSTATS_32BIT (51)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.10 HMONITOR (53) — Set Monitoring

Use this command to control optional line analyzer data collection functions. The packet enables or disables monitoring on one or more specified data links. The packet overrides any previous line analyzer control specification. Freeway sends an IMONITOR (54) response packet.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HMONITOR (53)
modifier	0
link	0
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus the number of bytes for one or more of the following link monitoring specification two-byte parameter sets:

byte 0:	Link ID (0–7 or 0–15)
byte 1:	Set monitoring (0 = off, 1 = brief, 2 = full, 3 = exceptions)
where:	"off" disables monitoring "brief" enables monitoring and skips data packet contents "full" enables monitoring and reports data packet contents "exceptions" enables monitoring and reports unusual events only.

10.3.11 HVERSION (55) — Request Software Version Data

Use this command to request the software version information. Freeway responds with an IVERSION (56) packet. The HDLC MANAGER application does not use this command.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HVERSION (55)
modifier	0
link	0
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.12 HSTATS_CLEAR (57) — Clear Statistics

Use this command to request Freeway to clear the current statistics for a specified link. To read the statistics before clearing them, use the HSTATS (33) command. The expected Freeway response is an IACKNOWLEDGE (62) packet.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HSTATS_CLEAR (57)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.13 HSTATS_SAMPLE (59) — Sample Statistics

Use this command to request Freeway to report the current statistics for a specified link without altering them. To clear the statistics after reading them, use the HSTATS (33) command. Freeway responds to a HSTATS_SAMPLE command with an ISTATS (34) packet.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HSTATS_SAMPLE (59)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.3.14 HCLSTATE (69) — Read Modem Control Line State

Use this command to request Freeway to report on the current status of either the clear to send (CTS) or data carrier detect (DCD) modem signal. Freeway responds with an ICLSTATE (70) packet.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HCLSTATE (69)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus one for the following data byte:

byte 0: modem signal ID (1 = CTS, 2 = DCD)

10.3.15 HREGRQ (71) — Facilities Registration Request

Use this command to invoke or revoke specific X.25 facilities for the DTE host and to adjust default values for DTE/DCE interface parameters. Also use this command to request a report of available X.25 facilities from the network DCE by sending only the SAP header (without data). Freeway responds with an IREGCON (72) packet. The HDLC MANAGER application does not use this command.

Table 10–4 lists the function codes for registration packets. Function codes 130 and 131 appear only in an IREGCON (72) response packet (Section 10.4.12).

Table 10–4: Function Codes for Facilities Registration Packets

Code Symbol	Code Number	Function	Packet Type
HF_NEGP1	128	Facilities negotiable in state *p1*	HREGRQ or IREGCON
HF_NEGANY	129	Facilities negotiable in any state	HREGRQ or IREGCON
HF_AVAIL	130	Availability of facilities	IREGCON only
HF_NON_NEG	131	Non-negotiable facilities	IREGCON only
HF_DFTHRU	132	Default throughput classes assignment	HREGRQ or IREGCON
HF_NSPACK	133	Non-standard default packet data sizes	HREGRQ or IREGCON
HF_NSWIN	134	Non-standard default packet window sizes	HREGRQ or IREGCON
HF_LOGCHAN	135	Logical channel types ranges	HREGRQ or IREGCON

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HREGRQ (71)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size) plus the data size which is variable. The facilities registration parameters are described below, arranged in ascending function code order:

Facilities Negotiable in State *p1* (128)

byte 0:	HF_NEGP1 (128)
byte 1:	Facility length (3)
byte 2:	Extended packet sequence numbering facility (0=no, 1=yes)
byte 3:	Packet retransmission facility (0=no, 1=yes)
byte 4:	D-bit modification facility (0=no, 1=yes)

Facilities Negotiable in Any State (129)

byte 0:	HF_NEGANY (129)
byte 1:	Facility length (7)
byte 2:	Incoming calls barred facility (0=no, 1=yes)
byte 3:	Outgoing calls barred facility (0=no, 1=yes)
byte 4:	Fast select acceptance facility (0=no, 1=yes)
byte 5:	Reverse charging acceptance facility (0=no, 1=yes)
byte 6:	Flow control negotiation facility (0=no, 1=yes)
byte 7:	Throughput class negotiation facility (0=no, 1=yes)
byte 8:	Charging information facility (0=no, 1=yes)

Default Throughput Class (132)

byte 0:	HF_DFTHRU (132)
byte 1:	Transmit throughput class selection (3–13)
byte 2:	Receive throughput class selection (3–13)

b/s rate selections are:

3 = 75	9 = 4800
4 = 150	10 = 9600
5 = 300	11 = 19200
6 = 600	12 = 48000
7 = 1200	13 = 64000[1]
8 = 2400	

Non-standard Default Packet Data Sizes (133)

byte 0:	HF_NSPACK (133)
byte 1:	Transmit packet data size selection (4–12)
byte 2:	Receive packet data size selection (4–12)

Data size selections are expressed as the power-of-two exponent of the actual size:

4 = 16	9 = 512
5 = 32	10 = 1024
6 = 64	11 = 2048
7 = 128	12 = 4096
8 = 256	

Non-standard Default Packet Window Sizes (134)

byte 0:	HF_NSWIN (134)
byte 1:	Transmit packet window size (1–127)
byte 2:	Receive packet window size (1–127)

1. The default throughput class of 64000 b/s is supported for the CCITT 1988 and unrestricted profiles only.

Window size values 8–127 are valid only when the *facilities negotiable in state p1*, function code HF_NEGP1 (128), are used to enable extended packet sequence numbering.

Logical Channel Types Ranges (135)

byte 0:	HF_LOGCHAN (135)
byte 1:	Facility length (12)
bytes 2, 3:	Lowest incoming channel (LIC)
bytes 4, 5:	Highest incoming channel (HIC)
bytes 6, 7:	Lowest two-way channel (LTC)
bytes 8, 9:	Highest two-way channel (HTC)
bytes 10,11:	Lowest outgoing channel (LOC)
bytes 12,13:	Highest outgoing channel (HOC)

10.3.16 HTEST (77) — TEST Command Frame

Use this command to send a TEST command frame to the remote DTE. Only the Manager Session for a link may send this command. The (eventual) Freeway response is an ITEST packet containing the data from the TEST response frame received from the remote DTE. The HDLC MANAGER application does not use this command.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HTEST (77)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = length of accompanying data to be sent in the TEST command frame.

10.3.17 HBUFCLEAR (81) — Enable Buffer Clearing

Use this command to configure Freeway to clear used buffers on the ICP before returning them to the ICP buffer pool resource. After buffer clearing is enabled, it cannot be disabled without downloading Freeway again. The expected Freeway response is an IACKNOWLEDGE (62) packet. The HDLC MANAGER application does not use this command.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	HBUFCLEAR (81)
modifier	0
link	0
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_write buf_length parameter = 16 (SAP header size).

10.4 Freeway Packets Received by the MANAGER Application

The X.25 or HDLC MANAGER application uses the CS API cs_read request to receive packets from Freeway. The return value of the cs_read request is the number of bytes received, which includes the 16-byte SAP header plus the size of the data which is variable. Section 10.4.2 through Section 10.4.12 describe the format of Freeway packets that the MANAGER application can receive.

10.4.1 ISTATS_32BIT (16) — Statistics Data

Freeway sends this packet in response to a HSTATS_32BIT (51) command or a HSTATS_32BIT_SAMPLE (15) command from the X.25 or HDLC MANAGER application.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	ISTATS_32BIT (16)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus the data field size, which is 72 for X.25 or 56 for HDLC. The data following the header has the following format:

longword 0:	Receive FCS errors
longword 1:	Receive I-frames too long
longword 2:	Receive overrun errors
longword 3:	Transmit underrun errors
longword 4:	Transmit watchdog errors
longword 5:	Unrecognized frames received
longword 6:	I-frames received
longword 7:	I-frames sent

longword 8:	FRMR frames received	
longword 9:	FRMR frames sent	
longword 10:	REJ frames received	
longword 11:	REJ frames sent	
longword 12:	SABM frames received	
longword 13:	SABM frames sent	
longword 14:	Restart packets received	X.25 only
longword 15:	Restart packets sent	X.25 only
longword 16:	LCNs currently in use	X.25 only
longword 17:	LCN usage high-water mark	X.25 only

10.4.2 IENABLE (24) — Link Active

Freeway sends this packet in response to a HENABLE (23) command from the X.25 MANAGER application. Freeway also sends this packet to report the restoration of a data link connection following a previously reported link failure (IDISABLE). It confirms a link-active state. The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IENABLE (24)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size).

10.4.3 IDISABLE (26) — Link Inactive

Freeway sends this packet in response to a HDISABLE (25) command from the X.25 MANAGER application. Freeway also sends this packet to report data link failure. It confirms a link-inactive state. The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IDISABLE (26)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size).

10.4.4 ISTATS (34) — Statistics Data

Freeway sends this packet in response to a HSTATS (33) command or a HSTATS_SAMPLE (59) command from the X.25 or HDLC MANAGER application.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	ISTATS (34)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus the data field size, which is 36 for X.25 or 28 for HDLC. The data following the header has the following format:

word 0:	Receive FCS errors
word 1:	Receive I-frames too long
word 2:	Receive overrun errors
word 3:	Transmit underrun errors
word 4:	Transmit watchdog errors

word 5:	Unrecognized frames received	
word 6:	I-frames received	
word 7:	I-frames sent	
word 8:	FRMR frames received	
word 9:	FRMR frames sent	
word 10:	REJ frames received	
word 11:	REJ frames sent	
word 12:	SABM frames received	
word 13:	SABM frames sent	
word 14:	Restart packets received	X.25 only
word 15:	Restart packets sent	X.25 only
word 16:	LCNs currently in use	X.25 only
word 17:	LCN usage high-water mark	X.25 only

10.4.5 IBUFIC (38) — Buffer Configuration Confirmation

Freeway sends this packet in response to a HBUFI (37) command from the X.25 MANAGER application. It confirms that the buffer-pool data structure is initialized. The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IBUFIC (38)
modifier	0
link	0
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus 4. The data format is as follows:

word 0:	Number of buffers in the segmentation buffer pool
word 1:	Number of buffers in the communication buffer pool

10.4.6 ITIMOUT (48) — Link Activation Timeout

Freeway sends this packet when a link does not become active within the TL1 time limit (Section 3.6.7 on page 71), or upon expiration of the T3 idle link timer (Section 3.4.13 on page 61). The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	ITIMOUT (48)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size).

10.4.7 IDIAG (50) — X.25 Network Diagnostic Data

Freeway forwards all diagnostic packets received from the network to the X.25 MANAGER application. No specific host action is required. The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IDIAG (50)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus the data size which is variable. The data format is as follows:

byte 0:	Diagnostic code from network
byte 1–*n*:	Diagnostic explanation from network

10.4.8 IMONITOR (54) — Monitoring Response

Freeway sends this packet periodically to report one or more line monitoring events when line monitoring is enabled (using the HMONITOR (53) command).

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IMONITOR (54)
modifier	0
link	0
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The data area concatenates one or more of the following event data entries. Each event data entry begins on a longword boundary within the data area. Any entry whose length is not an exact multiple of four is padded with additional NULL characters to the next longword boundary.

The sequence of these entries is the same as they occurred on the ICP. When data link analysis has been enabled on more than one link, the entries are intermixed in the approximate order in which they occurred. Due to small internal processing delays on the ICP, the order of events detected and reported by the ICP may differ from that determined by external frames of reference such as client program trace logs and serial data line monitors.

Due to internal accuracy limits on the ICP, the millisecond time stamp in each event report is approximate. The actual accuracy is roughly to the nearest 10 milliseconds. For most diagnostic purposes, protocol event sequencing, data transfer contents, and approximate timing are required. Because the shortest protocol timer setting available is 100 milliseconds, 10 millisecond accuracy is adequate.

Monitoring Event Data Entry Format

byte 0:	Monitoring change function code (1)
byte 1:	Link ID (0–*n*)
byte 2:	Reserved
byte 3:	Status (0 = off, 1 = on)
byte 4–7:	Event time stamp (milliseconds)

Modem Signal Event Data Entry Format

byte 0:	Modem signal event function code (2)
byte 1:	Link ID (0–*n*)
byte 2:	V.24 circuit ID (105 = RTS, 106 = RS, 107 = DSR, 108 = DTR, 109 = DCD)
byte 3:	Status (0 = off, 1 = on)
byte 4–7:	Event time stamp (milliseconds)

Transmit Event Data Entry Format

byte 0:	Transmit event function code (3)	
byte 1:	Link ID (0–*n*)	
byte 2:	Data format definition bit fields:	
	bit 0:	C/R indicator (0 = command, 1 = response)
	bits 1–2:	SLP header size (0, 2, or 3)
	bits 3–4:	MLP header size (0 or 2)
	bits 5–7:	X.25 header size (0, 3, or 4)
byte 3:	Status (0 = normal, 1 = timeout, 2 = abort, 3 = underrun)	
bytes 4–7:	Event time stamp (milliseconds)	
bytes 8–9:	Total transmit sample size *n*	
bytes 10–11:	Total transmit packet size *n*	
bytes 12–*n* + 12:	Transmit sample contents	

Receive Event Data Entry Format

byte 0:	Receive event function code (4)
byte 1:	Link ID (0–*n*)
byte 2:	Data format definition bit fields:
	bit 0: C/R indicator (0 = command, 1 = response)
	bits 1–2: SLP header size (0, 2, or 3)
	bits 3–4: MLP header size (0 or 2)
	bits 5–7: X.25 header size (0, 3, or 4)
byte 3:	Status (0 = FCS good, 1 = FCS bad, 2 = abort, 3 = underrun, 4 = oversize)
bytes 4–7:	Event time stamp (milliseconds)
bytes 8–9:	Total receive sample size *n*
bytes 10–11:	Total receive packet size *n*
bytes 12–*n* + 12:	Receive sample contents

10.4.9 IVERSION (56) — Freeway Software Version Information

Freeway sends this packet in response to a HVERSION (55) command from the X.25 MANAGER application. It contains the Freeway software version information. The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IVERSION (56)
modifier	0
link	0
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus the data size which is variable. The data area contains ASCII text identifying the software loaded, its version number, and its date of release.

10.4.10 IACKNOWLEDGE (62) — Command Acknowledge

Freeway sends this response packet to the X.25 or HDLC MANAGER application to report the successful completion of one of the commands listed below.

HCONFIG (27)
HCSCON (43)
HCONMLP (45)
HSTATS_CLEAR (57)
HBUFCLEAR (81)

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IACKNOWLEDGE (62)
modifier	Command type acknowledged
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The MANAGER application issues a non-blocking cs_write request to send a command packet to Freeway, then issues a blocking cs_read request. If Freeway processes the command successfully, then the cs_read return value (number of bytes read) = 16 (SAP header size) and the modifier field in the response packet identifies the command type acknowledged; however, if Freeway detects an error while trying to process a command, then the cs_read function returns the error code CS_SVRERR.

10.4.11 ICLSTATE (70) — Modem Control Line State Data

Freeway sends this packet in response to a HCLSTATE (69) command from the X.25 or HDLC MANAGER application.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	ICLSTATE (70)

modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus 2. The data format is as follows:

byte 0: Modem signal ID (1 = CTS, 2 = DCD)
byte 1: Signal status (0 = off, 1 = on)

10.4.12 IREGCON (72) — X.25 Facilities Registration Confirmation

Freeway sends this packet in response to a HREGRQ (71) command from the X.25 MANAGER application. The HDLC MANAGER application does not receive this response.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	IREGCON (72)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	CS API session ID
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus the data size which is variable. The data area of the IREGCON packet includes the following information but may also include additional function codes detailed in Section 10.3.15:

Availability of Facilities (130)

byte 0: HF_AVAIL (130)
byte 1: Facility length (13)
byte 2: Extended packet sequence numbering facility (0=no, 1=yes)

byte 3:	Packet retransmission facility (0=no, 1=yes)
byte 4:	D-bit modification facility (0=no, 1=yes)
byte 5:	Called line address modified facility (0=no, 1=yes)
byte 6:	Charging information (per interface) facility (0=no, 1=yes)
byte 7:	Charging information (per call) facility (0=no, 1=yes)
byte 8:	Reverse charging acceptance facility (0=no, 1=yes)
byte 9:	Reverse charging facility (0=no, 1=yes)
byte 10:	Default throughput classes (0=no, 1=yes)
byte 11:	Non-standard default packet window sizes (0=no, 1=yes)
byte 12:	Non-standard default packet data sizes (0=no, 1=yes)
byte 13:	Logical channel types ranges (0=no, 1=yes)
byte 14:	RPOA selection (per call) facility (0=no, 1=yes)

Non-negotiable Facilities (131)

byte 0:	HF_NON_NEG (131)
byte 1:	Facility length (1)
byte 2:	Local charging prevention facility (0 = disabled, 1 = enabled)

10.4.13 ITEST (78) — TEST Response Frame

Freeway sends this packet to deliver the data contained in a TEST response frame from the remote DTE. Only the link's Manager Session receives this packet.

The first eight 16-bit fields of the packet data area contain the following SAP header information:

command	ITEST (78)
modifier	0
link	Link ID (0–7 or 0–15)
circuit	0
session	Overwritten by CS API
sequence	0
reserved1	0
reserved2	0

The cs_read return value (number of bytes read) = 16 (SAP header size) plus the data size, which is variable. The data area of the ITEST packet contains the data received in the TEST response frame.

Chapter

11 Non-standard HDLC Options

Protogate supports four optional non-standard extensions to the HDLC data-link layer: raw HDLC access, SREJ selective recovery procedures, ISO HDLC Option 4 (UI frames), and ISO HDLC Option 12 (TEST frames). The options are mutually exclusive.

11.1 OPTION_RAW — Raw HDLC Access

Normal HDLC LAPB data link operations obey a complicated set of rules and require the use of a two-way simultaneous (full-duplex) physical circuit. For applications that receive (or send) data via a one-way (simplex) physical circuit, HDLC LAPB cannot be used. Instead, the raw HDLC option may be used to replace normal HDLC LAPB operations.

The raw HDLC option should not be used as the data link layer for X.25. Raw HDLC detects frame errors, but lacks the ability to recover data and may lose X.25 packets.

This option is mutually exclusive with each of the other options.

11.1.1 OPTION_RAW Configuration

The CS API permits a MANAGER application (such as x25_manager) to configure raw HDLC support for a data link by supplying the word pair shown below in addition to any other optional link configuration data described in Section 10.3.4.1 on page 158.

word 0:	OPTION_RAW (14)
word 1:	Raw HDLC option switch (0 = off (default); 1 = on)

11.1.2 **OPTION_RAW** Operation

When the raw HDLC option is enabled, the application is responsible for handling any protocol requirements, such as supplying or interpreting protocol header fields. Freeway handles the basic bit-synchronous SDLC envelope (flags and FCS), but ignores the contents of the frame. Freeway also discards any frame received with an FCS error, an abort sequence, or an excessive length.

Although the application must accommodate any HDLC protocol header fields that precede the actual data, the application interface is otherwise normal. However, use of the CS API function cs_reset causes HDLC operation on the data link to revert to normal HDLC operation by sending an SABM/E frame to reset the data link. Raw HDLC operation may be restored by using the CS API functions cs_disconnect and cs_connect in that order. Refer to the *X.25 Call Service API Guide* for more details about the standard application interface for HDLC.

11.2 **OPTION_SREJ** — SREJ Selective Recovery

Normal HDLC LAPB data link operations are optimized for ground-link operations. Although a satellite-link may be used, the normal REJ recovery procedures are inefficient and tend to adversely affect throughput as the frequency of bit-errors increases.

While neither CCITT X.25 nor ISO 7776 permits the use of selective recovery procedures, SREJ is supported under several other standards.[1] Although some differences exist among the various standards, Protogate's implementation incorporates the most common aspects of SREJ support, and should be compatible with most other implementations of SREJ.

If the remote DTE honors SREJ procedures, Protogate's SREJ option can be used on the local DTE to enhance data recovery. The SREJ option can be combined with modulo

1. ISO 4335, ISO 7809, ANSI X3.66, and ECMA 49 all support the use of SREJ procedures.

128 operation and an extended frame-transmit window to enhance satellite data link throughput as well.

The SREJ option may be enabled in the data link layer for X.25 only if the remote DTE also supports SREJ. Since they are not defined for X.25 by either CCITT or ISO, data link SREJ procedures are not generally recommended for X.25.

11.2.1 OPTION_SREJ Configuration

The CS API permits a MANAGER application (such as x25_manager) to configure SREJ support for a data link by supplying the word pair shown below in addition to any other optional link configuration data described in Section 10.3.4.1 on page 158.

word 0:	OPTION_SREJ (13)
word 1:	Data link SREJ option switch (0 = off (default); 1 = on)

11.2.2 OPTION_SREJ Operation

SREJ selective-recovery procedures operate transparently and do not affect the application interface to HDLC or X.25. Refer to the *X.25 Call Service API Guide* for more details about the standard application interface.

11.3 OPTION_UI — UI Frames

When this option is selected, HDLC LAPB operation may include the sending and receiving of UI frames. It does not preclude the normal operation with I frames. This option is valid only for operation via the service access point for SLP.

11.3.1 OPTION_UI Configuration

The CS API permits a MANAGER application (such as x25_manager) to configure UI frame support for a data link by supplying the word pair shown below in addition to any other optional link configuration data described in Section 10.3.4.1 on page 158.

word 0: OPTION_UI (16)
word 1: ISO HDLC Option 4 (UI frames) (0=off (default), 1=on)

11.3.2 **OPTION_UI** Operation

UI frame procedures operate with the low-level HUNDATA command and IUNDATA response. See *X.25 Low-Level Interface*, DC 900-1307.

11.4 **OPTION_TEST** — TEST Frames

When this option is selected, HDLC LAPB operation may include the sending and receiving of TEST frames by MANAGER applications. This option is valid only for operation via the service access point for SLP.

11.4.1 **OPTION_TEST** Configuration

The CS API permits a MANAGER application (such as x25_manager) to configure TEST frame support for a data link by supplying the word pair shown below in addition to any other optional link configuration data described in Section 10.3.4.1 on page 158.

word 0: OPTION_TEST (17)
word 1: ISO HDLC Option 12 (TEST frames) (0=off (default), 1=on)

11.4.2 **OPTION_TEST** Operation

TEST frame procedures operate with the low-level HTEST command (Section 10.3.16 on page 177) and IUNDATA response (Section 10.4.13 on page 189). Also see *X.25 Low-Level Interface*, DC 900-1307.

Chapter

12 Physical Level Considerations

At the physical level, X.25 offers two choices: X.21/V.11 or X.21 bis. Since the physical level provides a foundation for both link (frame) level operations and the network (packet) level operations, an understanding of the fundamental requirements at the physical layer is often helpful in diagnosing symptoms that might first be noticed in the operation of the X.25 or HDLC protocol layers.

For example, the physical level uses modem-control circuits to control (or indicate) the state of the physical level both prior to and during the transfer of data on the interface. Improper cabling might cause incorrect operation of modem-control circuits that could trigger an oscillation of the physical interface between *Online* and *Offline* states, affecting the transfer of data on the interface.

12.1 X.21/V.11 Interface

The X.21/V.11 physical interface implements leased-circuit service for a point-to-point physical connection to the X.25 network through a V.11 connector. This interface features a single external clock source circuit that is used as a timing reference for both transmit and receive data circuits. The interface also implements fewer modem-signal circuits than the more typical X.21 bis physical interface. Table 12–1 lists those circuits used by Freeway on the typical X.21/V.11 connection.

Each Freeway X.21/V.11 interface implements two modem-control signals. Freeway (the DTE) provides the Control (C) circuit to the DCE. The DCE provides the Indication (I) circuit to Freeway. Table 12–2 presents the interface state-transition definitions for the typical Freeway X.21/V.11 interface leased-line service. Freeway X.25/HDLC data transfer can occur only when the lower-level physical interface is in an *Online* state.

Table 12–1: Typical X.21/V.11 Circuits used by Freeway

Circuit Symbol	Circuit Name	Modem Control	Source
G	Signal ground or common		N/A
G_a	DTE common return		DTE
T	Transmit		DTE
R	Receive		DCE
C	Control	Yes	DTE
I	Indication	Yes	DCE
S	Signal element timing		DCE

Table 12–2: Freeway X.21/V.11 Interface State-Transitions

State Name	C	I
Offline	Off	Off
DTE Ready	On	Off
DCE Ready	Off	On
Online	On	On

12.2 X.21 bis Interface

The X.21 bis physical interface implements leased-circuit service for a point-to-point physical connection to the X.25 network through an EIA-232, EIA-449, EIA-530, or V.35 connector. This interface features separate clock source circuits for transmit timing and receive timing. Both transmit timing and receive timing are typically provided to Freeway by the DCE. As an option, Freeway can be configured to generate its own transmit timing; V.24 circuit 113 carries the associated timing signal to the DCE, and typically replaces V.24 circuit 114 when used. Table 12–3 identifies the X.21 bis circuits used by Freeway on the typical X.21 bis connection.

Table 12–3: Typical X.21 bis Circuits used by Freeway

V.24 Circuit No.	Circuit Name	Modem Control	Source
102	Signal ground or common return		N/A
103	Transmitted data		DTE
104	Received data		DCE
105	Request to send	Yes	DTE
106	Ready for sending	Yes	DCE
107	Data set ready	Yes	DCE
108/2	Data terminal ready	Yes	DTE
109	Data channel received line signal detector	Yes	DCE
114	Transmitter signal element timing		DCE
115	Receiver signal element timing		DCE

Each Freeway X.21 bis interface implements five modem control signals. Freeway (the DTE) provides the data terminal ready (108/2) circuit and the request to send (105) circuit. The DCE provides the data set ready (107) circuit, the ready for sending (106) circuit, and the data channel received line signal detector (109) circuit. Table 12–4 shows the terminology and symbolic names commonly used for these modem-control circuits.

Table 12–5 presents the interface state-transition definitions for the typical Freeway X.21 bis interface leased-line service. Freeway X.25/HDLC data transfer can occur only when the lower-level physical interface is in an *Online_DCD* or *Online_noDCD* state. The *Online_noDCD* state is a transition state in which the loss of DCD has been detected; loss of DCD is tolerated for up to 30 seconds before the Freeway turns DTR Off to force the X.21 bis interface to the *Offline* state.

Table 12–4: Terminology and EIA Symbols for X.21 bis Modem-Control Circuits

V.24 Circuit No.	Common Terminology	EIA-232	EIA-449	EIA-530	V.35	Source
105	Request-to-Send (RTS)	CA	RS	CA	RTS	DTE
106	Clear-to-Send (CTS)	CB	CS	CB	CTS	DCE
107	Data-Set-Ready (DSR)	CC	DM	CC	DSR	DCE
108/2	Data-Terminal-Ready (DTR)	CD	TR	CD	DTR	DTE
109	Data-Carrier-Detect (DCD)	CF	RR	CF	RLSD	DCE

Table 12–5: Freeway X.21 bis Interface State-Transitions

State Name	DTR	DSR[a]	DCD[b]	RTS	CTS
Offline	Off	N/A	N/A	N/A	N/A
DTR	On	Off	N/A	N/A	N/A
DTR_DSR	On	On	Off	N/A	N/A
DTR_DSR_DCD	On	On	On	N/A	N/A
DTR_DSR_DCD_RTS	On	On	On	On	Off
Online_noDCD	On	On	Off	On	On
Online_DCD	On	On	On	On	On

[a] Loss of DSR at any time causes the Freeway to turn DTR Off for several seconds, setting the X.21 bis interface to the *Offline* state during that time period.

[b] If DCD is not detected within 30 seconds of turning DTR On, or if DCD is lost for a period of 30 seconds after being detected, Freeway turns DTR Off for several seconds, setting the X.21 bis interface to the *Offline* state during that time period.

Glossary

API	application program interface
b/s	bits per second
CCITT	Consultative Committee of International Telephone and Telegraph
CTS	clear to send
CUG/OA	closed user group with outgoing access
D-bit	delivery bit, used in X.25 packets
DCD	data carrier detect
DCE	data circuit-terminating equipment
DISC	disconnect, an HDLC frame type
DM	disconnected mode, an HDLC frame type
DNIC	data network identification code
DTE	data terminal equipment
FCS	frame check sequence
GFI	general format indicator
FRMR	frame reject, an HDLC frame type
HDLC	high-level data link control
HIC	highest incoming channel

HOC	highest outgoing channel
HTC	highest two-way channel
ICP	intelligent communications processor
I-frame	information frame, an HDLC frame type
ISO	International Standards Organization
LAPB	link access procedure balanced, a specific type of HDLC
LCGN	logical channel group number
LCN	logical channel number
LIC	lowest incoming channel
LOC	lowest outgoing channel
LTC	lowest two-way channel
M-bit	more-data bit, specified using the CS_DF_X25MORE flag in the API cs_write request
MLP	multilink procedure; uses multiple SLPs
MW	multilink window size
MX	receive MLP window guard region
NTN	national terminal number
OSI	open systems interconnect
PDN	public data network
PVC	permanent virtual circuit
QOS	quality of service
REJ	reject (an HDLC frame or X.25 packet type)
RNR	receiver not ready, an HDLC frame or X.25 packet type

RPOA	recognized private operating agency
RR	receive ready, an HDLC frame or X.25 packet type
SABM	set asynchronous balanced mode, an HDLC frame type
SAP	service access point
SLP	single link procedure, an HDLC LAPB data link
SVC	switched virtual circuit
TOA/NPI	type-of-address/numbering-plan identifier
X.25	a packet-switching communications protocol

Index

Customer Report Form

We are constantly improving our products. If you have suggestions or problems you would like to report regarding the hardware, software or documentation, please complete this form and mail it to Protogate at 12225 World Trade Drive, Suite R, San Diego, CA 92128, or fax it to (877) 473-0190.

If you are reporting errors in the documentation, please enter the section and page number.

Your Name: ______________________________

Company: ______________________________

Address: ______________________________

____

____

Phone Number: ______________________________

Product: ______________________________

Problem or
Suggestion: ______________________________

____

____

____

____

____

Protogate, Inc.
Customer Service
12225 World Trade Drive, Suite R
San Diego, CA 92128