SunLink X.25 8.0.2 Reference Manual

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Preface

This manual provides reference material on SunLink X.25 product. The information here is useful toward an understanding of SunLink X.25, but is not required for its installation and configuration.

Chapter Summary

Chapter 1, "SunLink X.25 Overview", introduces SunLink X.25 , including a discussion of its primary uses. The chapter also includes a list of features supported by the product.

Chapter 2, "Configuration Reference", provides detailed information on the SunLink X.25 parameters you can change.

Chapter 3, "The X.25 Routing Configuration File", describes the X.25 routing configuration file as well as the `x25route` facility.

Chapter 4, "Troubleshooting", describes tests and diagnositic tools you can use to discover the cause of any problems you encounter.

Appendix A, "SunNet Manager Agent", provides the information you need if you plan to use SunNet Manager™.

Appendix B, "Error Messages and Error Codes", lists the error messages you may see while configuring SunLink X.25 in alphabetical order and suggests possible solutions. It also lists the error codes generated by the network you are attaching to. In most cases you will need to contact your service provider for help.

Appendix C, "Running IP over X.25", is a brief overview of some of the issues involved in running IP over X.25. It also provides information about the Defense Data Network (DDN).

Appendix D, "Compatibility with version 7.0", describes features that have been included purely to provide backwards compatiblity. The information given here is of no interest to users who do not have SunNet X.25 version 7.0 running on a network.

The Glossary lists X.25-related terms with their definitions.

Conventions Used in this Manual

- The acronym PSDN (Packet-Switched Data Network) refers to any public or private packet-switched network that makes interfaces that comply with the X.25 standard available to users.
- The term "Sun™ workstation" refers to any device running the Solaris™ 2.x system software.

We use the following typographic conventions:

`Typewriter font`
Represents what the system prints on your workstation screen and is used for program and file names.

`Boldface typewriter font`
Indicates literal user input, typically commands and responses to prompts that you can type in exactly as printed in this manual.

Italic font
Indicates variables or parameters that you replace with an appropriate word or string. Also used for emphasis.

`hostname%`
Represents your system's prompt for a non-privileged user's account.

`hostname#`
Represents your system's prompt for the `root` (super-user) account.

Boxes

```
Contain text that represents listings, a part of a
configuration file, or program output.
```

Boxes are also used to represent interactive sessions. In this use, user input is indicated by boldface typewriter font. For example:

```
hostname% df -k /usr
Filesystem            kbytes    used   avail capacity  Mounted on
/dev/sd0g              155015  103090   36424    74%    /usr
```

Notation

This manual uses an abbreviated notation to describe the graphical user interface. For example, Choose Define/Modify Interfaces➤X.25 Links, means press MENU on the Define/Modify interfaces menu button and choose the X.25 Links menu item.

Product Documentation

The other documents in this SunLink X.25 document set are:

- *SunLink X.25 8.0.2 Programmer's Guide*
  Part No.: 801-6287-11
- *SunLink X.25 8.0.2 PAD User's Guide*
  Part No.: 801-6286-11
- *SunLink X.25 8.0.2 Configuration Guide*
  Part No.: 801-6284-11

SunLink X.25 Overview 1

SunLink X.25 is a STREAMS implementation of the X.25 protocol suite. The X.25 protocol suite enables the reliable exchange of data packets between X.25-conformant systems over Packet-Switching Data Networks (PSDNs) or 802.*x* LANs. Sun workstations and servers running SunLink X.25 can exchange data with systems running any standard-conformant implimentation of X.25.

SunLink X.25 supports for the X.25 Packet Layer Protocol and LAPB and provides a Logical Link Control Type 2 (LLC2) interface so that you can run the X.25 Packet Layer over an 802.*x* or FDDI LAN.

In addition to implementing the protocols and services of the X.25 standard, SunLink X.25 supports the CCITT X.3 (PAD), X.28, and X.29 standards, enabling a workstation running SunLink X.25 to act as the server or user end of a virtual terminal connection.

A Sun workstation or server running SunLink X.25 is available (via `rlogin` or other TCP application) to all of the machines on a TCP/IP network. SunLink X.25 can support the PAD and PAD dæmon (X.29) applications and TCP/IP

clients at the same time as it maintains X.25 virtual circuits over a PSDN or LAN. Using these virtual circuits, the SunLink X.25 machine can communicate with any DTE, Sun or non-Sun, accessible from that PSDN or on that LAN.

1.1 Primary Uses for SunLink X.25

SunLink X.25 has the following primary uses:

- Connecting TCP/IP networks, including the Defense Data Network (DDN)
  For background information on IP routing over X.25, see Appendix C, "Running IP over X.25".
- Acting as a platform for PAD/PAD dæmon applications (supplied with SunLink X.25)
  Use of the PAD application is described in the *SunLink X.25 8.0.2 PAD User's Guide*.
- Supporting user-written applications
  The *SunLink X.25 8.0.2 Programmer's Guide* describes the products application programming interface to the product.

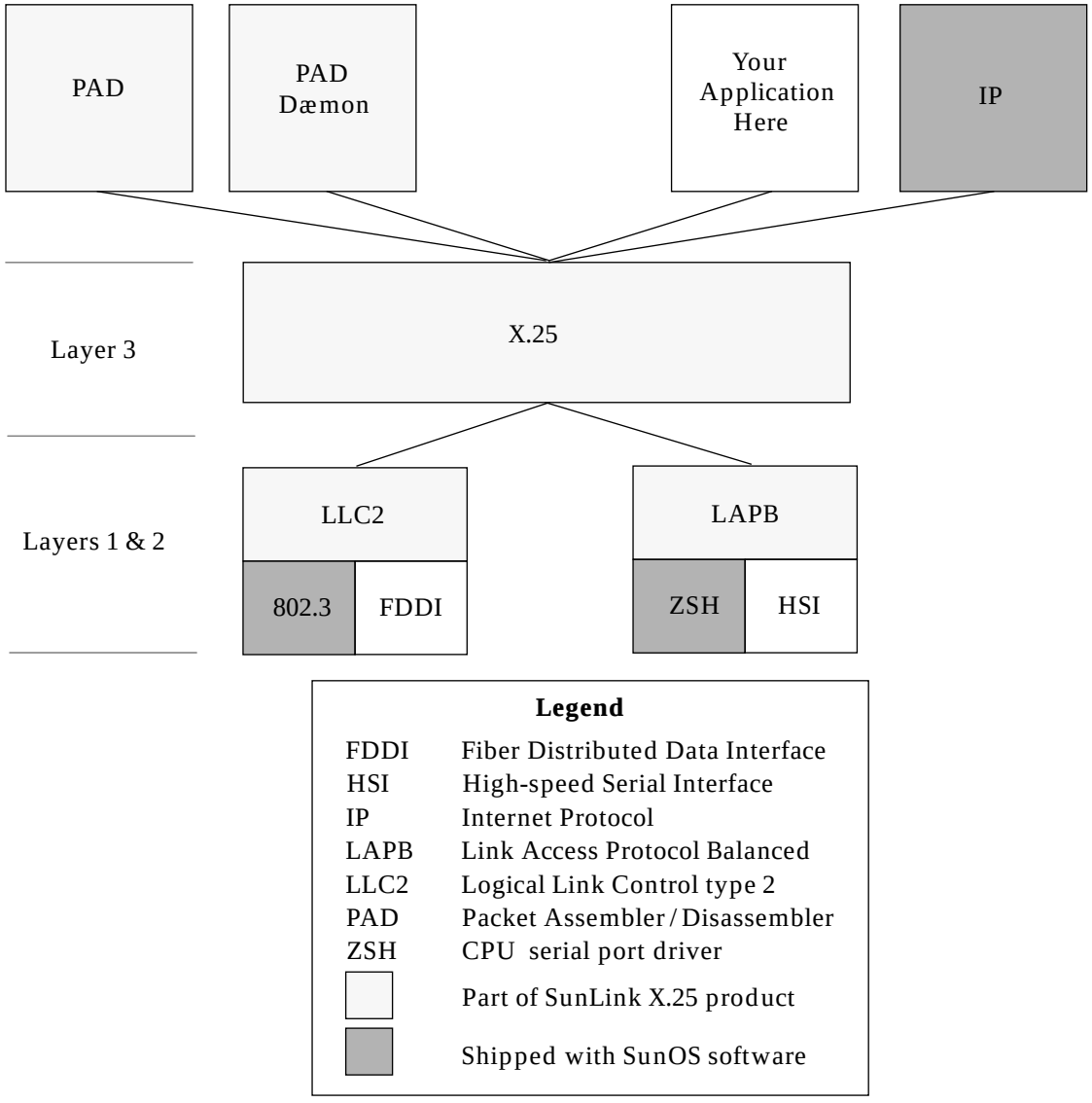

Figure 1-1 Primary Uses of SunLink X.25

1.1.1 Support for PAD and PAD Dæmon Applications

SunLink X.25 provides both PAD and PAD dæmon (X.29) applications in support of virtual terminal sessions over a PSDN or LAN. The PAD application allows Sun workstation users to log in to a remote host, over a PSDN or LAN. The PAD application provides the terminal emulation and PAD (packet assembler/disassembler) functions.

The PAD dæmon application allows Sun workstations to act as a packet-mode host, able to maintain sessions with remote, character-mode terminals (virtual or real), over a PSDN or LAN.

The PAD application is documented in the *SunLink X.25 8.0.2 PAD User's Guide*.

1.1.2 Connecting TCP/IP Networks

SunLink X.25 can use X.25 virtual circuits as point-to-point links for connecting remote TCP/IP networks over a PSDN. In this use, SunLink X.25 provides a transparent datagram service (conforming to RFC 877) for carrying Internet Protocol (IP) packets over X.25/LAPB links. This allows SunLink X.25 to support SunOS™ routing software so that you can create an internetwork of TCP/IP networks over a PSDN.

As part of its support for carrying IP packets, SunLink X.25 provides the DDN X.25 Standard and Basic Services in support of Class A, B and C TCP/IP networks connecting to the DDN.

Note – SunLink X.25 does not provide IP routing functions. It supports the IP routing that is part of the SunOS software and other IP implementations.

1.1.3 Support for User-written Applications

The *SunLink X.25 8.0.2 Programmer's Guide* tells you how to write applications that use a STREAMS-based Network Layer Interface to the X.25 Packet Layer Protocol. SunLink X.25 also supports a socket-based interface for backward compatibility with 7.0 SunLink (SunNet) X.25.

1.2 Shared Links and Multiple Links

SunLink X.25 allows a single link to be shared among multiple uses of the product. For example, you can have PAD/X.29 traffic and IP/X.25 traffic running over the same link. The product also supports multiple serial (LAPB) links and multiple LLC2 links. For machines with multiple links, SunLink X.25 provides routing based on X.121 or NSAP addresses. SunLink X.25 does not support multi-link protocol operations.

1.3 Feature Summary

SunLink X.25 conforms to the 1980, 1984, and 1988 CCITT Recommendations for X.25 .

1.3.1 SunLink X.25 8.x Features

The primary difference between SunNet X.25 7.0 and SunLink X.25 is that SunNet X.25 7.0 is SunOS 4.x-based and that SunLink X.25 is SunOS 5.x (Solaris 2.x) based. Because of this, the SunLink X.25 API is STREAMS-based, whereas the SunNet X.25 7.0 API is sockets based. Refer to the *SunLink X.25 8.0.2 Programmer's Guide* for details. The other main differences are:

- An OpenWindows based graphical configuration tool.
- Support for the X.3 (PAD) parameters in the 1984 X.3 recommendation.
- Support for non-standard throughput facility values.
- Support for Class C IP addresses.
- Ability to make changes to an active link.
- User-level access to LAPB using an HDLC interface.
- Ability to specify CUG, RPOA and Reversed Charging for IP over X.25.
- Automatic use of link selection according to routing algorithm available.
- Support for Solaris x86.

1.3.2 Overall Features

This section lists SunLink X.25's overall features. See Section 1.3.3, "1984 and 1988 Features," on page 1-7 for a list of the 1984 and 1988 X.25 features supported.

- Allows up to 4095 virtual circuits. This number is what the software allows. Machine resources and the configuration of your X.25 network will probably constrain you to a much smaller number.
- Maximum data rates of:
  - 2.048 Mbits per second on one HSI port
  - 1.544 Mbits per second on two HSI ports
  - 19.2 Kbits per second on SPARCstation CPU ports
- X.29 packet-mode host (PAD daemon) and X.3/X.28 virtual terminal (PAD) support
- Encapsulation of IP packets in X.25 packets, as defined in RFC 877
- Address Extension Facility (AEF) for running OSI over X.25
- OpenWindows-based configuration tool and standard configuration files for major PSDNs
- SunNet Manager agent
- Security mechanism (through full or partial address specification) for incoming calls to PAD dæmon
- APIs: STREAMS-based Network Layer Interface and sockets module for backward compatibility with 7.0 SunLink X.25
- For the X.25 Packet Layer
  - Extended packet sequence numbering.
  - Large flow control windows (up to 127 packets) and large packet sizes: up to 1024 bytes over 1980-compliant X.25 networks to 4096 bytes over 1984 and 1988 X.25 networks.
- For LAPB (1984 and 1988),
  - Basic and extended frame sequence numbering.
- ISO 8208 for DTE-to-DTE operation.
- LLC2 for running X.25 over a LAN (802.x or FDDI)

- Reverse charging, RPOA selection, flow control parameter negotiation, CUG selection, throughput class negotiation, and fast select on a per-call basis.
- Multiple physical links per system. You can have as many connections as serial ports and other resources allow.
- Routing (automatic link selection) among multiple links.
- Connections to the Defense Data Network via X.25 Standard and Basic Service.

1.3.3 1984 and 1988 Features

SunLink X.25 supports the following features of the 1984 and 1988 X.25 recommendations:

- optional user facilities:
  - extended packet sequence numbering
  - one-way incoming and one-way outgoing logical channels
  - non-standard default packet and window sizes
  - default throughput classes assignment
  - flow control parameter negotiation
  - throughput class negotiation
  - CUG-related facilities
  - bilateral CUG-related facilities
  - fast select and fast select acceptance
  - reverse charging and reverse charging acceptance
  - local charging prevention
  - charging information
  - RPOA selection
  - incoming and outgoing calls barred
  - called line address modified notification
  - call redirection notification
  - call deflection
  - transit delay selection and indication
  - TOA / NPI address format
  - Network User Identifier (NUI)
  - protection

- priority
- permanent virtual circuits
- two-way logical channels
- called and calling AEF
- expedited data negotiation
- minimum throughput class
- user data on Accept and Clear with Fast Select
- non-X.25 facilities (in Call Request and Call Accepted packets)
- programmable facilities field
- up to 32 bytes of interrupt data
- up to 109 bytes of facilities in Call Request and Call Accepted packets
- DTE-originated cause codes

SunLink X.25 does not support:

- on-line facility registration
- the Multilink Protocol at the LAPB level.
- the hunt group facility

1.4 Requirements for running SunLink X.25

The following sections detail the equipment and software you require in order to run SunLink X.25.

1.4.1 Software and Hardware

The current release of SunLink X.25 runs on devices that support the Solaris 2.x environment.

To use SunLink X.25 on a SPARCstation IPC or IPX, you must use an X.25 Adapter Cable, part number X989A. You can order this cable through SunExpress[1].

In addition to the CPU serial ports and standard Ethernet interfaces that are a part of SPARC machines, SunLink X.25 supports:

- SunLink HSI/S (for WAN connections)
- SunLink FDDI/S (for LAN connections)

SunLink X.25 supports SunLink HSI/S and FDDI/S at the maximum signalling rates those products allow.

1.4.2 Serial Port Options and Data Rates

SunLink X.25 supports the synchronous serial port options listed below. Your choice depends on the type of interface to the PSDN (or DDN PSN) and the signaling rate to which you subscribe. When deciding between the CPU serial ports and the remaining options, cost might be a further consideration. Note that SunLink X.25 supports multiple physical links. The maximum signaling rates listed for each option might be in excess of the rates specified by your PSDN (or the DDN) for each type of interface. For data rates in excess of 64 Kb/sec. clocking must be supplied by an external source, such as a synchronous modem.

CPU RS-232-C ports

Your workstation or server has one or two RS-232-C ports available for use with SunLink X.25. The maximum signaling rate for your port depends on your machine architecture. A SPARCstation CPU port supports a rate of 19.2 Kb/sec. Maximum achievable data rates are affected by the load, both on other ports and on the CPU and other resources. Consult your hardware documentation for guidelines on maximum rates.

HSI ports

A single HSI/S SBus card has four synchronous serial ports, all of which you can configure to be either RS-449/RS-422 or V.35 interfaces. For V.35, you must purchase a third-party converter. An HSI board supports a combined signaling rate of up to 3.5 Mbits/sec across the four ports. The product supports signaling rates up to 2.048 Mbits/sec over a single port. Under optimum conditions, you can configure two ports to run at 1.544 Mbits/sec. Consult SunLink HSI documentation for more information.

1. You can reach SunExpress by toll-free telephone, in France at 05-90-61-57, in Germany at 01-30-81-61-91, in the UK at 0800-898888, and in the US at 1-800-4SUN.

Note – Signaling rates, as defined above, are necessarily greater than throughput at the X.25 (packet) layer. In a test environment of back-to-back SPARCstation-2s using CPU ports, with low CPU load and large packet and window sizes, SunLink X.25 has attained a throughput of more than 90% of a serial connection's bandwidth. Throughput varies depending on the load on your machine, your X.25 and LAPB configuration, and the type of application you run.

1.4.3 Modem

For a connection to a PSDN (or the DDN), you need a synchronous modem, a Channel Service Unit (CSU), or a direct connection. You also need a cable to the modem, CSU, or PSDN interface. For direct connections to the DDN, the Network Operations Center usually provides a cable from the PSN to your machine.

With remote PSDN connections, the modem (or equivalent interfacing equipment) must be compatible with that used at the remote end of the point-to-point circuit. The equipment must support synchronous signaling techniques and must be matched to the transmission facility. The equipment should support local and remote loopback to facilitate reliable installation and diagnostics. In addition, the cable between the communication port and the interfacing equipment must support the signals required for synchronous communication.

At some sites, the physical interface of your Sun serial port might differ from the interface provided by the network interfacing equipment. In such a situation, you must obtain a third-party protocol converter to achieve the necessary physical-interface compatibility.

Configuration Reference 2

This chapter is a reference for the use of `x25tool`, the OpenWindows-based tool that is your interface to SunLink X.25. It provides detailed information on all parameters available using `x25tool`. This chapter assumes that you have followed the instructions in the *SunLink X.25 8.0.2 Configuration Guide* to create a default configuration, and that you are familiar with `x25tool`. If you are not familiar with `x25tool`, refer to Chapter 1, “Configuring SunLink X.25 (beta)—Using this x25tool Defaults”, of the *SunLink X.25 8.0.2 Configuration Guidee*.

This chapter deals with the base window menu items, in the order in which they appear in the base window. Individual parameters are also indexed by both name and function. The items and their functions are:

- Define / Modify interfaces
  Assigns values to new X.25 interfaces and edits existing interfaces.
- Create / Modify configuration files
  Specifies the X.25 parameters to be used at each protocol level.

- Network Control
  Puts any changes you make into effect and starts and stops X.25.
- Application Configuration
  Configures the PAD and IP applications.
- Advanced Configuration
  Fine tunes the kernel and device parameters.

The `x25tool` has a help facility: press the Help key on your keyboard with your mouse pointer in an `x25tool` window to display a help screen describing the function of that window.

All configuration procedures start with the `x25tool` base window. To display it, start `x25tool` as follows:

```
hostname# /opt/SUNWconn/bin/x25tool &
```

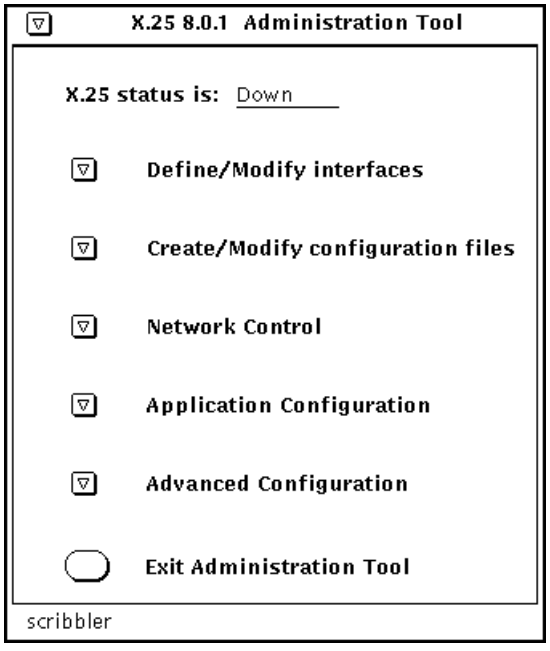

Figure 2-1 The `x25tool` Base Window

2.1 Defining and Modifying Interfaces

Define and modify interfaces using the X.25 Interface Configuration window. To display this window, choose Define/Modify interfaces➤X.25 Links. The X.25 Interface Configuration window looks like this:

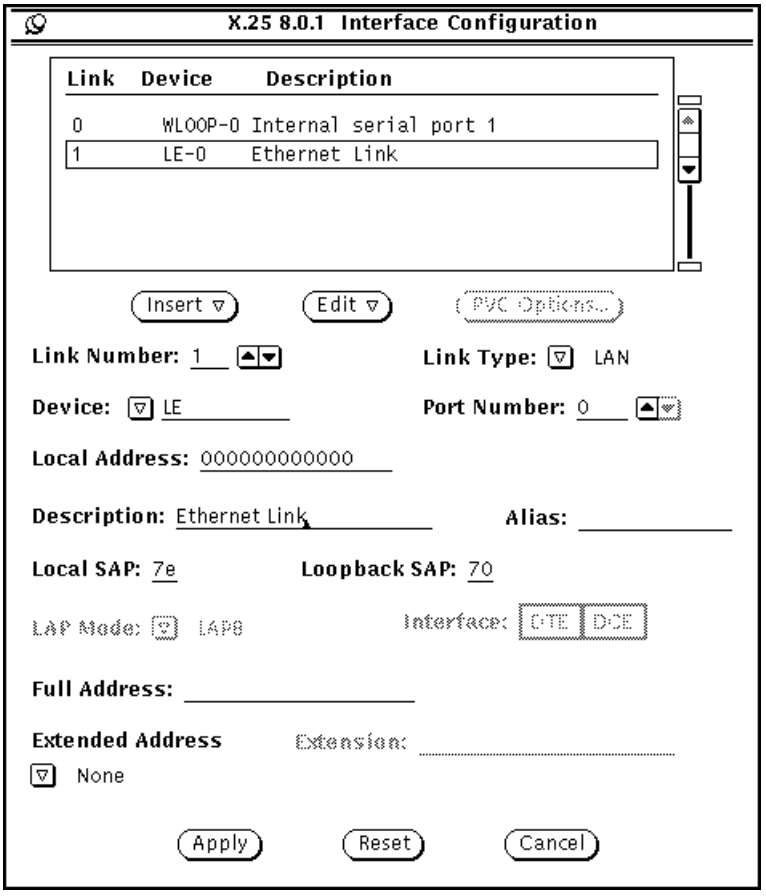

Figure 2-2 X.25 Interface Configuration Window

To create a new link:

1. Click SELECT on the Insert button to begin configuring the new link.

2. **Enter or choose values for each of the parameters in the window.**
   See Section 2.1.1, “X.25 Interface Configuration,” on page 2-5 for details.
3. **When you finish entering values, click SELECT on Apply.**
4. **Click SELECT on the pushpin in the upper left corner of the Interface Configuration window to dismiss the window.**
5. **Press MENU on Network Control button, and choose the Create Network Master files item. Release MENU.**
   This makes the link available to SunLink X.25 the next time you restart the X.25 network.

To edit an existing link:

1. **Click SELECT on the link to be changed in the scrolling list of links.**
2. **Enter or choose values for the parameters you want to change.**
   See Section 2.1.1, “X.25 Interface Configuration,” on page 2-5 for details.
3. **Click SELECT on Apply.**
4. **Click SELECT on the pushpin in the upper left corner of the Interface Configuration window to dismiss the window.**
5. **Press MENU on the Network Control button, and choose the Create Network Master files item. Release MENU.**
   This makes the link available to SunLink X.25 the next time you restart the X.25 network.

If you decide you have made a mistake while entering values, click on Reset to restore all parameters to their previous values, and continue editing. To discard your changes and quit the window, click on Cancel.

If you configure more than six LAPB links or more than eight LLC2 links, use the Advanced Configuration options to increase the value of the parameters for those link types in that window. See Section 2.5, “Advanced Configuration,” on page 2-83 for details.

If you use permanent virtual circuit(s) (PVCs) you may require those PVCs use different packet and window sizes than those configured for a given link. If you are in this category, you must enter data in the PVC Options➤PVC Parameters window. You configure PVCs on a per-link basis. See Section 2.1.2, “PVC Parameters,” on page 2-9 for an explanation of how to enter parameter values for PVCs.

2.1.1 X.25 Interface Configuration

This section describes the individual items in the X.25 Interface Configuration window. The items are listed as they appear in the window, from left to right, top to bottom.

Link Number

A number that you choose to identify a connection over a specific network interface (serial port or LAN interface) to a PSDN or LAN destination. Start with 0 as your first link number and increment any succeeding link numbers by one. Each link must have a unique number.

Link Type

If your link type is other than WAN (1984), the default, choose one of the options, 1980, 1984, 1988 or LAN, from the menu. If you are connecting to a PSDN, obtain the link type from the administration of that PSDN.

Device

The name of the link level device, regardless of whether you are running over a LAN or WAN. If you are not using a local CPU serial port (ZSH), the default, choose a description from the device menu. As a default, the menu contains ZSH, for the CPU serial port driver; WLOOP, for the loopback driver; and LE, for the Ethernet driver, as shown in the following figure:

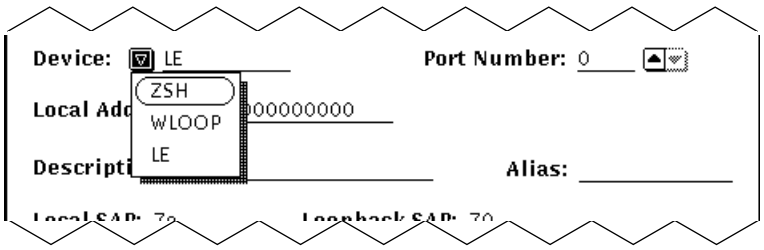

Figure 2-3 Default Menu of Devices

Note – If you are using the WLOOP option, you need to configure two interfaces, one DTE and the other DCE.

If you are using a link level device other than ZSH, LE, or WLOOP, return to the `x25tool` base window and click SELECT on the Advanced Configuration menu button. The Device Parameters window appears. In this window, enter the number of cards for each type of device you have in your machine and over which you plan to run X.25. See Section 2.5.1, "Device Parameters," on page 2-83 for further details on the Device Parameters window.

For WAN links, the following device-types are available:

`zsh` *number* (corresponds to ZSH in Device menu)

A CPU serial port; that is, the RS-232-C port that is part of your machine. The first port is `called zsh0`, the second, `zsh1`, and so on. On a SPARCstation IPC or IPX, you need an X.25 Adapter Cable, part number X989A, to use the CPU serial port. You can order this cable through SunExpress[1].

Other SPARC machines, such as the SPARCstation LX™ require special cables for synchronous communication. Consult your hardware documentation for cable requirements and the number of ports you can use for synchronous communication.

`hsi` *number* (corresponds to HSI in Device menu)

A serial port on an HSI/S SBus card that is shipped with the SunLink HSI/S product. There are four ports on each HSI card. The first port is `hih0`, the second, `hih1`, and so on.

For LAN links, the following device-types are available:

`le` *number* (corresponds to LE in Device menu)

The single Ethernet interface that is shipped with most SPARC machines is `le0`. You might have more than one `le` interface on your machine.

`ie` *number* (corresponds to IE in Device menu)

1. You can reach SunExpress toll-free telephone, in France at 05-90-61-57, in Gernmany at 01-30-81-61-91, in the UK at 0800-898888, and in the US at 1-800-4SUN.

An Ethernet interface that is shipped with some Sun-4 machines is `ie0`. You might have more than one `ie` interface on your machine.

`bf`*number* (corresponds to FDDI/S in Device menu)

A port on an FDDI/S SBus card that is shipped with the SunLink FDDI/S product. There is a single FDDI port on each FDDI/S card.

For each of the above, you need to know the name of the card and the port number (*number*) used for X.25 (see Port Number item, below).

Port Number

The port number of the LAN or WAN device you use beneath X.25. This is the *number* in the device descriptions above.

Local Address (for WAN interfaces)

Your DTE or DCE address, normally an X.121 address, consisting of a DNIC, NTN, and, optionally, a subaddress. Use of this address in outgoing packets is determined by the value of the Source Address parameter in the Link Mode Parameters window (see “Source Address Control” on page 2-23).

A small number of networks require that the calling address in an outgoing packet not contain the full X.121 address (for example, Transpac requires you only to enter the sub-address). In such a case, enter the “short” version of your X.121 address in this field and enter your full X.121 address in the Full Address item, see “Full Address” on page 2-9.

Local Address (for LAN interfaces)

A six-byte (12 hexadecimal) digit address, such as an Ethernet address. The default of twelve zeroes tells SunLink X.25 to use your machine’s default MAC address, which is displayed when you power up your machine. If you want to use the MAC address stored on an interface controller card (such as the address on the FDDI/S SBus card) instead of the default MAC address, enter the address as twelve consecutive hexadecimal digits or as pairs of hexadecimal digits, with colons between each pair and leading zeroes within pairs omitted.

Description

Optional field. Enter an alphanumeric string of 80 or fewer characters. Spaces are allowed.

Alias

Optional field. You can enter one or several aliases. Enter an alphanumeric string of 40 or fewer characters. Enter a space between each alias. You can later use this alias, rather than a number, to refer to the link in the Network Control➤Network Statistics window or in an `x25stat` command. If you have multiple links, the alias is displayed in the Select a Link window that is displayed when you choose the Active or Working options for a protocol layer's configuration file.

Local SAP (for LAN connections only)

A one-byte (two-hexadecimal-digit) address. The default of `7e` is the standard SAP for LLC2 under X.25.

Loopback SAP (for LAN connections only)

A one-byte (two-hexadecimal-digit) address. The default of `70` is the standard loopback SAP for LLC2.

LAP Mode (for WAN connections only)

If your network is not using LAPB, the default, press or click MENU to display the following options:

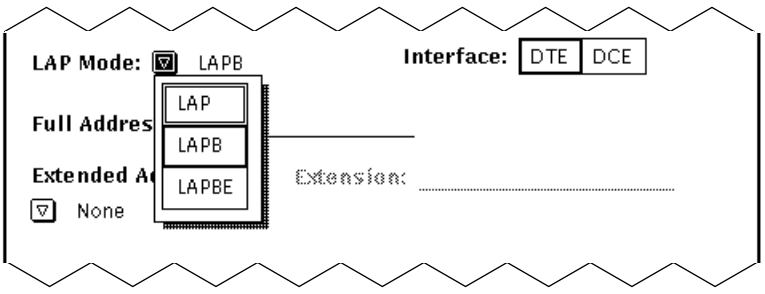

Figure 2-4 LAPB Options

Choose the LAP mode appropriate for your link.

Interface (for WAN connections only)

Choose either DTE or DCE, as appropriate for your link.

Full Address

Your complete X.121 address, including DNIC, NTN, and subaddress, if any. This address is available to X.25 application programmers through routines described in the *SunLink X.25 8.0.2 Programmer's Guide*. Also, this value is used as the calling address by the pad program that is shipped with SunLink X.25. For outgoing pad calls, use of this address is controlled by the value of the Source Address parameter in the Link Mode Parameters window (see "Source Address Control" on page 2-23).

For LAN interfaces that do not have an X.121 address, you can ignore this field or insert your full MAC address.

Extended Address

Choose among None (the default), OSI, and non-OSI. This is the type of extended address you use in the network to which the link you are configuring is attached. Not available for WAN (1980) link types.

***Extension* (for non-OSI) or *OSI NSAP* (for OSI extended addresses)**

For an OSI NSAP, enter a hexadecimal address of 40 digits or fewer. Not available for WAN (1980) link types.

Once you are satisfied with the values you have set, click on Apply to save the parameters and dismiss the window.

2.1.2 PVC Parameters

The steps described here are only required if both of the conditions below apply:

- If you plan to use one or more permanent virtual circuits (PVCs) to connect to your X.25 network
- you require different packet and window sizes for the PVCs than you use for switched virtual circuits on the same link.

Note – PVCs are supported only over LAPB links, not over LLC2 links.

If you meet the conditions specified above, click SELECT on the "PVC Options..." in your X.25 Interface Configuration window. The PVC Parameters window appears.

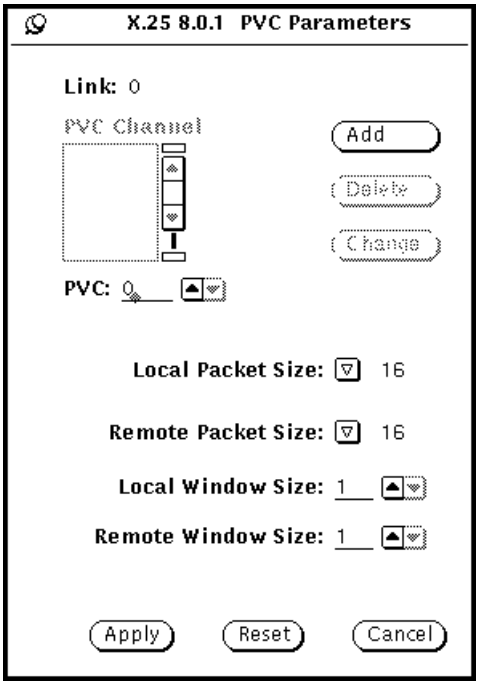

Figure 2-5 The PVC Parameters Window

You configure PVCs on a per-link basis. For a given PVC channel, enter or select data for the items in the window, then click SELECT on Add to add the channel information and update the PVC Channel scrolling list. When you are finished configuring parameters for all PVC channels for a given link, click SELECT on Apply. The parameters are described later in this section.

To restore the PVC parameters to the values they had the last time you chose Apply, or Cancel, select Reset. If you press Cancel after making changes, you have the choice of discarding or saving your changes. With either choice you dismiss the PVC parameters window.

To change values for a given PVC channel, click SELECT on the channel in the PVC Channel scrolling list, make your changes, then click SELECT on Change. For PVCs, enter or accept values for the following parameters:

PVC

This is a number assigned by your PSDN. If you do not know the number, contact your service provider. Enter a number by typing it in or by clicking SELECT on the up or down buttons until the window displays the PVC channel number you want. Then, click SELECT on the Add button to add your entry.

To delete a channel number, click SELECT on the number in the PVC Channel scrolling list, then click SELECT on Delete. To change a channel number, click SELECT on the number in the PVC Channel scrolling list, enter a new number, then click SELECT on Change.

Local Packet Size and Remote Packet Size

This is a number determined by the requirements of your PSDN. The process of changing the packet size is the same for both local and remote. If your packet sizes are different from the default of 128, choose a value from the Local (or Remote) Packet Size menu.

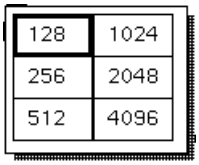

Figure 2-6 Local Packet Size Menu

Local Window Size and Remote Window Size

This is a number determined by the requirements of your PSDN. If the default window size of 7 is not appropriate for your link, enter a number by typing it in or by clicking SELECT on the up or down buttons until the window displays the window size number you want. If you are not sure which value to use, contact your service provider.

Once you are satisfied with the values you have set, click on Apply to save the parameters and dismiss the window.

2.2 Create/Modify Configuration Files

You need to configure the parameters that are used at the different protocol layers. To do this, press or click MENU on Create/Modify configuration files in the `x25tool` base window to display the following menu:

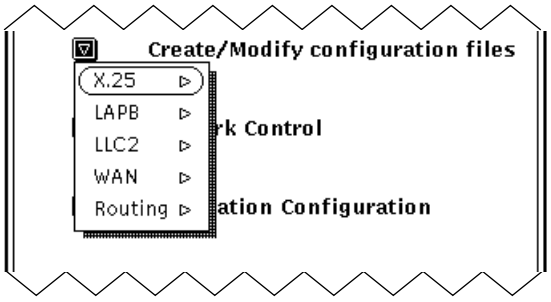

Figure 2-7 Create/Modify Configuration Files Menu

You can configure the menu options in any order you like. In this guide, they are described in the order they appear in.

2.2.1 Navigation

To use the options available from the Create/Modify Configuration Files menu, you need to know how to load files and select files and windows.

2.2.1.1 Loading Files

Press MENU and drag right over any of the configuration file options (corresponding to the protocol layers), to display the choices:

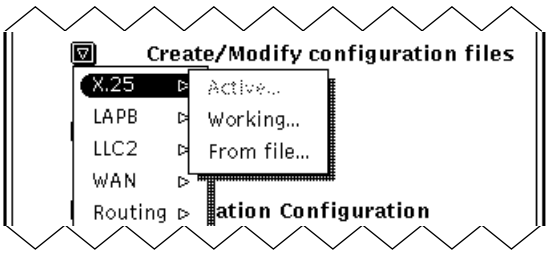

Figure 2-8 Choice of Active, Working, or From File

The choices are:

- "Active..." activates a window that displays the set of parameters for a given layer for a currently running link. For the X.25 layer, parameters are spread over six windows. The "Active..." option is greyed-out if the X.25 network is down.
- "Working...", like "Active...", activates a window that displays the set of parameters for a given layer. The working configuration is the set of parameters that is put into effect the next time you start the X.25 network.
- "From file..." option a Select a File window of template configuration files and configuration files created from those templates. If you are saving, rather than loading, parameters, this option becomes "To file...".

Note – The active parameters are usually the same as the working parameters. However, you can change the active configuration and not save your changes to the working configuration, in which case the active and working configurations differ.

If you are using the file manager, an alternative way of loading parameters is to use the drag-and-drop target, present in all *protocol layer* parameters windows. Drag the icon for the file you want to open, and drop it into the target. You can only do this, if the relevant parameters window is already open.

2.2.1.2 Selecting a File

A Select a File window appears when there is more than one file that you could use. Use it to choose the file you want to work with. The Select a File window appears at the following points in the use of `x25tool`:

- when you use Create / Modify configuration files➤*protocol layer*➤From file
- in a *protocol layer* parameters window, when you use File➤Load Parameters➤From file
- in a *protocol layer* parameters window, when you use File➤Save Parameters➤To file

The sections on the individual protocol layers contain information on choosing between the files.

The files displayed in the Select a File scrolling list contain parameter settings for a given layer. They include template configuration files, with a prefix of `def.`, and configuration files that you create. You cannot write to the template files; these are provided as a basis for your own working configuration or your own customized configuration files.

When you select a file, the parameters window for a given layer appears. This parameters window displays the parameters as set in the file you loaded.

If you select a file using a "To file..." menu item, the parameters window has a Save button instead of a Load button. Use this window, to write the parameter settings from the *protocol layer* parameters window to a file.

You can also save parameters to a new file, when you use File➤Save Parameters➤To file. Enter the filename you want to use, without a suffix. `x25tool` automatically appends a suffix to the name indicating the protocol layer. For the X.25 layer, `x25tool` appends `.x25` to the file name you enter; for LAPB, `.lapb`; for LLC2, `.llc2`; for WAN, `.wan`.

2.2.1.3 Selecting a Link

If you have multiple links, a Select a Link window appears when you need to specify which one you are working with:

- when you choose Create / Modify configuration files➤*protocol layer*➤"Active..." or "Working...";
- in a *protocol layer* parameters window, when you choose File➤Load Parameters➤"Active..." or "Working...";
- in a *protocol layer* parameters window, when you choose File➤Save Parameters➤"Active..." or "Working...".

protocol layer is X.25, LAPB, LLC2, or WAN, as you choose in the Create / Modify configuration files menu, shown in Figure 2-8 on page 2-12.

Select a Link windows work the same way for all protocol layers. In the window's scrolling list, click SELECT on the link you want to configure, then click SELECT on the Select button.

To dismiss the Select a Link window and return to the *protocol layer* parameters window, click SELECT on Cancel to dismiss the Select a Link window.

2.2.2 Setting X.25 Parameters

The X.25 Parameters window is displayed at the following points in the use of `x25tool`:

- from the base window, when you choose Create/Modify configuration files➤X.25➤"Active..." or "Working...";
- after having selected Create/Modify configuration files➤X.25, when you choose Load from a Select a File window;
- after having selected Create/Modify configuration files➤X.25, when you choose Select from a Select a Link window.

If you need to select an X.25 Parameters file, the choices are:

- Files contains settings for specific PSDNs, for example Tymnet (`def.dteTymnet.x25`), GNS [Global Network Service] (`def.dteGNS.x25`) and Transpac (`def.dteTranspac.x25`).
- Files containing settings for categories of PSDNs, distinguished by the year of the X.25 recommendation supported by the network and whether the host is a DTE or a DCE. Examples are `def.dte88.x25` and `def.dce84.x25`.
- The file `def.dteISO8208.x25` that contains settings as specified in the ISO standard for X.25.
- The `def.lan.x25` template. This is the only availabe file for LANs. Later, if the need arises, you can create a new configuration file, based on this template file.
- The file, `ISO8882`, that is primarily for conformance testing.

If you are connecting to a major public or private PSDN, look for the file corresponding to that network in the list.

If you are not connecting to one of the PSDNs for which there is a customized file, choose a file based on:

- whether your side is a DTE or a DCE
- the X.25 recommendation, 1980, 1984, or 1988, followed by your X.25 network.

The X25 Parameters window looks like this:

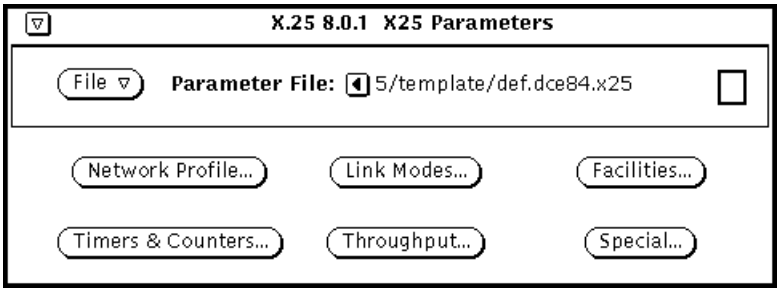

Figure 2-9 X25 Parameters Window

The name of the configuration file you chose is displayed in the top line. Most of the parameters in all categories are preset according to the contents of this file. If you are connecting to a PSDN for which there is a configuration file, the X.25 parameters are set according to the requirements of your network. Whether you have a general (for example, `def.dte84.x25`) or a network-specific configuration file, there may be some optional facilities to which you subscribe or hard-to-predict values, such as logical channel number ranges, for which you must change a setting.

To dismiss the X25 Parameters window press MENU on File➤Quit and release MENU.

The order in which you make changes to different categories of parameters is not significant. The menus are covered here in the order in which they appear in the X25 Parameters window, left to right, top to bottom.

Once you have finished configuring the different catagories of parameters, choose File➤Save to save the parameters. The software *does not* save them until you do this.

2.2.2.1 *Network Profile*

Click SELECT on the "Network Profile..." button to display the Network Profile window:

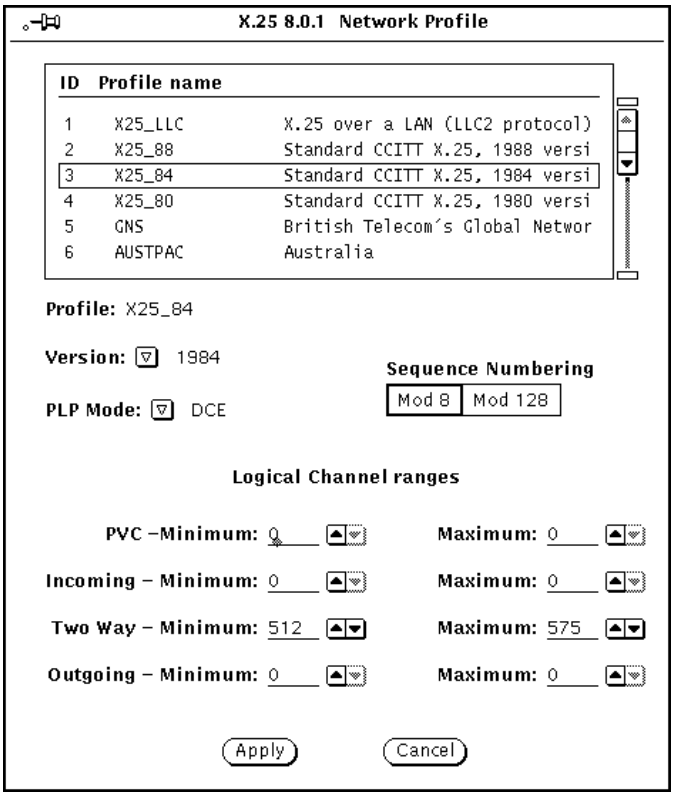

Figure 2-10 The Network Profile Window

The window consists of a list of profiles (names and descriptions) and a set of configurable items:

Profile

Names the profile you chose. Except for the X25_LLC and DATAPAC options, the choice of profile has only a subtle effect on X.25 operation and performance.

Version

If your PSDN conforms to the 1980 or 1984 X.25 recommendation, instead of 1988 (the default), choose the appropriate value.

PLP Mode

Determines the DTE/DCE role of the link's Packet Layer Protocol (PLP), or how that role is resolved. The default, Auto, means that the DTE/DCE role is resolved using the procedures in ISO 8208 for DTE-DTE operations. Auto is the appropriate choice when you run X.25 over a LAN. Otherwise choose the appropriate value for your device.[1]

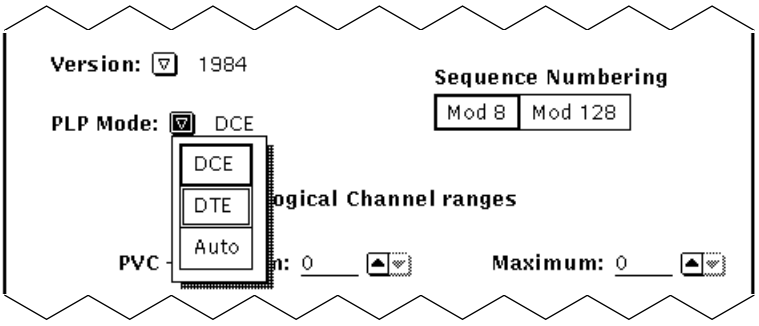

Figure 2-11 Network Profile PLP Mode Menu

Sequence Numbering

A toggle (Mod 8 or Mod 128) that indicates whether the profiled network uses packet sequence numbers in the range from 1 to 7 (modulo 8) or from 1 to 127 (modulo 128).

Logical Channels

For the profile you are modifying, allows you to enter ranges for the following types of virtual circuits:

- Permanent Virtual Circuit (PVC)
- One-way incoming

1. See the *SunLink X.25 8.0.2 Programmer's Guide* for technical details on DTE resolution per ISO 8208.

- Two-way
- One-way outgoing

Obtain logical channel number ranges from your PSDN administration. Enter a number by typing it in or by clicking SELECT on the up or down buttons until the window displays the channel number you want.

For each type of virtual circuit you use, you must match the range of channel numbers specified by your PSDN or, with back-to-back or LAN connections, the logical channel numbers used by the remote hosts with which you intend to communicate. Mismatches between logical channel number ranges are a common cause of X.25 users' inability to establish connections.

The total number of channels you set here must be less than or equal to the number of virtual circuits you set using Advanced Configuration➤Parameters➤Max number of VCs.

Once you are satisfied with the parameters you have set, click SELECT on Apply. This dismisses the window.

Note – Clicking on Apply does not save the values permanently. You must use the File➤Save option of the X.25 Parameters window to do this.

2.2.2.2 *Link Modes*

Click SELECT in the "Link Modes..." button in X25 Parameters window to display the Link Mode Parameters window:

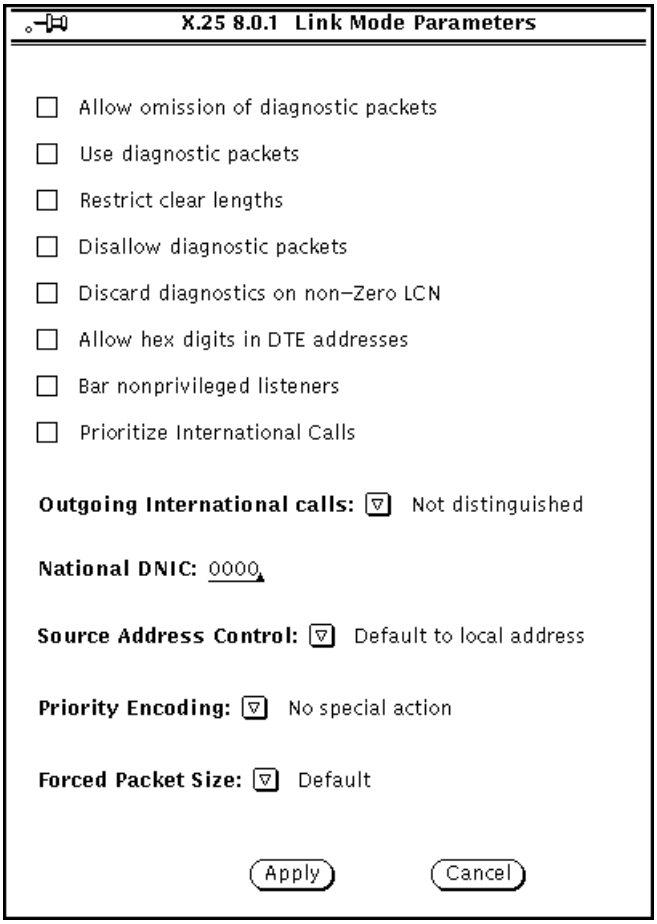

Figure 2-12 Link Mode Parameters Window

The Link Mode Parameters window consists of a set of check boxes and a set of items that have a menu of different parameter values. The parameters in this window deal with options and requirements of the PSDN to which you are connecting.

The check box items in the Link Mode Parameters window are listed below. Click SELECT on the check boxes next to the items that are in effect for your PSDN. If you are not sure which values to use, consult your service provider.

Allow omission of diagnostic packets

Allow the omission of the diagnostic byte in incoming Restart, Clear and Reset Indications.

Use diagnostic packets

Force the use of the diagnostic byte in incoming Restart, Clear and Reset Indications.

Disallow diagnostic packets

Disallow the use of the diagnostic byte in incoming Restart, Clear and Reset Indications.

Discard diagnostics on non-Zero LCN

Some PSDNs use channels other than zero to transmit diagnostic information. This parameter lets you discard this information, should you need to.

Restrict Clear Lengths

Restrict the length of a Clear Indication to 5 bytes and Clear Confirm to 3 bytes. This parameter only applies to 1980 networks.

Allow hex digits in DTE addresses

Use this parameter if you want to be able to use addresses that do not conform with the X.121 specification.

Bar nonprivileged listeners

Only the superuser can start a process that “listens”, for example the PAD dæmon.

Prioritize International Calls

Some networks let you give priority to international calls. If you set this parameter, you need to set Priority Encoding—see below.

The remaining items have menus:

Outgoing International calls

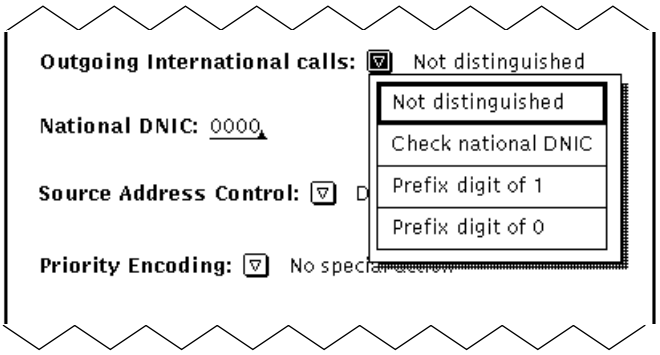

Figure 2-13 Outgoing International Calls Menu

The choices are:

- Not distinguished: No special action taken for international calls.
- Check National DNIC: SunLink X.25 compares the DNIC in the called address to the local DNIC. The software assumes a mismatch indicates an international call.
- Prefix digit of 1: The software assumes a called address with a prefix of 1 indicates an international call
- Prefix digit of 0: The software assumes a called address with a prefix of 0 indicates an international call

National DNIC

Enter your national DNIC. You must enter this value if you choose Check National DNIC in the Outgoing International calls menu.

Source Address Control

Determines the value inserted in the calling address field of outgoing call requests over a WAN link. It does not apply to LAN links.

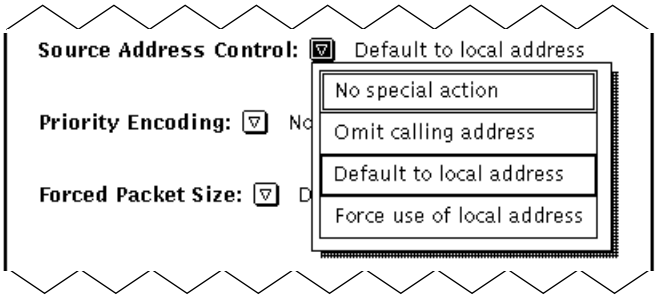

Figure 2-14 Source Address Control Menu

The choices are:

- No special action: SunLink X.25 puts the calling address in the outgoing call request exactly as it receives it from an application making the call.
- Omit calling address: SunLink X.25 sets the calling address to null in the outgoing call request, regardless of what was specified by the calling application.
- Default to local address: The software uses the local address as the calling address if an application supplies no calling address.
- Force use of local address: The software uses the local address as the calling address, even if an application has supplied a calling address.

The term *local address* refers to the value of the Local Address parameter in the Interface Configuration window, as described on page 2-7.

Priority Encoding

The value of this parameter determines SunLink X.25's action with respect to prioritizing international calls.

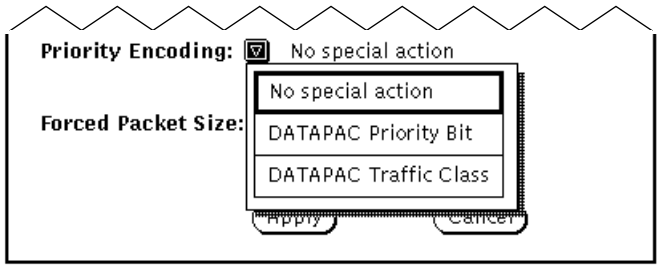

Figure 2-15 Priority Encoding Menu

The choices are:

- No special action: SunLink X.25 performs no special encoding.
- DATAPAC Priority Bit: The software encodes the priority request using the DATAPAC Priority Bit (1976 version).
- DATAPAC Traffic Class: Priority request encoded using the DATAPAC Traffic Class (1980 version using the Calling Network facility marker).

Forced Packet Size

Sets the packet size for all priority call requests and incoming calls. The choices are:

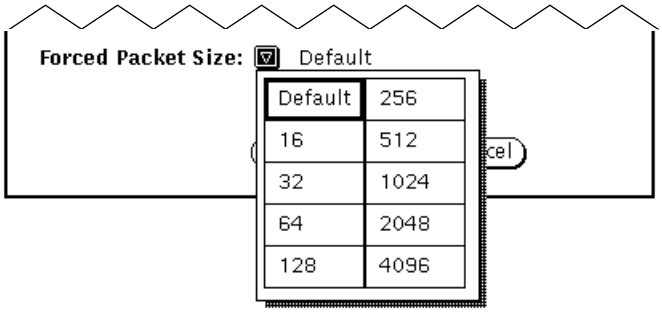

Figure 2-16 Forced Packet Size Menu

Once you have finished, click SELECT on Apply. To save the values permanently, use the File➤Save option of the X.25 Parameters window.

2.2.2.3 *Closed User Groups and Facilities*

Click SELECT on the "Facilities..." button in X25 Parameters window to display the Closed User Group and Facilities Window. The parameters in this window deal with Closed User Groups (CUGs) and optional features of the PSDN to which you are connecting.

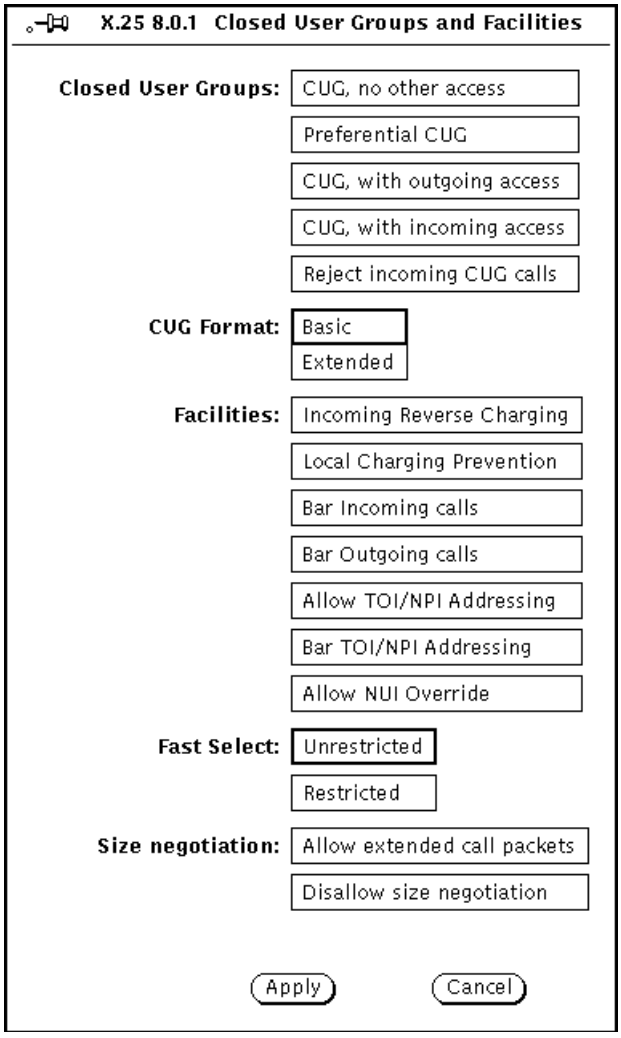

Figure 2-17 Closed User Group and Facilities Window

The configurable parameters are:

Closed User Groups

Choose any of the non-exclusive settings, listed below, that correspond to CUG options to which you subscribe.

- CUG, no other access
- Preferential CUG
- CUG, with outgoing access
- CUG, with incoming access
- Reject incoming CUG calls

CUG Format

Choose one of the exclusive settings, Basic or Extended.

Facilities

Choose any of the non-exclusive settings, listed below, that correspond to PSDN facilities to which you subscribe.

- Incoming Reverse Charging
- Local Charging Prevention
- Bar Incoming calls
- Bar Outgoing calls
- Allow TOI/NPI Addressing
- Bar TOI/NPI Addressing
- Allow NUI Override

Fast Select

Unrestricted allows incoming fast select calls with no restriction on response. Restricted allows incoming fast select calls with restriction on response. When selected together, Unrestricted and Restricted allow all incoming fast select calls.

Size Negotiation

Choose one of the exclusive settings, Allow extended call packets or Disallow size negotiation.

If you set Allow extended call packets, outgoing calls automatically contain packet and window size negotiation. Incoming calls are negotiated if they contain packet and window size negotiation.

If you Disallow size negotiation, incoming calls containing packet and window and size negotiation are rejected.

Once you are satisfied with all of the values, click SELECT on Apply.

Note – Clicking on Apply does not save the values permanently. You must use the File➤Save option of the X.25 Parameters window to do this.

2.2.2.4 *Timers, Counters, and Delays*

Click SELECT on the “Timers and Counters...” button in X25 Parameters window to display the Timers, Counters and Delays window:

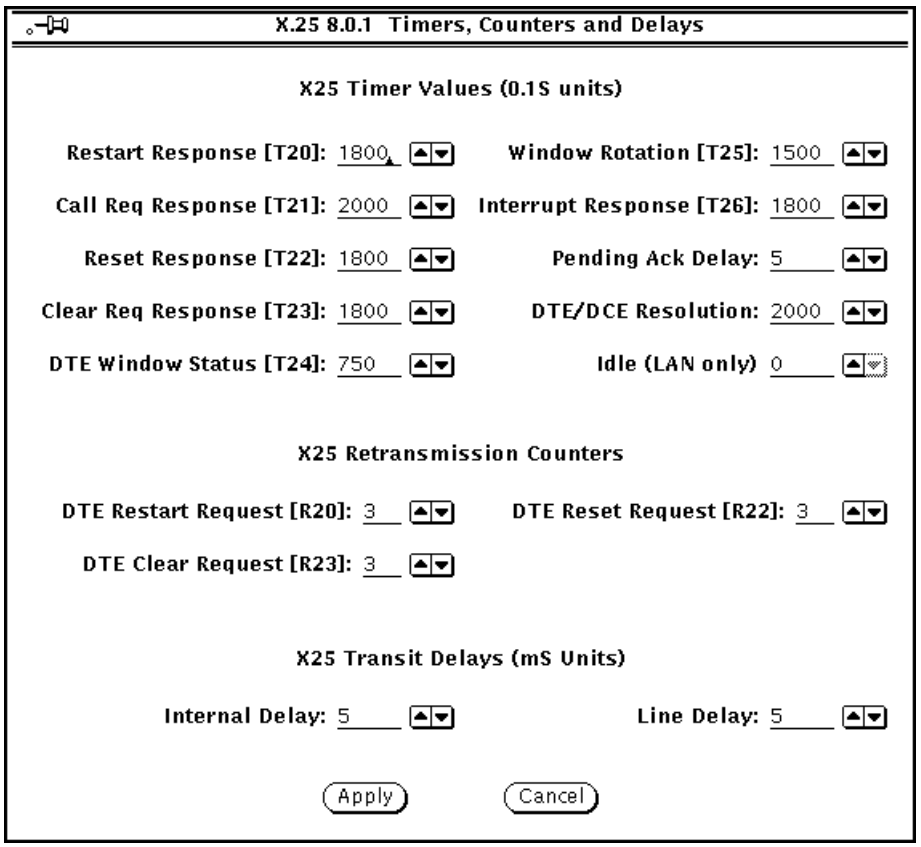

Figure 2-18 Timers, Counters, and Delays Window

Use the Timers, Counters, and Delays window to set CCITT-defined timers.

The top section of the screen contains X25 Timer Values. These parameters have values expressed in tenths of a second. The allowable range for these timers is 0-32000. Except for T24 (see description below), the CCITT timers are defined as documented in the 1988 CCITT X.25 recommendation.

Restart Response [T20]

This timer starts when the DTE issues a Restart Request. It terminates when the DTE receives a Restart Confirmation or a Restart Indication. If neither is received in the time allowed, the DTE retransmits the Restart Request. The recommended value is 1800.

Call Req Response [T21]

This timer starts when the DTE issues a Call Request. It terminates when the DTE receives a Call Connected, Clear Indication or Incoming Call. If none of these are received in the time allowed, the DTE issues a Call Request. The recommended value is 2000.

Reset Response [T22]

This timer starts when the DTE issues a Reset Request. It terminates when the DTE receives a Reset Confirmation or a Reset Indication. If neither is received in the time allowed, the DTE retransmits the Reset Request or sends a Clear Request. The recommended value is 1800

Clear Req Response [T23]

This timer starts when the DTE issues a Clear Request. It terminates when the DTE receives a Clear Confirmation or Clear Indication. If neither is received in the time allowed, the DTE retransmits the Clear Request. The recommended value is 1800.

DTE Window Status [T24]

This timer does not exactly match the DTE Window Status Transmission Timer, T24. Instead, it specifies the maximum time for which data received from the remote side can remain unacknowledged due to a flow control condition. After expiration of this timer, any outstanding acknowledgments are carried by an X.25 Receive Not Ready packet. This timer makes sure that the remote side not receiving an acknowledgment does not cause resets within the virtual circuit. This timer should be about half the value of Window Rotation (see following). The default value is 600.

Window Rotation [T25]

This timer starts when the DTE transmits a data packet, or the DTE's window is rotated, but there are still outstanding data packets. It terminates when there are no outstanding data packets in the window. If this does not happen withing the allowed time, the DTE retransmits all data packets in the window, and restarts this timer. The default value is 2000.

Interrupt Response [T26]

This timers starts when the DTE sends an Interrupt packet. It terminates when the DTE receives an Interrupt Confirmation. It this is not received in the time allowed, the DTE transmits a Reset Request. The default value is 1800.

Pending Ack Delay

Specifies the maximum time during which a pending acknowledgment is withheld. SunLink X.25 tries to suppress the generation of Layer 3 Receiver Ready control packets. Acknowledgment carried by data or multiple acknowledgments is preferred to each data packet being explicitly and separately acknowledged.

DTE/DCE Resolution

The period in which the DTE/DCE resolution should be completed. This prevents two packet-level entities failing to resolve their DTE/DCE roles. When this timer expires, the link connection is disconnected and all pending connections aborted.

Idle (LAN only)

The period over which SunLink X.25 maintains a link-level connection associated with no connections. A useful value for LANs is 600. For WANs, leave at 0.

The parameters listed below are under the heading X25 Retransmission Counters. These parameters have values that indicate the number of times that SunLink X.25 performs an action, for example, sends a Restart Request. The allowable range for these parameters is 1 to 255. Make sure you set a value that is high enough to cope with lost traffic and network delays, but low

enough to resolve problems with little disruption to users. Exactly what this value is depends to a great extent upon the speed of your network and the load it is carrying.

DTE Restart Request[R20]

The number of Restart Requests that will be sent before the link is assumed to be down.

DTE Reset Request[R23]

The number of Reset Requests that will be sent before the link is assumed to be down.

DTE Clear Request[R22]

The number of Clear Requests that will be sent before the link is assumed to be down.

The parameters listed below are under the heading X25 Transit Delays. These parameters have values are expressed in thousandths of a second (milliseconds). The allowable range for these timers is 0-32000.

Internal Delay

The period by which transmission is delayed due to internal processing.

Line Delay

The period by which transmission is delayed due to the effects of line transmission rate.

Once you are satisfied with the parameters you have set, click SELECT on Apply. This dismisses the window.

Note – Clicking on Apply does not save the values permanently. You must use the File➤Save option of the X.25 Parameters window to do this.

2.2.2.5 *Throughput Class and Packet Sizes*

Click SELECT on the "Throughput..." button in X25 Parameters window to display the Throughput Class and Packet Sizes window:

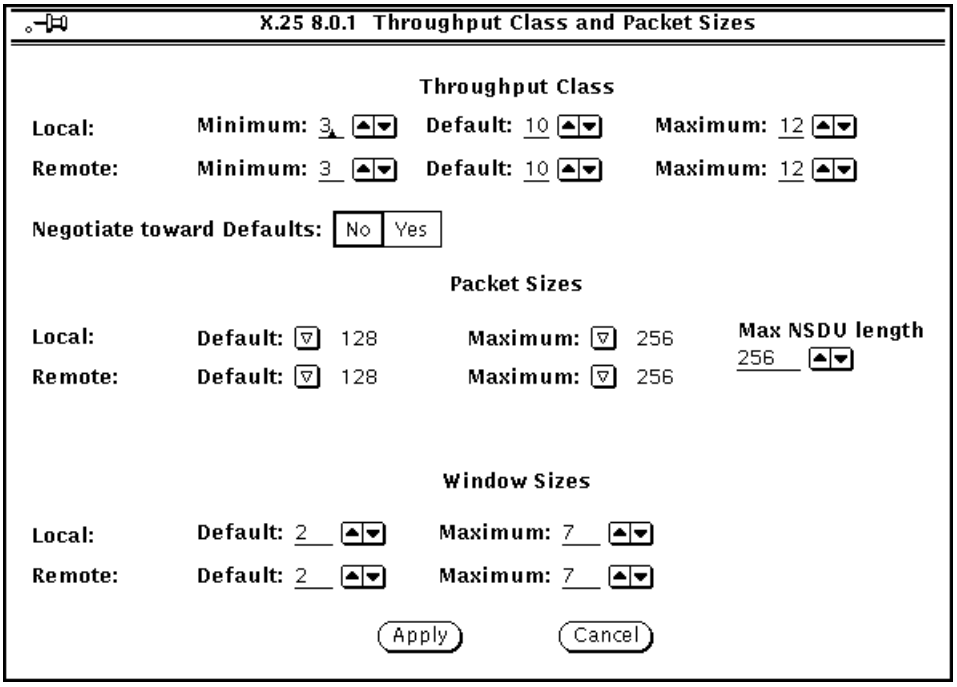

Figure 2-19 Throughput Class and Packet Sizes Window

The Throughput Class and Packet Sizes window allows you to set values for throughput class parameters and to set Layer 3 (network layer) window and packet sizes.

You can change the following parameters in the Throughput Class and Packet Sizes window:

Throughput Class

Enter (or accept the defaults for) a minimum, default, and maximum throughput class.

The “standard” range for throughput class, as specified in ISO 8208, is 3 through 12, corresponding to a range of 75 to 48000 bps. However, SunLink X.25 supports 0 through 15, allowing for non-standard X.25 network implementations. If you connect to a non-standard network, use the throughput class options in the Special Parameters window (see “Special Parameters” on page 2-34) to specify values for that network. If you need to use non-standard values, your service provider should tell you what they are.

Negotiate toward Defaults

A yes/no toggle. Allows for configuration for non-standard X.25 networks, such as TELENET (a US network). The default (no) is the appropriate choice for the vast majority of network connections. In this case, negotiation is towards mutually acceptable minima, rather than the default values.

Packet Sizes

You need to specify the Default and Maximum packet sizes for the local and remote networks.

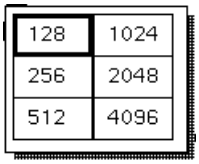

Figure 2-20 Layer 3 Packet Size Menu

The default must be less than or equal to the maximum.

Max NSDU Length

Determines the maximum size (in bytes) to which packets with the M (More data) bit set can be concatenated. This parameter has a range of 1 to 32000. The default maximum size is 256.

Window Sizes

Window sizes can be in the range 1 to 7 for modulo 8 networks or 1 to 127 for modulo 128 networks.

Specify (or accept) default and maximum window sizes for both local and remote hosts. The default must be less than or equal to the maximum.

Once you are satisfied with the parameters you have set, click SELECT on Apply. This dismisses the window.

Note – Clicking on Apply does not save the values permanently. You must use the File➤Save option of the X.25 Parameters window to do this.

2.2.2.6 *Special Parameters*

Click SELECT on the "Special..." button in X25 Parameters window to display the Special Parameters window:

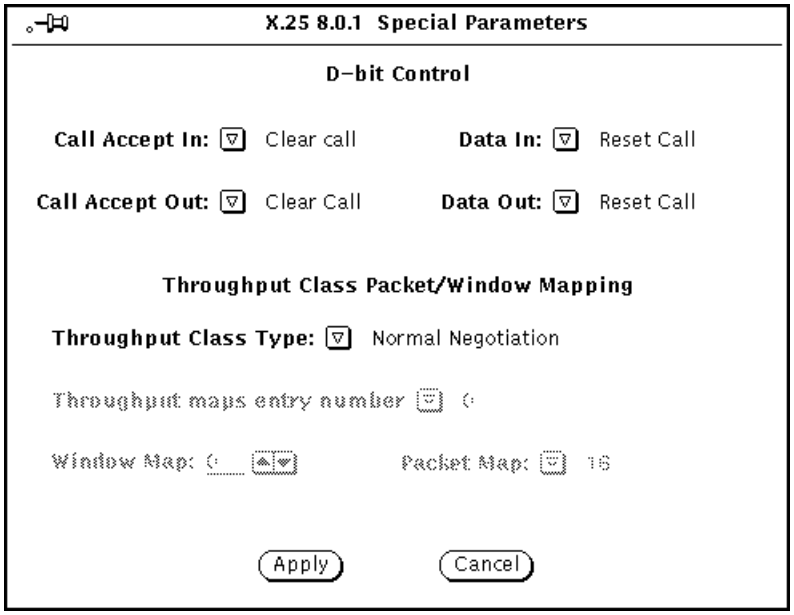

Figure 2-21 Special Parameters Window

Use the Special Parameters window to set values for D-bit options and throughput class. The throughput class parameters are only for those X.25 networks that do not use standard X.25 packet and window size negotiation.

The following parameters are listed under D-bit Control:

Call Accept In

Determines SunLink X.25's response when it receives a Call Accept packet with the D-bit set and end-to-end acknowledgment was not requested. The default action is to clear the call. The other options are:

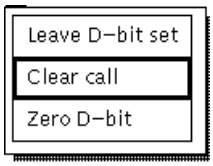

Figure 2-22 D-bit Control: Call Accept In / Out Menu

Call Accept Out

Determines SunLink X.25's response when it sends a Call Accept packet with the D-bit set and receives a packet from the remote side with the D-bit turned off. The options are the same as those shown above for the "Call Accept In" parameter.

Data In

Determines SunLink X.25's response when it receives a Data packet with the D-bit set. If the default action (Reset Call) is not appropriate for the applications that use SunLink X.25, press or click MENU to display the other options:

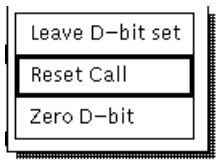

Figure 2-23 D-bit Control: Data In / Out Menu

Data Out

Determines SunLink X.25's response when an application tries to send a data packet with the D-bit set. The options are the same as the ones shown above for the Data In parameter.

Listed below are the parameters under the Throughput Class Packet/Window Mapping heading. You only need to set these parameters if you are connecting to a non-standard X.25 network.

Throughput Class Type

If the default action (Normal Negotiation) is not appropriate for your X.25 network, choose one of these options:

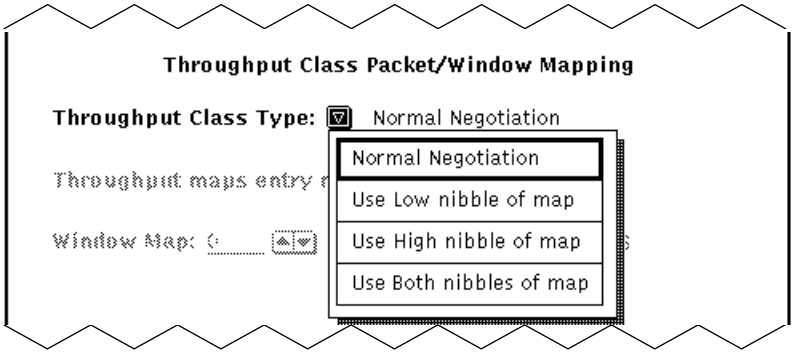

Figure 2-24 Throughput Class Type Menu

If you accept Normal Negotiation, the remaining items in the Special Parameters window are greyed-out. If you are attaching to a PSDN that uses packet or window size negotiation (the most usual case) keep the default. If you choose either Use Low nibble of map or Use High nibble of map, there is no window or packet size negotiation.

Throughput maps entry number

If you are connecting to a non-standard X.25 network and the map entry of 0 is not appropriate for your X.25 network, choose one of these options:

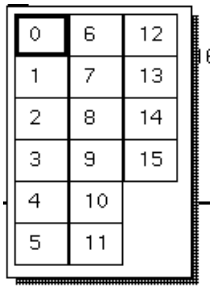

Figure 2-25 Throughput Maps Entry Menu

Window Map

A number in the range from 1 to 127.

Packet Map

The range for valid packet sizes is 16 to 4096.

If the default packet map value of 16 is not appropriate for your X.25 network, choose one of these values:

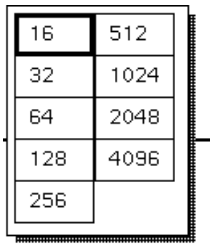

Figure 2-26 The Packet Map Menu

Once you are satisfied with the parameters you have set, click SELECT on Apply to dismiss the window. Then use the File➤Save option of the X.25 Parameters window to save the changes permanently.

2.2.3 LAPB Parameters Window

The LAPB Parameters window is displayed when you choose Create/Modify configuration files➤LAPB➤"Active...", "Working..." or "From file" from the `x25tool` base window.

If you chose the "From file" item, the Select a File window appears. If you are attached to a PSDN, choose the appropriate file from the list.

If you are not connecting to one of the PSDNs for which there is a customized file, choose a file based on:

- whether your side is a DTE or a DCE
- the X.25 recommendation, 1980, 1984, or 1988, followed by your X.25 network.

When you have made your choice, the LAPB Parameters window appears. If you chose the "Active...", "Working..." items, the LAPB Parameters window appears immediately:

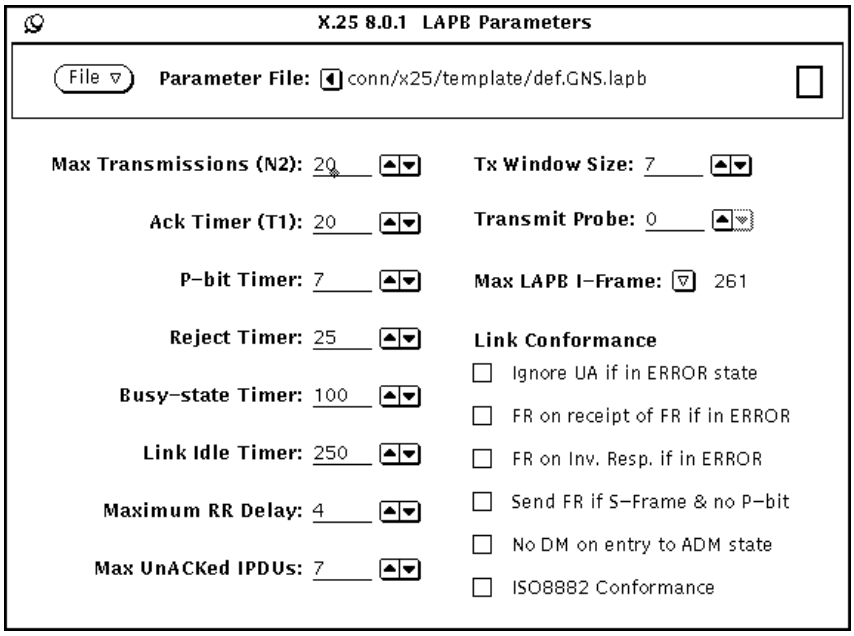

Figure 2-27 LAPB Parameters Window

The LAPB Parameters window displays the values set in the template or configuration file you chose in the Select a File window, or from the active or working configuration. You can view or modify these settings and save them to your working configuration or to a configuration file.

Listed below are the parameters displayed in the LAPB Parameters window.

Max Transmissions (N2)

The maximum number of times that an I-frame is sent following the expiration of the Ack Timer, the P-bit Timer, or the Reject Timer. It also limits the number of times Receive Ready with P-bit set is sent when the remote side is busy and the Busy Timer expires. The valid range for this parameter is 1 to 255.

Ack Timer (T1)

The period, in tenths of a second, during which the LAPB software expects to receive an acknowledgment to an outstanding I-frame or during which LAPB expects a response to a sent unnumbered frame. The valid range for this parameter is 1 to 3000.

P-bit Timer

The period, in tenths of a second, during which the LAPB software expects to receive a frame with the F-bit set to 1 in response to a command with the P-bit set to 1. This value should be less than that specified for the Ack Timer. The valid range for this parameter is 1 to 3000.

Reject Timer

The period, in tenths of a second, during which the LAPB software expects to receive a reply to a sent Reject frame. The valid range for this parameter is 1 to 10000.

Busy-state Timer

The period, in tenths of a second, during which the LAPB software waits for an indication of the clearance of a busy condition at the other end of the link. The valid range for this parameter is 1 to 30000.

Link Idle Timer

The period, in tenths of a second, during which the LAPB software expects to receive a frame from the other end of the link. If this timer expires, the Poll/Final cycle—which might result in link disconnection—is initiated. A zero value disables this function. The valid range for this parameter is 0 to 32000.

Maximum RR Delay

The maximum delay, in tenths of a second, before transmitting a delayed Reset Request. The value for this parameter must be significantly lower than the Ack Timer value. The valid range for this parameter is 0 to 3000.

Max UnACKed IPDUs

The maximum number of unacknowledged I(nformation)-frames that can be received before the Receive Ready acknowledging those I-frames must be sent. The valid range for this parameter is 0 to 127.

Tx Window Size

The number of unacknowledged I-frames that can be sent. In normal mode, when modulo 8 sequence numbering is in effect, the default value is 7 and the valid range is 1 to 7. In extended mode, when modulo 128 sequence numbering is in effect, the default value is 7 and the valid range is 1 to 127.

Transmit Probe

The position within a window at which the LAPB software sends an I-frame with the P-bit set, to ask for an acknowledgment from the receiver.

Max LAPB I-Frame

The LAPB software rejects incoming I-frames above the size specified here. This value consists of the combination of:

- maximum X.25 data size
- X.25 protocol length
- LAPB protocol length

Permitted values are 261 to 4103.

Listed below are check box items under the heading “Link Conformance”.

Click SELECT on a check box to enable (check mark present) or disable a feature.

Ignore UA if in ERROR state

When the connection is in an Error state, ignore any Unnumbered acknowledgment frames received.

FR on receipt of FR if in ERROR

When the connection is in an Error state, retransmit a Frame Reject if one is received.

FR on Inv. Resp. if in ERROR

When the connection is in an Error state, transmit a Frame Reject if an invalid Frame Response is received.

Send FR if S-Frame & no P-bit

If an S-frame is received without the P-bit set, send a Frame Reject.

No DM on entry to ADM state

Do not transmit a DM on entry to the ADM state.

ISO8882 Conformance

Run the link so that it is conforms *exactly* to the specifications in the ISO 8882 standard.

Once you are happy with your choice of parameters, choose File➤Save.

2.2.4 LLC2 Parameters Window

The LLC2 Parameters window is displayed when you choose Create/Modify configuration files➤LLC2➤"Active...", "Working..." or "From file" from the `x25tool` base window. If you choose the "From file" item, a Select a File window appears. Choose `def.llc2`, the only available choice. The LLC2 parameters window looks like this

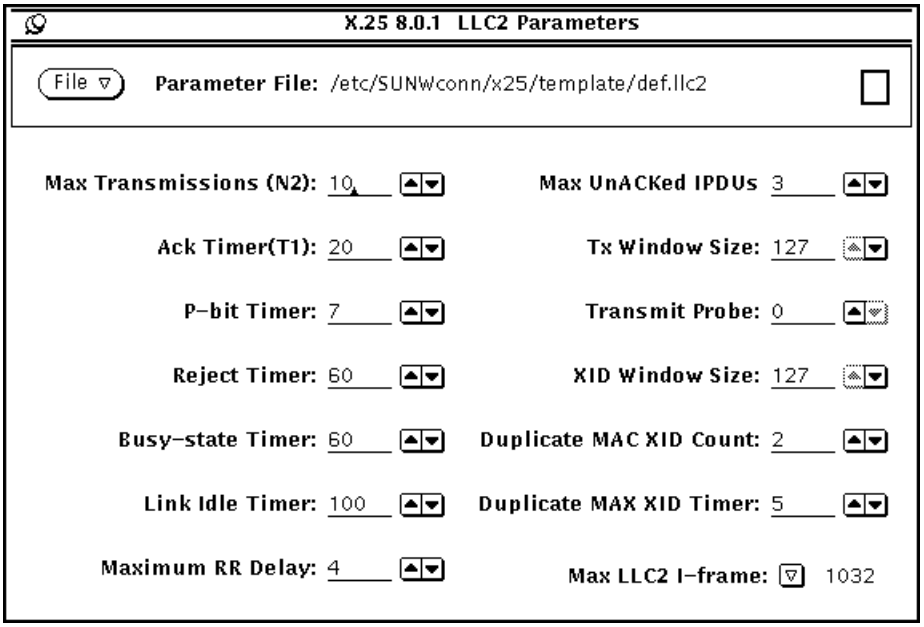

Figure 2-28 LLC2 Parameters Window

The LLC2 Parameters window displays the values set in the template or configuration file you chose in the Select a File window, or from the active or working configuration. The LLC2 Parameters window allows you to view or modify parameter settings and to save them to your working configuration or to a configuration file.

To dismiss the LLC2 Parameters window press MENU on File➤Quit and release MENU. If you have unsaved changes, `x25tool` allows you to save them before dismissing the window.

Listed below are the parameters displayed in the LLC2 Parameters window. For each parameter, if the default value is inappropriate for your link, enter a number by typing it in or by clicking SELECT on the up or down buttons until the window displays the link number you want.

Max Transmissions (N2)

Maximum number of times the LLC2 software sends a PDU following the expiration of the Ack Timer, the P-bit Timer, or the Reject Timer. The value of this parameter also limits the number of times Receive Ready with P-bit set is sent when the remote side is busy and the Busy Timer expires. The valid range for this parameter is 1 to 255.

Ack Timer (T1)

The period, in tenths of a second, during which the LLC2 software expects to receive an acknowledgment to an outstanding I-frame or during which LAPB expects a response to a sent unnumbered frame. The valid range for this parameter is 1 to 3000.

P-bit Timer

The period, in tenths of a second, during which the LLC2 software expects to receive a frame with the F-bit set to 1 in response to a command with the P-bit set to 1. This value should be less than that specified for the Ack Timer. The valid range for this parameter is 1 to 3000.

Reject Timer

The period, in tenths of a second, during which the LLC2 software expects to receive a reply to a sent Reject frame. The valid range for this parameter is 1 to 10000.

Busy-state Timer

The period, in tenths of a second, during which the LLC2 software waits for an indication of the clearance of a busy condition at the other end of the link. The valid range for this parameter is 1 to 30000.

Link Idle Timer

The period, in tenths of a second, during which the LLC2 software expects to receive a frame from the other end of the link. If this timer expires, the Poll/Final cycle is initiated. A zero value disables this function. The valid range for this parameter is 0 to 32000.

Maximum RR Delay

The maximum delay, in tenths of a second, before transmitting a delayed Reset Request. The value for this parameter must be significantly lower than the Ack Timer value. The valid range for this parameter is 0 to 3000.

Max UnACKed IPDUs

The maximum number of unacknowledged I-frames that can be received before the Receive Ready acknowledging those I-frames must be sent. The valid range for this parameter is 0 to 127.

Tx Window Size

The number of unacknowledged I-frames that can be sent. The valid range is 1 to 127.

Transmit Probe

The position within a window at which the LLC2 software sends an I-frame with the P-bit set, to ask for an acknowledgment from the receiver.

XID Window Size

The receive window size. That is, the maximum number of unacknowledged I-frames that the remote end of the link can send.

Duplicate MAC XID Count

Number of times the LLC2 software tries to find stations with duplicate MAC addresses. A value of 0 means no attempt is made. The valid range for this parameter is 0 to 255.

Duplicate MAC XID Timer

The period, in tenths of a second, during which incoming XID response frames are checked for a duplicate response to the station LSAP. A value of 0 tells the LLC2 software not to perform the duplicate address check. The valid range for this parameter is 0 to 3000.

Max LLC2 I-Frame

The LLC2 software rejects incoming I(nformation) frames above the size specified here. This value consists of the combination of:

- maximum X.25 data size
- X.25 protocol length
- LLC2 protocol length

If the default of 1032 bytes does not meet your requirements, choose one of the following values:

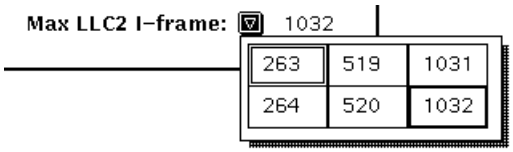

Figure 2-29 LLC2 Maximum I-Frame Size Menu

Once you are happy with your choice of parameters, choose File➤Save.

2.2.5 WAN Parameters Window

The WAN Parameters window is displayed when you choose Create/Modify configuration files➤WAN➤"Active...", "Working..." or "From file" from the `x25tool` base window. If you choose the "From file" item, a Select a File window appears. Choose `def.wan`, currently the only available choice. If you choose "Active...", "Working...", the LLC2 paramaters window appears immediately. The LLC2 parameters window looks like this.

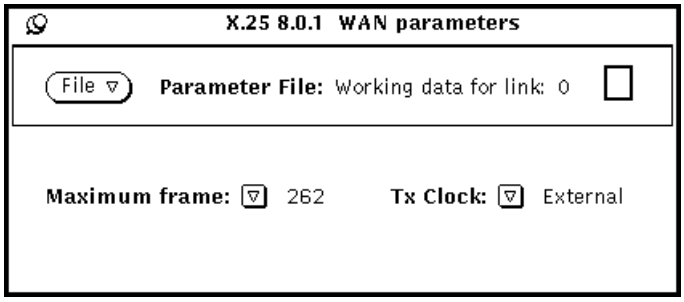

Figure 2-30 WAN Parameters Window

The WAN Parameters window displays the values set in the template or the values used in the active or working configuration. You can view or modify parameter settings and save them to your working configuration or to a configuration file. The default template file values are suitable in most cases. The parameters are:

Maximum frame

The maximum frame size at the WAN level. The options are:

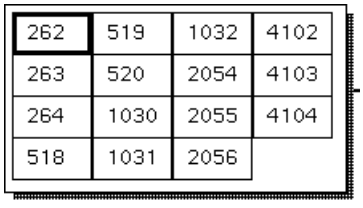

Figure 2-31 WAN Maximum Frame Size Menu

Note that a SunLink HSI/S port uses a fixed frame size of 1600. For links that use an HSI/S port, SunLink X.25 ignores the value of the maximum frame parameter.

Tx Clock

If the local machine is supplying the clocking, this parameter determines the bit transmission (not reception) rate of your link, in bits per second. Most customer installations use synchronous modems, which supply clocking. If you use a synchronous modem, accept the default, External. If the local machine is to supply transmit clocking, choose one of these options:

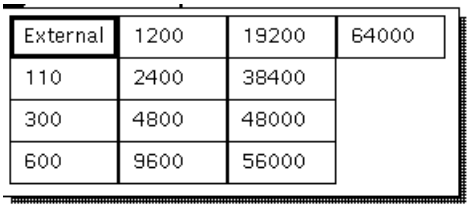

Figure 2-32 Transmission Bit Rate Menu

Note that Receive Clock is always external.

Note – See the appendix on Cabling in the *SunLink X.25 8.0.2 Configuration Guide* for an explanation of SunLink X.25 clocking options and instructions on making a null modem cable.

Once you are happy with the parameters, chose File➤Save.

2.2.6 Configuring X.25 Routing

Routing describes the process by which SunLink X.25 automatically selects a link for outgoing calls based on address information in a Call Request packet. This process is only relevant to machines that have multiple X.25 links.

Configure the X.25 routing software using Create / Modify configuration➤Routing➤Working... The Routing Entries window looks like this:

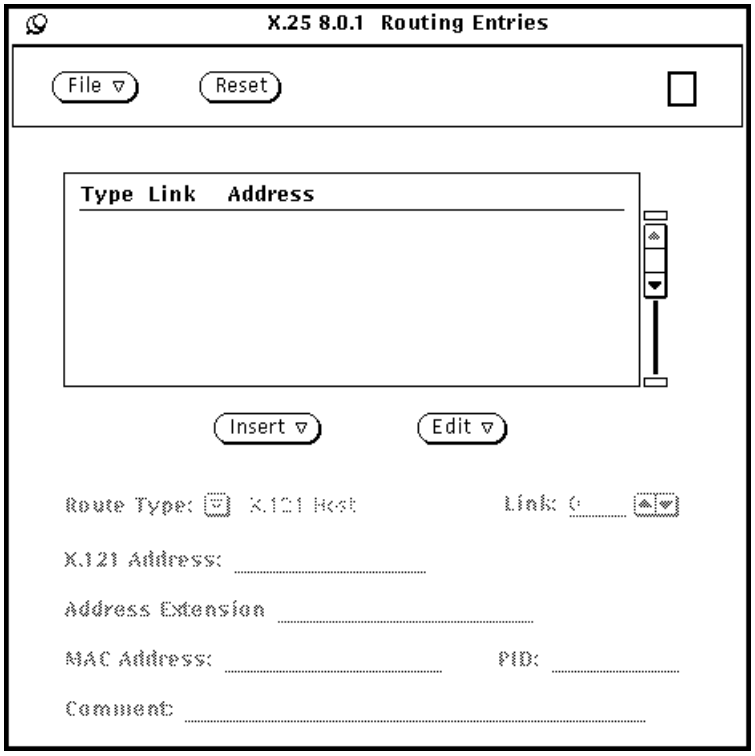

Figure 2-33 The Routing Entries Window

The Routing Entries window consists of a scrolling list of your entries and a set of configurable items. A routing entry consists of an association of a link, a route type, and one or more addresses, with an optional comment.

Click SELECT on the Insert button. The previously grayed-out entries become available. Enter (or modify) data for each item for a given entry.

The parameters you can set are:

Route Type

Press MENU in the Route Types menu button to list the available route types:

X.121 Host
: Associates the complete X.121 address of a remote host with a link. This type of entry can include a MAC address.

X.121 Prefix
: Associates the leading digits (one or more) of an X.121 address with a link. This type of entry can include a MAC address.

X.121 Default
: Contains a link and an optional MAC address. This entry (there can be only one) is used if no match is found between a called address and any X.121 host or prefix entries.

AEF Host
: Associates the complete extended address (such as an OSI NSAP address) of a remote host with a link. This type of entry can include an X.121 address or a MAC address, and a protocol id.

AEF Prefix
: Associates the leading digits (one or more) of an extended address with a link. This type of entry can include an X.121 address or a MAC address, and a protocol id.

AEF Default
: Contains a link and, optionally, an X.121 or a MAC address, and a protocol id. This entry (there can be only one) is used if no match is found between a called address and any AEF host or prefix entries.

Link

The link number to be associated with a host address, an address prefix, or a default entry. This is the same number as you specified it in the Link Number item in the Interface Configuration window in `x25tool`.

X.121 Address

For an X.121 host-type entry, enter a complete X.121 host address, as it would be specified in the called address portion of a Call Request packet. For an X.121 prefix-type entry, enter the leading digits (for example, the DNIC) of an X.121 address. For the optional portion of an AEF routing entry, enter a complete X.121 address.

Address Extension

For an AEF host-type entry, enter a complete extended address, such as an OSI NSAP address. For an AEF prefix-type entry, enter the leading digits (at least one) of an extended address.

MAC Address

The MAC address to which the call will be routed if the link is a LAN link.

Enter a six-byte (twelve-digit) hexadecimal value, such as an Ethernet or FDDI address. You can enter the address as consecutive digits or with colons separating bytes. For example, both 080020110233 and 08:0:20:11:2:33 are valid entries. When you save a routing entry with a colon-delimited MAC address, `x25tool` removes and subsequently displays the address without colons and with leading zeroes within bytes.

PID

A protocol id of no more than five bytes (10 decimal digits). A protocol id is an optional addition to an AEF host, prefix, or default entry. Enter a PID as a string of consecutive digits.

Comment

You can add an optional comment.

6. Save your entry.

Choose the Save Routes➤Active item. To discard the changes you have made in the current session, click SELECT on Reset. The routing table returns to the state it was in when you brought up the window.

Note – In this case, you do not need to stop and restart the network to activate your changes.

2.3 Network Control

The Network Control menu allows you to do the following:

- record any link changes made in `x25tool` in network master files
- start SunLink X.25
- stop SunLink X.25
- display statistics for the various layers of SunLink X.25

In the `x25tool` base window, press or click MENU in the Network Control abbreviated menu button. This displays the following menu:

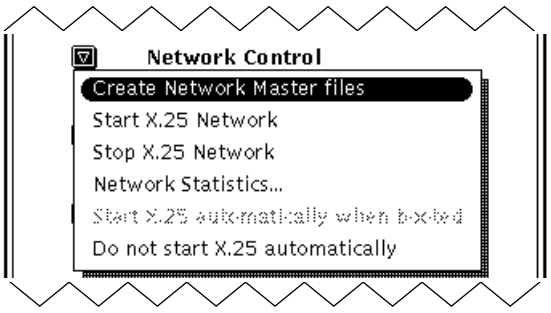

Figure 2-34 Network Control Menu

If your X.25 network is not running, the Stop X.25 Network button is dimmed. If it is running, Start X.25 Network is dimmed.

2.3.1 Creating Network Master Files

You need to create the Network Master files if you have used `x25tool` to make any changes to your links in the Interface Configuration window (see Section 2.1.1, “X.25 Interface Configuration,” on page 2-5). Choosing this option causes your changes to take effect.

You can use the “master file” option without stopping the X.25 network. However, making changes while the network is up can disrupt users. Section 2.3.3, “Stopping the X.25 Network,” on page 2-52 tells you how to bring down X.25 with a minimum of disruption.

When you choose the master file option, `x25tool` creates files that are read by the X.25 network dæmon when that dæmon starts up. The `x25tool` issues a warning if you try to start the X.25 network without having created or re-created the network master files.

2.3.2 Starting the X.25 Network

To start the X.25 network (for exmple, after having created the network master files, as described in the previous subsection), choose Start X.25 Network. `x25tool` displays the window shown below, in which it reports status as the X.25 network comes up.

Startup is complete after SunLink X.25 brings up the three layers of X.25. At this point you can initiate and receive calls.

If you want SunLink X.25 to start automatically each time you reboot, choose "Start X.25 automatically when booted". If you have previously chosen the automatic startup feature and want to disable it, choose "Do not start X.25 automatically".

2.3.3 Stopping the X.25 Network

Before stopping the X.25 network, check the status line at the top of the `x25tool` base window. If it indicates that your X.25 network is up:

1. Use the Network Statistics option described in the following subsection to determine if there are any active connections (see Figure 2-35 on page 2-53).
2. If there are, use the Solaris operating system `/usr/bin/who` command to see who is logged on to the machine running SunLink X.25.
3. If possible, have those users terminate their calls gracefully before you bring down the network. (If you use SunLink X.25 as an IP gateway, or another application whose requirements for a virtual circuit is continuous, you may have not have the option of graceful termination.)

To bring down the X.25 network, choose Stop X.25 Network. This action brings down the three layers of X.25. Any calls that are in progress are cleared.

2.3.4 Network Statistics

To view network statistics, click SELECT on the Network Statistics item. The Network Statistics window appears, with no statistics in it. To display the statistics, click SELECT on Display. The Network Statistics window looks like this:

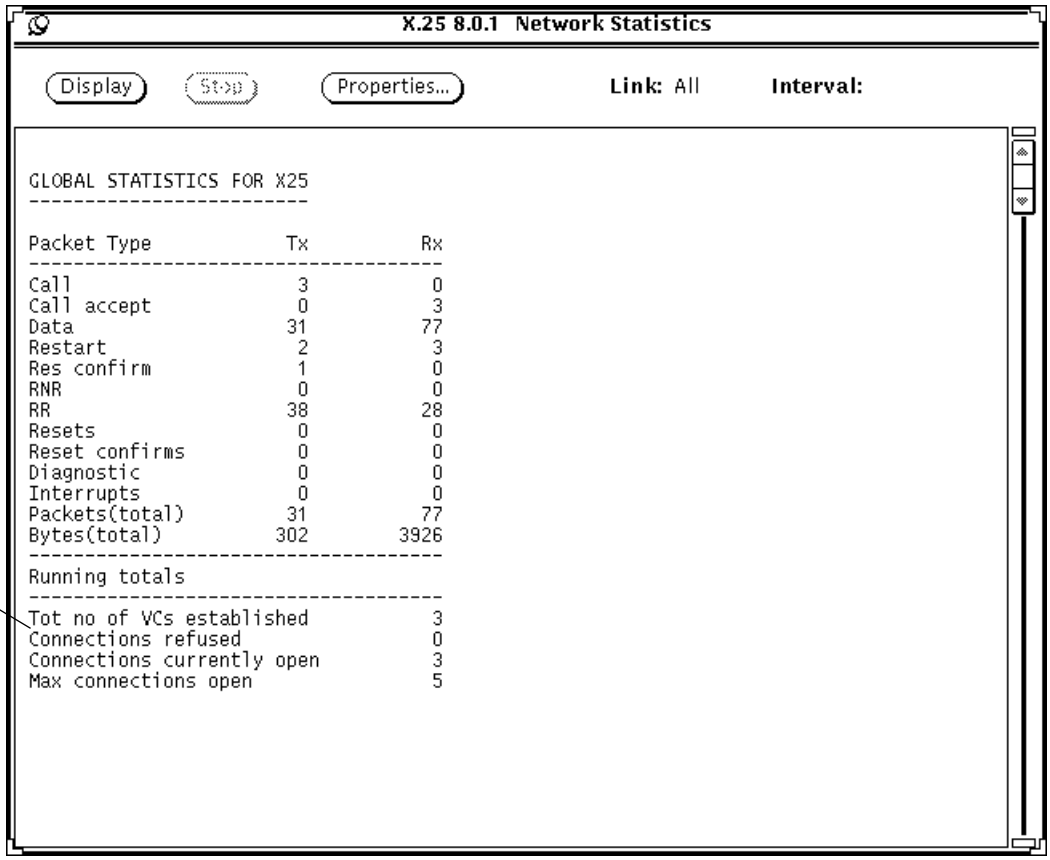

Figure 2-35 Network Statistics Window

While statistics are being updated the Stop button is available. Click SELECT on it to stop the update. Once the update is complete, the Stop button is greyed-out, as above while the Display button is not. The Display button toggles between Display and Clear, depending on the setting you make in the properties window. The Link and Interval items are described below.

Note the line “Connections currently open” in the figure above. Check this item if you intend to stop the X.25 network. If there are current connections, use `/usr/bin/who` to determine who is logged in to the machine running X.25.

2.3.4.1 Statistics Properties

In the Network Statistics window, click SELECT on the Properties... button to display the Statistics Properties window. Use it to specify which statistics you want to view:

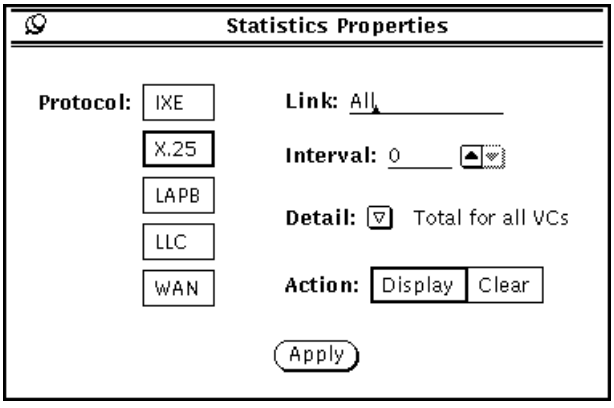

Figure 2-36 Statistics Properties Window

The items in the properties window are described as follows:

Protocol

Click SELECT on the protocols for which you want to receive information. The following subsection gives examples of output for each protocol. You can select any combination of the protocols displayed. For example, if you are running IP over X.25, you might select IXE, X.25, LAPB, and WAN.

Link

Accept the default of All or enter a link number or alias as you entered it in the X.25 Interface Configuration window, as described in Section 2.1.1, "X.25 Interface Configuration," on page 2-5. The value you enter here is displayed in the Link item in the Network Statistics window.

Interval

The default of 0 means that `x25tool` displays a snapshot of current activity for the selected protocol(s). With a non-zero value, `x25tool` displays a running count of statistics, updated at an interval you specify here in seconds.

Detail

A choice between the default, Total for all VCs, and Display per VC.

Action

A toggle between Display and Clear. With the default, Display, you receive a display of current statistics, as collected since the last reboot or since the last time you chose the Clear option. With the Clear option, you zero the statistics count for the selected protocol(s).

If you select Display, the Network Statistics window displays a Display button. If you select Clear, the Display button changes to Clear.

After you click SELECT on Apply, your changes take effect the next time you start or clear statistics (by clicking SELECT on the Start/Clear button in the Network Statistics window). If you are currently displaying network statistics, you must stop and restart the statistics display for the changes made in the properties window to take effect.

2.3.4.2 Statistics Examples

The following are examples of output from the various types of statistics displayed by `x25tool`

IXE (IP over X.25) Statistics

The following is the display for IXE statistics:

```
ixe:
              0  connections
              0  datagrams in
              0  datagrams out
              0  NSDUs in
              0  NSDUs out
              0  Input errors
              0  Output errors
              0  Pkts lost due to flow control
              0  Buffer allocation failures
```

Figure 2-37 IXE Statistics

X.25 Statistics

The option for X.25 Packet Layer Protocol statistics is the default when you choose Network Control➤Network Statistics. The statistics display for this protocol is shown in Figure 2-35 on page 2-53.

LAPB Statistics

The following is the display for LAPB statistics:

```
GLOBAL STATISTICS FOR LAPB
--------------------------

Statistic        RX       TX
---------------------------------
  Frames        151        6223
  Bytes           0         205
  SABMs           0           2
```

Figure 2-38 LAPB Statistics

LLC2 Statistics

The following is the display for LLC2 (X.25 over LLC2) statistics:

```
GLOBAL STATS FOR LLC2
---------------------
Statistic        RX       TX
---------------------------------
  Frames         150         153
  Bytes          913         132
  SABMEs           0           1
```

Figure 2-39 LLC Statistics

WAN Statistics

The following is the display for WAN (X.25 over LAPB over a serial port driver) statistics:

```
STATISTICS FOR WAN
------------------

Device      : /dev/zsh0
Link    : 1

            1072  input packets
            6239  output packets
            2580  input bytes
           12683  output bytes
               0  abort received
               0  CRC error
               0  receiver overrun
               0  xmitter underrun
               0  input error (rxbad)
               0  output error (watchdog timeout)
               0  no active rx block available
```

WAN statistics are not guaranteed to be accurate, because they are obtained through the LAPB interface.

2.4 Application Configuration

The Application Configuration menu gives you access to PAD and IP configuration.

2.4.1 PAD Configuration

You need to configure the PAD Hosts database and the PAD Dæmon Listen database. Both of these are available from the PAD option of the Application Configuration menu. You may also need to change the X.3 parameters. These are not a separate menu option, but are available from within the PAD Hosts and PAD Dæmon Listen configuration windows. They are dealt with separately in section Section 2.4.1.3, “Configuring the X.3 Parameters,” on page 2-68. The PAD menu looks like this:

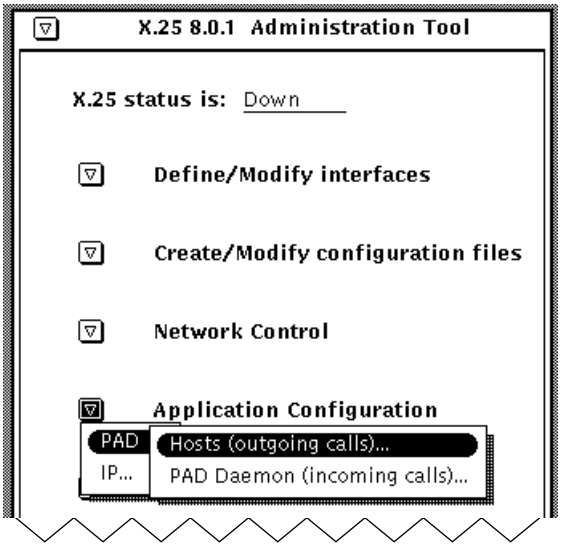

Figure 2-40 Choosing the Hosts(outgoing calls) Item

2.4.1.1 The PAD Hosts Database

The PAD Hosts Database window contains of a list of remote PAD hosts and a set of configurable items:

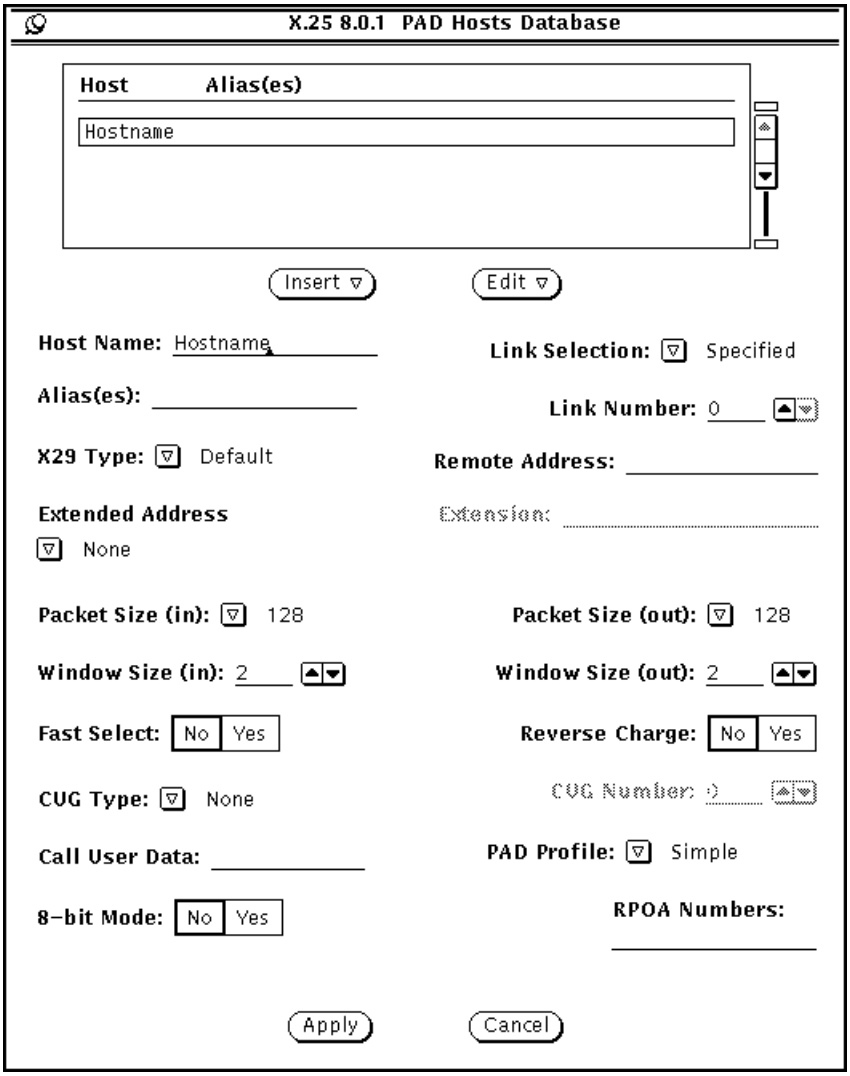

Figure 2-41 The PAD Hosts Database Configuration Window

Click SELECT on Insert to begin adding entries for a host. Enter or select data for each item, starting with Host Name.

In most cases you only need to enter the local and remote host addresses. The other parameters allow for differences between the PAD configuration and other applications. If you intend to use any of the other parameters, make sure you know the information you need before you start. The parameters are:

Host Name

An alphanumeric string that is the name of the remote host. This name is for your use, it is not seen by the remote PAD or host.

Link Selection

Choose either Automatic or Specified. Automatic uses the SunLink X.25 routing (link selection) feature, and grays out the Link Number option.

Alias(es)

This optional field can hold up to 80 alphanumeric and whitespace characters. Separate multiple aliases with spaces. (An individual alias cannot contain spaces.) A PAD user can substitute any aliases entered here for the host name of a remote host when making a PAD call.

Link Number

The number over which PAD makes calls to the specified remote host. This parameter only applies if you have multiple links. This option is grayed-out if you chose automatic Link Selection.

X29 Type

Specifies the year of the X.29 recommendation supported by the remote host. Default means that you use the X.25 type specified for a given link.

Remote Address

The DTE or LSAP address of the remote host. A valid DTE address is of 15 or fewer decimal digits. A valid LSAP (MAC plus SAP) address is 14 hexadecimal digits in length. In most cases, the last two digits of an LSAP address (the SAP address) are 7e. The `x25tool` program accepts ARP-style notation, with colons separating the bytes within an LSAP address. Within a colon-delimited byte, you can omit a leading zero.

Extended Address

Choose among None (the default), OSI, and non-OSI. This is the type of extended address you use in the network to which the link you are configuring is attached. Extended Addressing is not available if your call is traversing a 1980-type WAN.

Extension (for non-OSI) or OSI NSAP (for OSI extended addresses)

For an OSI NSAP, enter a hexadecimal address of 40 digits or fewer. This feature is not available if your call is traversing a 1980-type WAN.

Packet Size (in and out)

This is a number determined by the requirements of your remote host and PSDN. If your packet sizes are different from the default of 512, press MENU in the Local (or Remote) Packet Size button and select the packet size appropriate for your remote host.

Window Size (in and out)

This is determined by the requirements of your PSDN and your remote host.

Fast Select

Determines whether Fast Select is in effect for the calls to the specified host. If you enter more than 12 characters of Call User Data (below), the PAD software automatically uses Fast Select, regardless of the setting here.

Reverse Charge

Determines whether the PAD software will propose calls to the remote with reverse-charging requested (that is, the remote host pays).

CUG Type

If your host is a member of a Closed User Group, choose the appropriate CUG type.

CUG Number

If your host is a member of a multi-user or bilateral CUG, enter the CUG number by typing it in or by clicking SELECT on the up or down buttons until the window displays the correct number.

Call User Data

A string of up to 124 ASCII characters that the PAD software will include in Call Request packets.

PAD Profile:

Profile names refer to specific sets of PAD (X.3) parameter settings. If the Simple profile (the default) is not appropriate for the specified remote host, choose one of the other named profiles. Your network provider should tell you which profile you need to use.

If none of the seven profiles provided with the product suit your needs, you can modify some or all of the 22 parameters defined in the 1988 CCITT X.3 recommendation. To access them, select User-Defined. The PAD parameters window appears. See Section 2.4.1.3, “Configuring the X.3 Parameters,” on page 2-68 for information about these parameters.

8-bit Mode

In 7-bit mode (the default), characters are seven bits long and parity is filtered. In 8-bit mode, characters are eight bits long with no parity.

RPOA Numbers

A four-digit number that provides networks between you and the remote host with additional routing information. You can have up to four RPOA numbers. Enter RPOA numbers on the line shown below. If you have multiple RPOA numbers, enter them together in the same sequence of digits, with no spaces between.

Note – When you make changes in the PAD Hosts Database window, those changes take effect immediately. There is no need to stop and restart your X.25 network.

2.4.1.2 *Configuring the PAD Dæmon Listen Database*

The PAD dæmon is the piece of SunLink X.25 software that handles incoming PAD calls. The PAD dæmon allows you to configure a set of parameters for all incoming PAD callers and for individual PAD hosts. (Any settings you make for individual hosts override settings made for all hosts.)

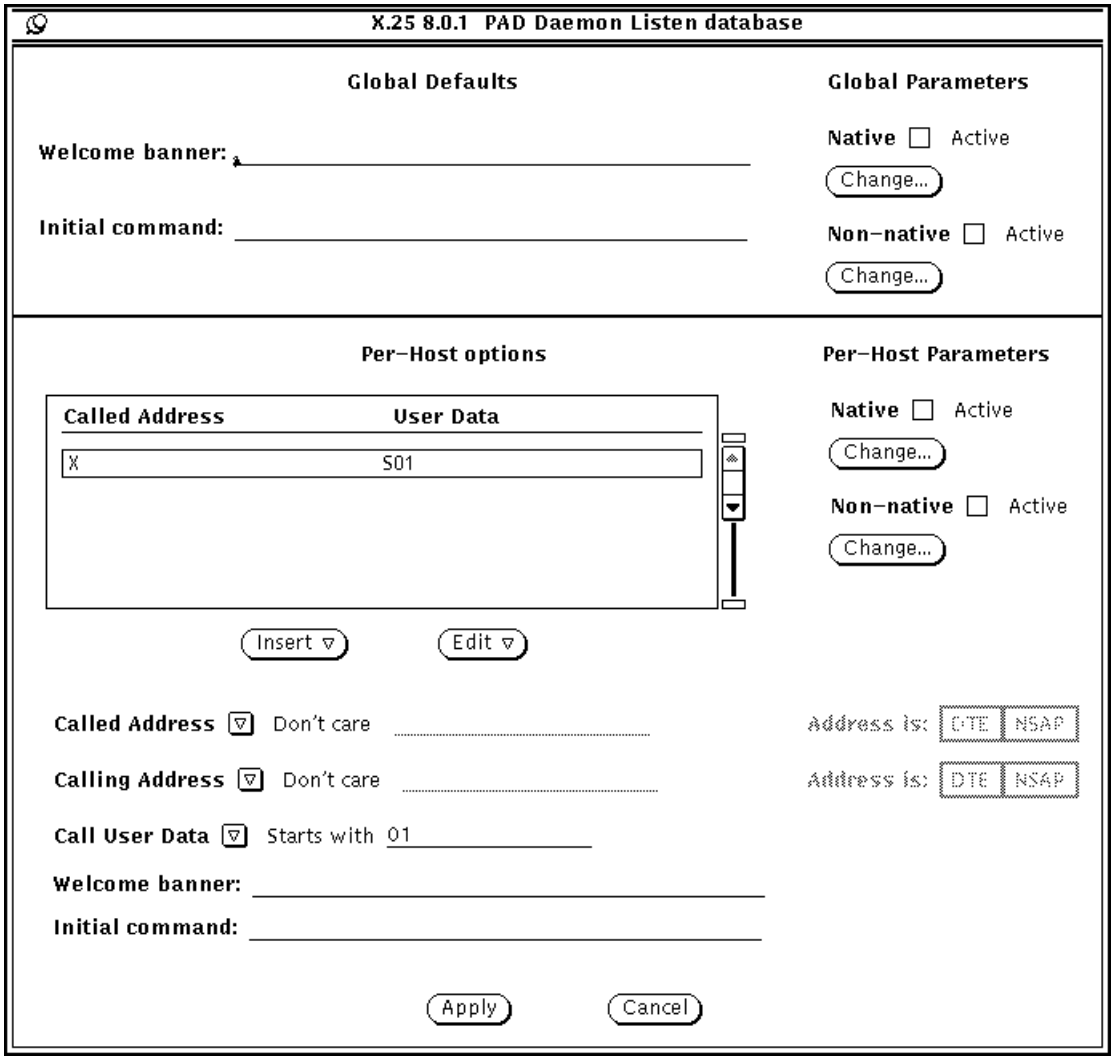

Figure 2-42 The PAD Dæmon Listen Database window

There are two categories of PAD dæmon parameters — global and per-host. Configure global parameters in the top half of the screen, and per-host parameters in the bottom half. Global parameters apply to all hosts that call the local PAD dæmon. Per-host parameters apply only to a given host and override global parameters.

The global parameters are:

Welcome banner

A string that the PAD dæmon displays to incoming PAD callers. Enter 80 or fewer alphanumeric (including whitespace) characters. If you do not set a string, the default is `SunLink X.29 Terminal Services`.

Initial command

The command that the PAD dæmon invokes automatically when a connection is established with an incoming PAD caller. By default, the initial command is `/bin/login`.

Native

In native mode the parameter settings are:

Table 2-1 Native Mode parameter settings

Parameter Number	Setting
2	0
4	1
10	0
15	0

This means that echoing is disabled, data forwarding timeout is enabled there is no line folding and local editing is disabled.

Click SELECT on the Active check box to enable native mode. If you want to modify any X.3 (PAD) parameters associated with native-mode PAD calls, click SELECT on “Change...”. The PAD (X.3) Parameters window appears.

Non-native

In non-native mode the parameter setting are:

*Table 2-2*Non-Native Mode parameter settings

Parameter	Setting
2	1
4	0
10	0
15	1

This means that echoing is on, data forwarding is disabled, there is no line folding and editing is disabled.

Click SELECT on the Active check box to enable non-native mode. If you want to modify any X.3 (PAD) parameters associated with non-native-mode PAD calls, click SELECT on “Change...”. Your network provider should tell you if you need to do this. The PAD (X.3) Parameters window appears. For information about the parameters you set in this window, see Section 2.4.1.3, “Configuring the X.3 Parameters,” on page 2-68.

The per-host parameters are:

Native

As described above for global parameters.

Non-native

As described above for global parameters.

Note – The three parameters, Called Address, Calling Address, and Call User Data, specify strings of digits, which the PAD dæmon uses to match address information in incoming PAD calls. If you specify digits for all (or any combination of these) parameters, incoming calls must match the values you specify for both or all. The PAD dæmon does not accept a call if, for example, an incoming call matches your Called Address parameter but not your Call User Data parameter.

Called Address

Specifies the pattern of digits the PAD dæmon uses to match the called address on incoming PAD calls. The options are:

- Starts with: The PAD dæmon accepts calls from PAD callers that have called addresses that have leading digits that match the string of digits you enter here.
- Matches: The PAD dæmon accepts calls from PAD callers that have called addresses that exactly match the string of digits you enter here.
- Don't care: The PAD dæmon accepts calls from any PAD caller, regardless of its called address. You do not enter a string for this option. The default is "Don't care".
- Pattern:Allows the use of standard wildcard characters in order to match on part of an address. Select this option to use the style of addressing used by version 7.0 of SunLink X.25.

You also need to use the Address is: parameter to specify the type of the called address.

Address is:

Specify the type of the called address. If the called address is not a DTE address (the default), click SELECT on NSAP.

Calling Address

Specifies the pattern of digits the PAD dæmon uses to match the calling address on incoming PAD calls.

The options are explained under Called Address, above. You also need to use the Address is: parameter to specify the type of the calling address.

Call User Data

Specifies the pattern of digits the PAD dæmon uses to match the Call User Data on incoming PAD calls. By convention this is 01.

Welcome banner

As described above for global parameters.

Initial command

As described above for global parameters.

Address is:

Specify the type of the called address. If the called address is not a DTE address (the default), click SELECT on NSAP.

Note – You do need to stop and restart the X.25 network to make these changes take effect.

2.4.1.3 *Configuring the X.3 Parameters*

If none of the seven profiles provided with the product suit your needs, you can modify some or all of the 22 parameters defined in the 1988 CCITT X.3 recommendation. Your network provider should tell you which values you need to set. To access them, select User-Defined. The parameter numbering is in accordance with the X.3 Parameter standard.

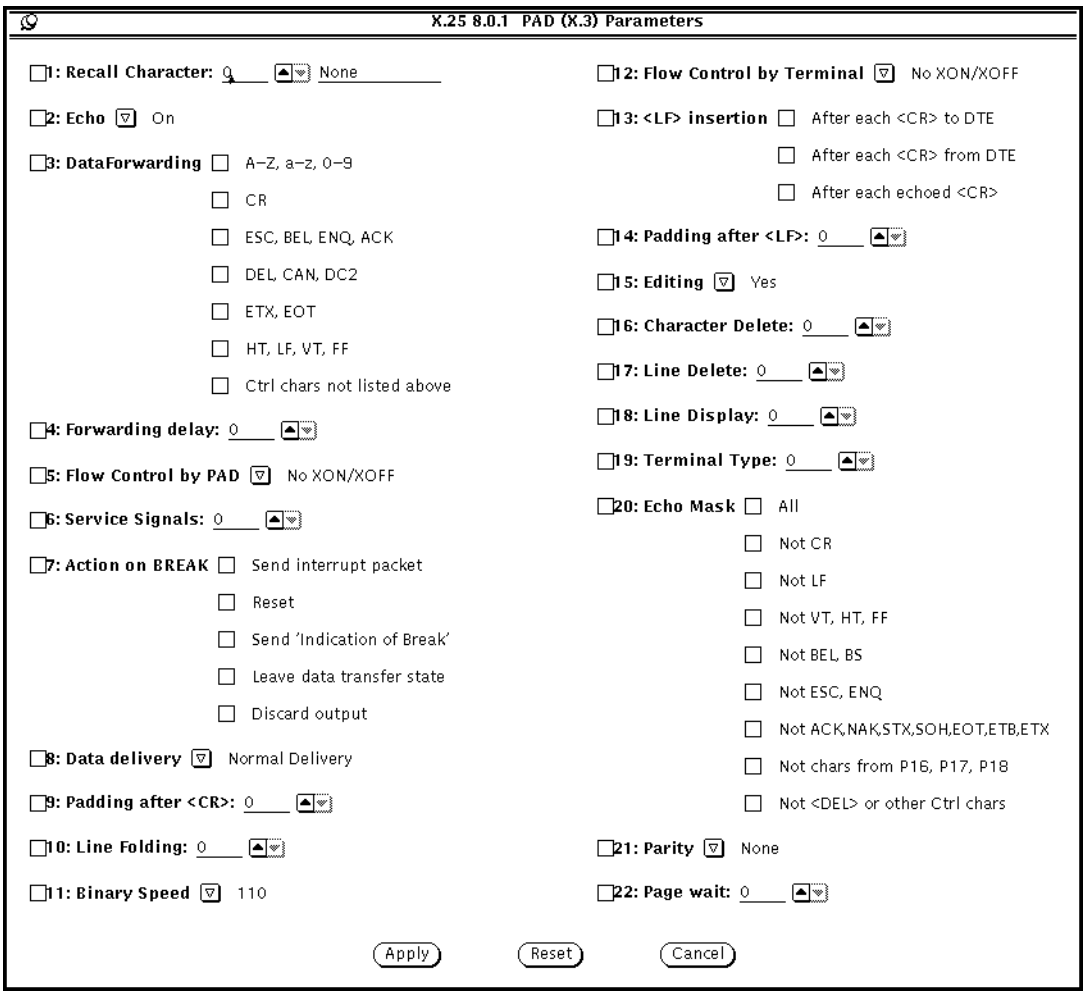

Figure 2-43 The PAD (X.3) Parameters Window

To use the PAD X.3 parameters window, click SELECT on a check box for a given parameter, then specify—by check box, menu selection, or typing a number—the value you want for that parameter. Leaving a parameter's check box unchecked means that you use the default value for that parameter, as negotiated by the local PAD and remote PAD dæmon (X.29) software. The parameters are:

1:Recall Character

Setting this parameter lets you configure a character to use to switch from the data transfer state to recall the PAD. Use the up and down arrows to scroll through the options. The decimal numbers each represent a different character sequence, as follows:

*Table 2-3*Recall Character Values

decimal value	**character used**
0	none
1	DLE (Ctrl-P)
32 - 126	user defined character

Note – Decimal values 2 to 31 (inclusive) have no effect, and are rejected when you try to Apply them.

2:Echo

If this is set to On, as well as processing characters received itself, the Pad echoes them back to the terminal.

3:Dataforwarding

The Dataforwarding characters tell the Pad that it has received a complete packet sequence, which it should assemble and forward. Choose the character sequence you want to use from the list. If your PSDN has supplied you with a numerical value, you need to find out which character sequences it defines.

4:Forwarding Delay

The Pad waits for this interval after receiving the last character, before assuming that it has received a whole packet, and forwarding it.

5:Flow Control by PAD

Determines the type of flow control used by the Pad on incoming data from the terminal. Make sure that this is the same type as is used by the terminal.

6:Service Signals

Set the decimal value according to the way you want PAD service signals to be handled. The values and possible actions are:

*Table 2-4*PAD Service Signals

Decimal Value	Action
0	no service signals transmitted to start-stop mode DTE
1	service signals, other than the Prompt PAD service signal, are transmitted in standard format
4	prompt PAD service signal transmitted in standard format
8 - 15	PAD service signals transmitted in a network-dependent format

7:Action on BREAK

Determines the PAD's action when it receives a break signal. Choose from the list of available options. If your PSDN has supplied you with a numerical value, you need to find out which break action it represents.

8:Data Delivery

Choose the value you want.

9:Padding after <CR>

This lets you set the PAD to insert padding characters in the character stream after the occurance of a carriage return. This lets the terminal process the carriage return correctly.

10:Line Folding

Determines how often the Pad inserts a Line Feed followed by a Carriage Return. In effect, this sets the line length for your terminal.

11:Binary Speed

This displays the speed of the line connecting the Pad and the terminal. You cannot change this parameter.

12:Flow Control by Terminal

Defines the type of flow control used by the terminal on incoming data from the Pad.

13<LF> Insertion

Determines when the PAD will insert a Line Feed character. This is only relevant when the PAD is in data transfer state. If your PSDN has supplied you with a numerical value, you need to find out which action it represents.

14:Padding after <LF>

This lets you set the PAD to insert padding characters in the character stream after the occurance of a line feed. This lets the terminal process the carriage return correctly.

15:Editing

This provides for local editing during the data transfer state as well as during the command state.

16:Character Delete

This determines the ASCII character used as the Character Delete key. Enter the appropriate ASCII number.

17:Line Delete

This determines the ASCII character used as the Line Delete key. Enter the appropriate ASCII number.

18:Line Display

This determines the ASCII character used to redisplay a line. Enter the appropriate ASCII number.

19:Terminal Type

You need to specify whether you are using a video or hardcopy terminal. The affects how the Pad handles deletions.

20:Echo Mask

Choose the approprate echo mask, from the list of available values. If your PSDN has supplied you with a numerical value, you need to find out which mask it represents.

21:Parity

The only available value is None.

22:Page Wait

The Pad halts the display after the number of lines you specify here. Pressing the space bar displays the next “page” of data.

2.4.2 IP Configuration

Use the IP over X.25 Configuration window to configure the local network map, the listen information and the remote IP host to X.25 Address Map. This section describes each in turn.

The complete IP over X.25 Configuration window looks like this:

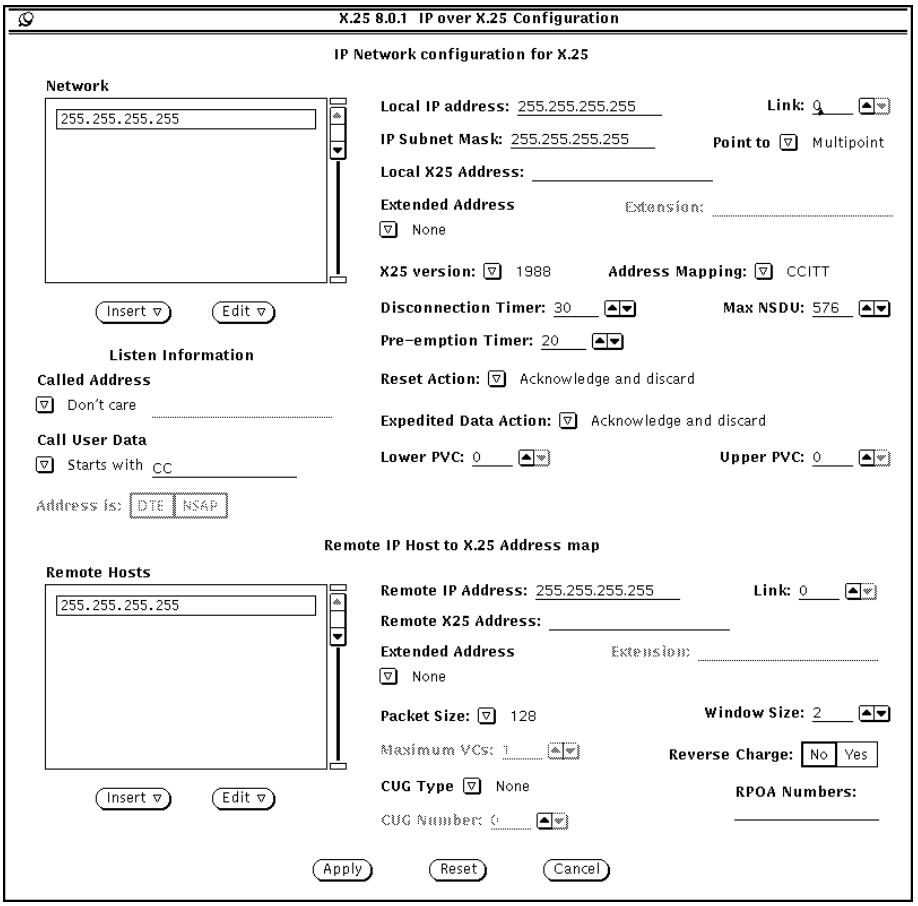

Figure 2-44 IP over X.25 Configuration Window

Use the menu in the top left hand corner to choose the network you want to configure.

2.4.2.1 *Configuring your Local Network*

The top right-hand section of the screen contains the parameters you need to modify to allow IP to run over your X.25 network:

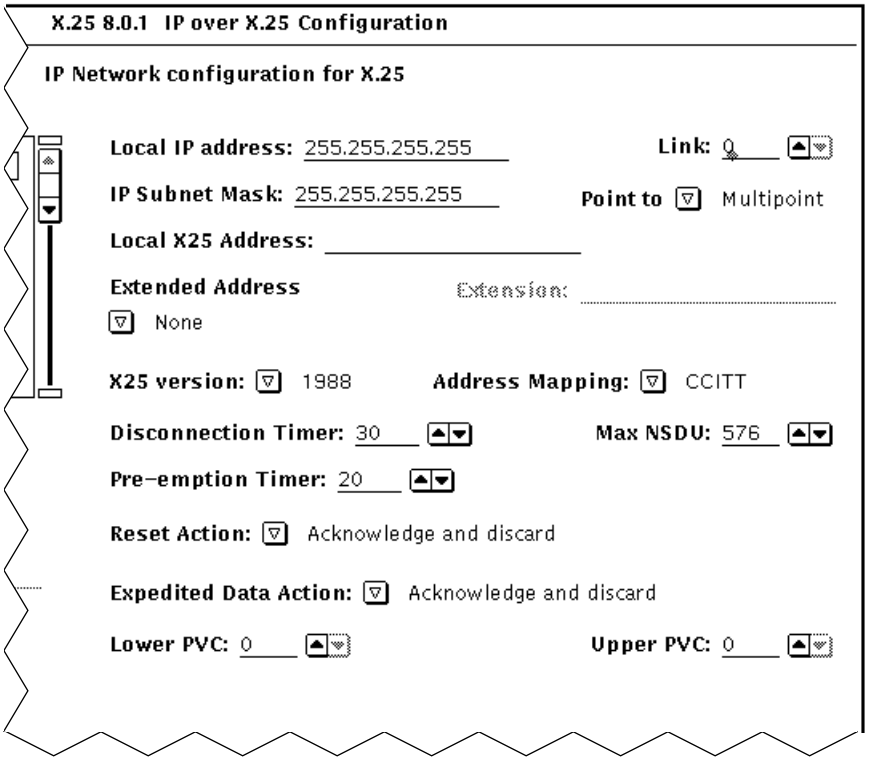

Figure 2-45 IP Network Configuration Parameters

Listed below are descriptions of individual items under the heading “IP Network configuration for X.25”. After you specify values or accept defaults for a given IP network, click SELECT on Insert to add the network to the list in the upper left corner of the window. Click MENU on Edit to view options to delete or rearrange items in the list of networks.

Local IP address

Enter an IP address in either name or numeric form (IP "dot" notation, for example, 129.144.0.0).

Link

Enter a link number specifying the link over which you reach the IP network specified in the preceding parameter. Enter the link number by typing it in or by clicking SELECT on the up or down buttons until the window displays the correct number.

Point to

Press MENU and drag the mouse to choose between point-to-multipoint and IP Subnet Mask or Remote IP Address.

IP Subnet Mask/Remote IP Address

For point-to-multipoint networks, this is "IP Subnet Mask"; for point-to-point networks, the item is "Remote IP Address".)

For *IP Subnet Mask*: The mask number used in the specified IP network, expressed in IP dot notation. For example: 255.255.255.0, for a Class C subnetwork mask. Enter + to use the local default.

For *Remote IP Address*: The IP address, in name or numeric form, for the host at the remote end of the point-to-point connection.

Local X25 Address

Your local X.25 (X.121) address, as you specified it in the DTE Address item in the X.25 Interface Configuration window. You do not need to enter this if you are using one of the DDN services, but you may find it convenient to do so, as this allows the system to use any packet and window sizes you set using this window.

Extended Address

Specify an extended address option (None [the default], OSI, or non-OSI).

Extension

If you are using extended addressing, enter the OSI NSAP address or non-OSI address extension. An OSI NSAP address is 40 or fewer hexadecimal digits.

X25 version

If the X.25 version supported by the remote network is not 1988 (the default), choose the appropriate year.

Address Mapping

Choose between CCITT, DDN Basic and DDN Standard. These options are alternative ways of mapping between IP and X.25 addresses.

Disconnection Timer

This is the time in tenths of a second that a connection to a given network can remain idle before being closed. This timer is configurable for each X.25 network to which you connect. When the disconnection timer expires, if there is no data on a connection, the virtual circuit to the X.25 network is closed. If data arrives from IP after this, the circuit is reopened.

When setting this timer, take account of the amount of traffic on your link and the speed your link runs at. The default is suitable for links running at 9600 bps.

Pre-emption Timer

This is the time in seconds that a connection must have been open before it can be closed (pre-empted). If all X.25 virtual circuits available to IP are in use and an IP packet arrives for transmission to a new destination, SunLink X.25 closes one of the existing connections—the one that has been idle the longest. The pre-emption timer determines the minimum time a connection must be open before it can be pre-empted in this way.

When setting this timer, take account of the amount of traffic on your link and the speed your link runs at. The default is suitable for links running at 9600 bps.

Max NSDU

SunLink X.25 tries to concatenate X.25 packets that have the M-bit set into a single network service data unit (NSDU). When the NSDU size exceeds the setting of this parameter, concatenation stops and SunLink X.25 passes the packet up to IP.

Reset Action

If the default reset action of Acknowledge and discard is not appropriate for your installation, press or click MENU in the Reset Action abbreviated menu button. The options are:

- Acknowledge and discard: Acknowledge Reset Request packet and discard it.
- Disconnect: Causes a Clear Request packet to be sent to remote host

Expedited Data Action

For expedited data, the menu options are defined as follows:

- Acknowledge and discard: Acknowledge expedited data and discard its.
- Disconnect: Disconnect connection in response to expedited data.
- Reset connection: Reset connection in response to expedited data.

Lower PVC and *Upper PVC*

If you use PVCs to connect to the remote IP network, enter the highest (in Upper) and lowest (in Lower) numbers in the range of PVC channels. Enter a number by typing it in or by clicking SELECT on the up or down buttons until the window displays the number you want.

2.4.2.2 *Listen Information*

This section describes the Listen Information parameters. They are in the center-left of the IP over X.25 Configuration window:

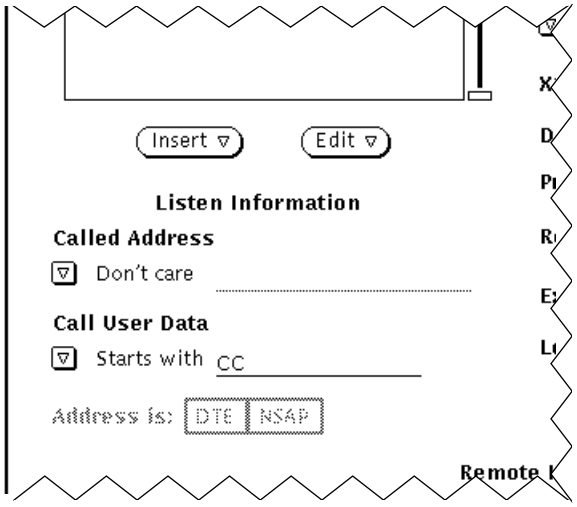

Figure 2-46 Listen Information Parameters

Listed below are descriptions of individual items under the heading "Listen Information" in the IP over X.25 Configuration window.

Called Address

Specifies the pattern of digits the SunLink X.25 uses to match the called address on incoming calls for IP. The options are:

- Starts with: SunLink X.25 accepts calls from callers that have called addresses that have leading digits that match the string of digits you enter here.
- Matches: SunLink X.25 accepts calls from callers that have called addresses that exactly match the string of digits you enter here.
- Don't care: SunLink X.25 accepts calls from any caller, regardless of its called address.

If you choose "Starts with" or "Matches", enter a string of digits to be matched.

Call User Data

Specifies the pattern of digits the SunLink X.25 uses to match the Call User Data on incoming calls for IP. Press or click MENU in the abbreviated menu button to receive a menu of the same options available for Called Address, shown in “Called Address” on page 2-78. These options are explained under Called Address, above.

The default of “Starts with” CC is the standard Call User Data value for IP over X.25 as specified in RFC 877. If you use a non-standard value or do not use Call User Data to identify X.25 packets bound for IP, release MENU or click SELECT to choose the option you want. If you choose “Starts with” or “Matches”, enter a string of digits to be matched.

Address is:

Choose between DTE and NSAP. This item indicates whether the Called Address (see above) is a DTE or an NSAP address.

Once you have configured all of these parameters, go on and configure the Address Map.

2.4.2.3 *Remote IP Host to X.25 Address Map*

This section describes the parameters that configure the IP Host to X.25 Address Map. These are in the bottom third of the screen:

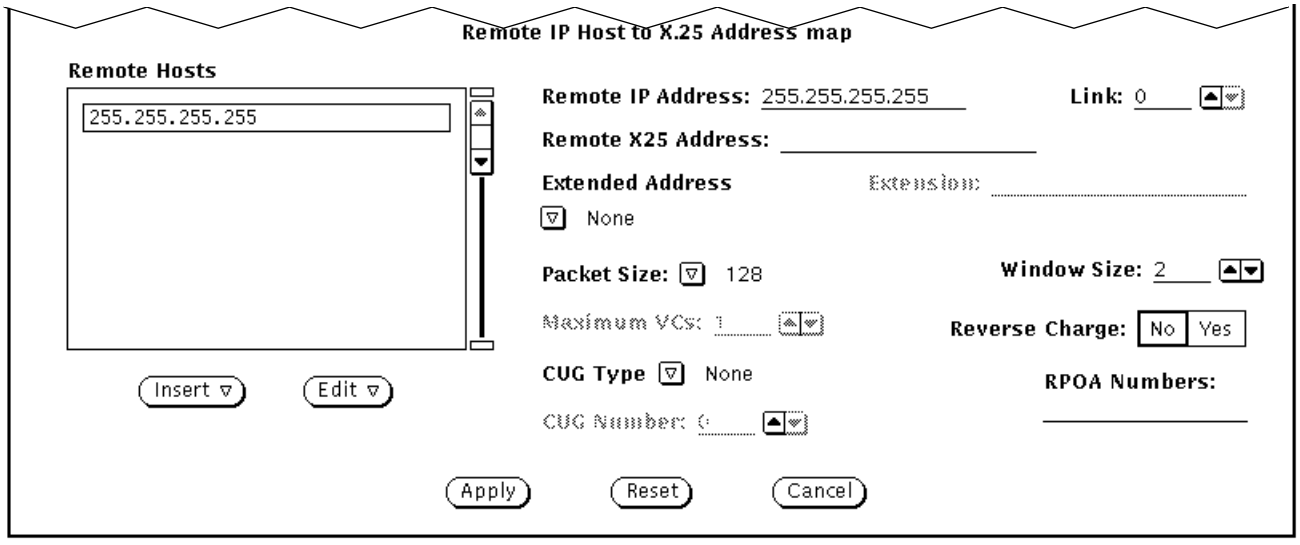

Figure 2-47 Remote IP Host to X.25 Address Map Parameters

Listed below are descriptions of individual items under the heading “Remote IP Host to X.25 Address Map” in the IP over X.25 Configuration window. After you specify values or accept defaults for a given IP host, click SELECT on Insert to add the host to the list in the upper left corner of the window. Click MENU on Edit to view options to delete or rearrange items in the list of hosts.

For each remote host with which you intend to exchange IP packets, enter:

Remote IP Address

Enter the IP address of the remote IP host, in either hostname or numeric form (IP “dot” notation, for example, 129.144.31.145).

Remote X25 Address

Enter the X.25 (X.121) address of the specified remote host. If you are attached to the DDN, the X.25 address is generated using the IP address. You do not need to enter it here, although if you do other information you enter can be taken into account. If you do want to enter the X.25 address, you need to calculate it in the same way as the DDN software.

Link

Enter a link number specifying the link over which you reach the specified host.

Extended Address

If you are using extended addressing, choose between OSI, or non-OSI).

Extension

If you are using extended addressing, enter the OSI NSAP address or non-OSI address extension. An OSI NSAP address is 40 or fewer hexadecimal digits.

Packet Size

Size of the X.25 packet that will carry IP datagrams. In accordance with RFC 877, when IP datagrams are longer than the X.25 packet size, SunLink X.25 uses the M-bit to transmit the datagrams as complete packet sequences. Fragmentation of IP datagrams occurs only if the size of an IP packet exceeds the maximum transmission unit (MTU) size for a given subnetwork.

Window Size

This parameter applies to calls in both directions and should not be larger than the window size value you specified for X.25.

Maximum VCs

In the current release, the only valid value for this parameter is 1, because only one virtual circuit is supported per logical IP link.

Reverse Charge

Determines whether the software will propose calls to the remote with reverse-charging requested (that is, the remote host pays).

CUG Type

If your host is a member of a Closed User Group, choose the appropriate CUG type.

CUG Number

If your host is a member of a multi-user or bilateral CUG, enter the CUG number by typing it in or by clicking SELECT on the up or down buttons until the window displays the correct number.

RPOA Numbers

A four-digit number that provides networks between you and the remote host with additional routing information. You can have up to four RPOA numbers. Enter RPOA numbers on the line shown below. If you have multiple RPOA numbers, enter them together in the same sequence of digits, with no spaces between.

When you are happy with the values you have set, click on Apply.

2.5 Advanced Configuration

This section covers the “fine-tuning” kernel and device parameters of the SunLink X.25 product. Most configurations do not need these parameters: the system defaults are adequate for most installations. However, you do need these parameters if you plan to run SunLink X.25 over an interface other than a CPU serial port or the Ethernet interface that is shipped with your machine. Section 2.5.1, “Device Parameters,” on page 2-83 covers this condition.

2.5.1 Device Parameters

Parameters in the Device Parameters window specify the number of hardware cards you have installed in your system. Use this window to specify only those cards over which you plan to run SunLink X.25.

Choose “Device...” to display the Device Parameters window:

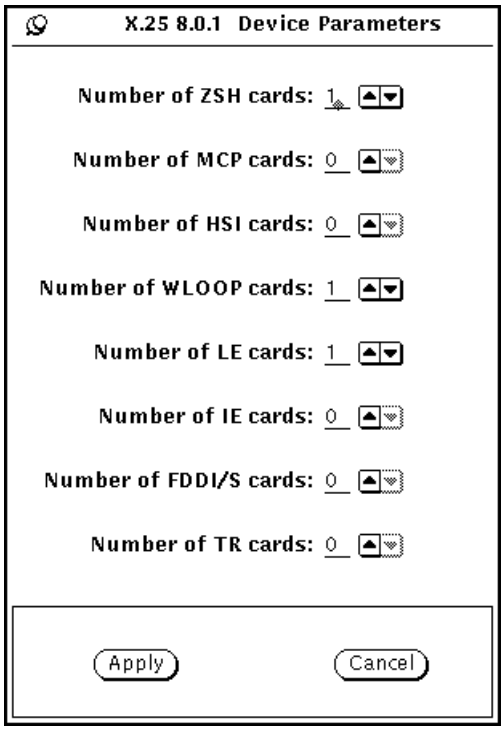

Figure 2-48 Device Parameters Window

The default for the ZSH, WLOOP, and LE cards is 1. If you plan to run SunLink X.25 only over your CPU serial port (`zsh0` or `zsh1`), there is no benefit to changing LE to 0. (Specifying 1 when you have no cards has no effect on your system performance.)

If you plan to run SunLink X.25 over one of the optional interfaces, you must enter the number of interfaces (cards) you intend to use. (Specifying 0 when you plan to use a card for X.25 makes it impossible to configure that interface.)

The following are the devices listed in the Device Parameters window:

- ZSH refers to the CPU serial port(s) that are standard on your machine.
- HSI refers to the SunLink HSI/S SBus card.
- WLOOP refers to the loopback interface, which can be used for troubleshooting. A single WLOOP interface supports one pair of loopback links, as configured in the Define/Modify interfaces➤Interface Configuration window.
- LE refers to the Ethernet driver and interface that is standard with most Sun SPARC machines.
- IE refers to an Ethernet driver and interface that is shipped with some Sun-4 model machines.
- FDDI/S refers to the SunLink FDDI/S SBus card.
- TR cards refers to the SunLink TRI/S Token Ring card.

2.5.2 Kernel Parameters

Parameters in the Kernel Parameters window determine the amount of memory allocated for the various modules that make up SunLink X.25.

Choose “Parameters...” to display:

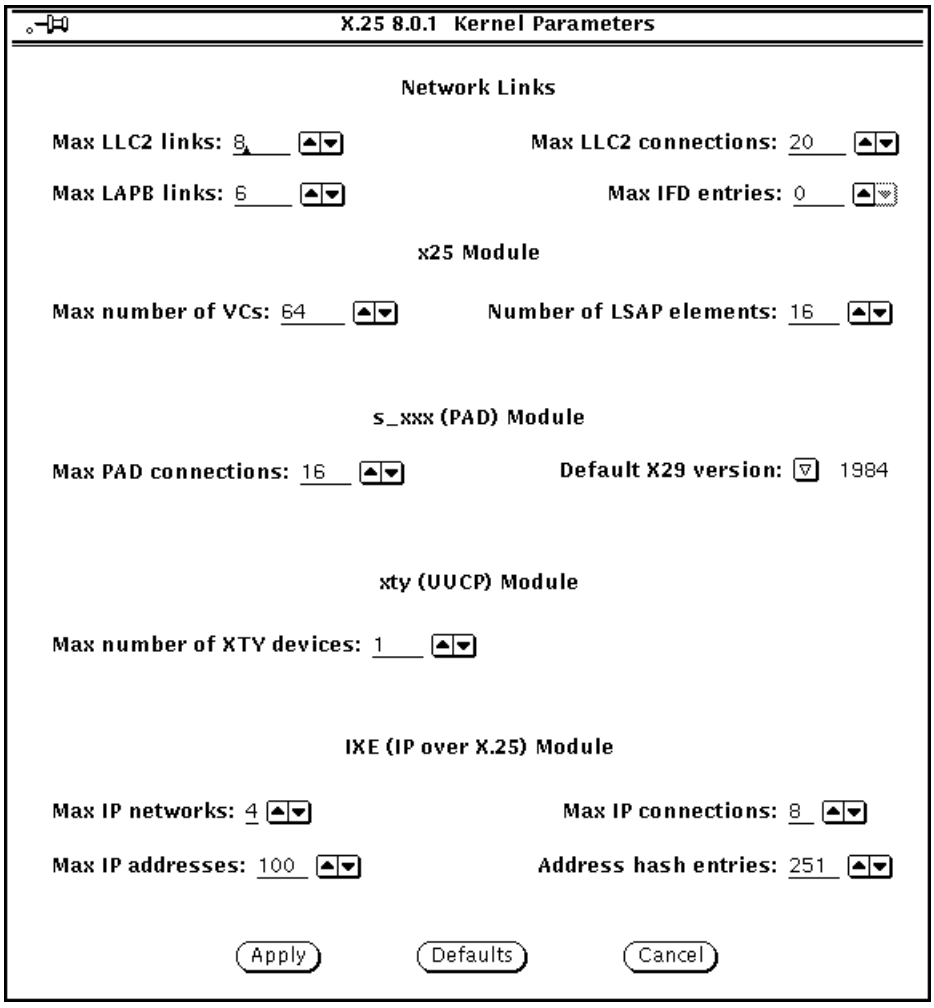

Figure 2-49 Kernel Parameters Window

Listed below are the parameters in the Kernel Parameters window. Values for all of the parameters except the Default X.29 version are decimal integers

2.5.2.1 Network Links

Max LLC2 devices

Maximum number of LLC2 links that you can configure.

Max LLC2 connections

Maximum number of LLC2 connections that can be established. As there can be one LLC2 connection for each host, this is equivalent to the maximum number of hosts to which you can simultaneously connect.

Max LAPB links

Maximum number of LAPB links that you can configure. You can have up to 61 links.

Max IFD entries

The number of `/dev/ifd` entries you need for the HDLC interface. This parameter is only relevant if you are making use of the HDLC interface for reasons of compatibility with SunNet X.25 7.0.

2.5.2.2 x25 Module

Max number of VCs

Maximum number of virtual circuits that you can run simultaneously.

Number of LSAP elements

Maximum number of layer 2 connections allowed. You need one connection for each LAPB link and one connection for each LLC2 connection.

2.5.2.3 s_xxx (PAD) Module

Max PAD connections

Maximum number of virtual circuits used for PAD calls. This must be less than or equal to the "Max number of VCs" parameter, above.To work out the value to set, add together the number of of xty devices you set above and the number of simultaneous PAD calls you anticipate your system making and receiving. The value you set here should be four higher than this number.

Default X29 version

Refers to the version of the local PAD dæmon. If the default of 1984 is not correct for you, choose 1980 or 1988.

2.5.2.4 xty (UUCP) Module

Maximum number of XTY devices

Maximum number of outgoing `uucp` connections. You need to configure this, to be able to work with both `uucp` and `tip`. The `xty` device behaves like a `tty` device, but is used only for outgoing calls. Incoming calls are handled directly by the PAD dæmon which executes the login process. Refer to the chapter on configuring `uucp` and `tip` in the *SunLink X.25 8.0.2 Configuration Guide*. Make sure that the value you set for Max PAD Connections is at least four greater than the value you set here.

2.5.2.5 IXE (IP over X.25) Module

Max IP networks

Maximum number of networks that can be configured under IP. The presence of each IP network is indicated by an entry for an `ixe` device in the output from the `ifconfig -a` command.

Max IP connections

Maximum number of X.25 virtual circuits that IP connections are routed over.

Max IP addresses

Maximum number of addresses in the X.25/IP address-mapping table.

Address hash entries

The value of this parameter must be greater than twice the value of the Max IP addresses value and must be a prime number.

The X.25 Routing Configuration File 3

Note – The material here is provided for reference purposes. Use the `x25tool` program, described in the *SunLink X.25 8.0.2 Configuration Guide* and in Chapter 2, “Configuration Reference”, unless you do not have access to Open Windows.

SunLink X.25 supports routing on full or partial Address Extension Facilities (AEFs) or X.121 addresses. AEFs can be OSI NSAP addresses or non-OSI addresses. This chapter describes the syntax for the SunLink X.25 routing file, which is input to the `/opt/SUNWconn/bin/x25route` command. This chapter also describes the syntax for `x25route`, which is used to add routes from the X.25 routing configuration file and perform other routing-related operations.

3.1 Routing File Syntax and Routing Algorithms

The SunLink X.25 routing configuration file is an ASCII text file that is input to the `x25route` command (see Section 3.2, “The x25route Command”). By default, the routing file is stored in `/etc/SUNWconn/x25`, with other SunLink X.25 configuration files.

The routing configuration file supports entries for:

- AEF routes
- X.121 address routes

For AEF and X.121 address routes, there are the following entries:

- `aef_host`
- `aef_prefix`
- `aef_default`
- `x121_host`
- `x121_prefix`
- `x121_default`

These entries are described in detail in the following subsections. The order of these entries is not significant within the file. Each entry occupies a single line. You can extend an entry to a second line by using the backslash (\) at the end of the line being extended. Precede comments with a hash mark (#) in the first column.

There is a sample routing file, `routes.sample`, stored in `/etc/SUNWconn/x25`, which contains examples of the routing entries described here.

3.1.1 AEF Routes

SunLink X.25 uses AEF routing entries if a Call Request has a called AEF and no called X.121 address. When SunLink X.25 finds a matching entry, it inserts the address present in the entry and routes to the link, also specified in the entry.

There are three types of entries associated with AEF routes, `aef_host`, `aef_prefix`, and `aef_default`. SunLink X.25 searches these entries in the order just listed.

1. SunLink X.25 searches for an exact match between the called AEF and the AEF specified in `aef_host` entries.

2. If SunLink X.25 does not find a match among `aef_host` entries, it searches `aef_prefix` entries, starting with the longest entries and working toward the shortest. SunLink X.25 uses the first, longest match it finds.
3. If no match is found among `aef_prefix` entries, SunLink X.25 uses the link specified in the `aef_default` entry. The `aef_default` entry matches any called AEF. You can have only one such entry.
4. If there is no `aef_default` entry, SunLink X.25 routes the call to the lowest-numbered WAN link.

In AEF routing entries, you can specify X.121 and MAC or SNPA addresses. If you supply both an X.121 and a MAC (or SNPA) address, SunLink X.25 inserts both addresses in the Call Request.

3.1.1.1 `aef_host` *Entries*

An `aef_host` entry has the following general form:

```
aef_host aef_addr IF_id [X.121_addr] [MAC_addr] [pid]
```

Following the `aef_host` keyword, the components of an `aef_host` entry are as follows:

aef_addr
A complete OSI NSAP address, of 40 or fewer hexadecimal digits.

IF_id
Corresponds to the value of the Link Number parameter in the Interface Configuration window in `x25tool`.

X.121_addr
An X.121 address of 14 or fewer decimal digits that starts with the string `X.121=`. Normally, you do not use an X.121 address if you are connected to a LAN.

MAC_addr
Either an 802.*x* SNPA address (MAC address, plus LSEL) or a MAC address. For an SNPA address, precede the address with the string `802=`. For a MAC address, use `MAC=`. MAC addresses are expressed in hexadecimal digits with

a colon between each of six bytes. An LSEL (two hexadecimal digits), if present, is preceded by a comma, following the last byte of the MAC address.

If you use a MAC, rather than an SNPA, address, SunLink X.25 appends the LSAP provided in the Local SAP parameter in the Interface Configuration window in `x25tool` for the link specified in the *IF_id* field of this entry. You do not use a MAC or SNPA address if you are using LAPB links.

pid
The protocol identifier (pid) of no more than five bytes (10 decimal digits). You precede the pid digits with the string `PID=`

The following are example `aef_host` entries:

```
aef_host 37000070755512120000342100 1 X.121=8881217070 MAC=08:00:00:aa:11:11 PID=1234
aef_host 370000000888111100223300 2 802=08:11:22:aa:cc:55,7e
```

Note that the first entry contains an X.121 address, a MAC address, and a pid, while the second address contains only an SNPA address.

3.1.1.2 `aef_prefix` Entries

An `aef_prefix` entry has the following general form:

```
aef_prefix aef_prefix IF_id [X.121_addr] [MAC_addr] [pid]
```

Following the `aef_prefix` keyword, the fields in an `aef_prefix` entry are identical to the fields in an `aef_host` entry, except that an `aef_prefix` has an address prefix (*aef_prefix*, above) rather than a complete address.

An *aef_prefix* is a set of digits that is the leading digits of an AEF.

The following are example `aef_prefix` entries:

```
aef_prefix 37002233 1 X.121=8881217070 MAC=08:00:00:aa:11:11 PID=1234
aef_prefix 370000555 2 802=08:11:22:aa:cc:55,7e
```

Note that the first entry contains an X.121 address, a MAC address, and a pid, while the second address contains only an SNPA address.

3.1.1.3 `aef_default` Entry

The single `aef_default` entry has the following general form:

```
aef_default IF_id [X.121_addr] [MAC_addr] [pid]
```

The `aef_default` entry is the same as the `aef_host` and `aef_prefix` entries, except that an `aef_default` entry does not have an address (*aef_addr*) or an address prefix (*aef_prefix*).

The following is an example `aef_default` entry:

```
aef_default 1 X.121=8881217070 MAC=08:00:00:aa:11:11 PID=1234
```

In the entry above, note the omission of an address or prefix.

3.1.2 X.121 Address Routes

SunLink X.25 uses X.121 address routing entries if a Call Request has a called X.121 address. When SunLink X.25 finds a matching entry, it inserts the addresses present in the entry and routes to the link specified in the same entry.

There are three types of entries associated with X.121 address routes, `x121_host`, `x121_prefix`, and `x121_default`. SunLink X.25 searches these entries in the order given above.

1. SunLink X.25 searches for an exact match between the called X.121 address and the X.121 address specified in `x121_host` entries.
2. If SunLink X.25 does not find a match among `x121_host` entries, it searches `x121_prefix` entries, starting with the longest entries and working toward the shortest. SunLink X.25 uses the first, longest match it finds.
3. If no match is found among `x121_prefix` entries, SunLink X.25 uses the link specified in the `x121_default` entry. The `x121_default` entry matches any called X.121 address. You can have only one such entry.

4. If no routing entries match (indicating there is no `x121_default` entry in the routing file), SunLink X.25 checks the DNIC in the DTE or DCE Address parameter, as specified in the Interface Configuration window in `x25tool`. SunLink X.25 performs this check for each LAPB link, looking for a match with the DNIC in the called X.121 address. If it finds a match, SunLink X.25 routes the call to the link where the DNIC match was found. The link is specified in the Link Number parameter in the Interface Configuration window in `x25tool`.
5. If no DNIC match is found, SunLink X.25 routes the call to the lowest-numbered LAPB link.

In X.121 address routing entries, you can specify MAC or SNPA addresses if the routing entry specifies a LAN interface.

3.1.2.1 `x121_host` Entries

An `x121_host` entry has the following general form:

```
x121_host X.121_addr IF_id [MAC_addr]
```

Following the `x121_host` keyword, the components of an `x121_host` entry are as follows:

X.121_addr
A complete X.121 address, of 14 or fewer decimal digits. You do not precede the X.121 address with the string `X.121=`.

IF_id
Corresponds to the value of the Link Number parameter in the Interface Configuration window in `x25tool`.

MAC_addr
Either an 802.*x* SNPA address (MAC address, plus LSEL) or a MAC address. For an SNPA address, precede the address with the string `802=`. For a MAC address, use `MAC=`. MAC addresses are expressed in hexadecimal digits with

a colon between each of six bytes. An LSEL (two hexadecimal digits), if present, is preceded by a comma, following the last byte of the MAC address.

If you use a MAC, rather than an SNPA, address, SunLink X.25 appends the LSEL provided in the Local SAP parameter in the Interface Configuration window in `x25tool` for the link specified in the <*IF_id*> field of this entry. You do not use a MAC or SNPA address if you are using LAPB links.

The following are example `x121_host` entries:

```
x121_host 7075551212 1 MAC=08:00:00:aa:11:11
x121_host 8881111002233 2
```

Note that the first entry contains an X.121 address and a MAC address, while the second address contains only an X.121 address.

3.1.2.2 `x121_prefix` Entries

An `x121_prefix` entry has the following general form:

```
x121_prefix x121_prefix IF_id [MAC_addr]
```

Following the `x121_prefix` keyword, the fields in an `x121_prefix` entry are identical to the fields in an `x121_host` entry, except that an `x121_prefix` has an X.121 address prefix (*x121_prefix*, above) rather than a complete X.121 address. This prefix is *not* preceded by the string `X.121=`.

An *x121_prefix* is a set of digits that is the leading digits of an X.121 address. You do not precede the X.121 address prefix with the string `X.121=`.

The following are example `x121_prefix` entries:

```
x121_prefix 8881217070 1 MAC=08:00:00:aa:11:11
x121_prefix 12340000555 2
```

Note that the first entry contains an interface identifier and a MAC address, while the second address contains only the interface identifier.

3.1.2.3 `x121_default` Entry

The single `x121_default` entry has the following general form:

```
x121_default <IF_id> [<MAC_addr>]
```

The `x121_default` entry is the same as the `x121_host` and `x121_prefix` entries, except that an `x121_default` entry does not have an X.121 address (*X.121_addr*) or an X.121 address prefix (*X.121_prefix*).

The following is an example `x121_default` entry:

```
x121_default 1 MAC=08:00:00:aa:11:11
```

In the entry above, note the omission of an X.121 address or prefix. The inclusion of a MAC or SNPA address is optional.

3.2 The `x25route` Command

Use the `x25route` command to add the routes specified in your routing configuration file. `x25route` can also display run-time routing configuration information.

The command has the following syntax:

```
# /opt/SUNWconn/x25/bin/x25route -s [interval]
# /opt/SUNWconn/x25/bin/x25route [-f] [routing_file]
```

The options and arguments to this command are:

`-s`
Show all routes, including number of packets using each entry. An example of this option is shown below.

interval
An interval (number of seconds) at which `x25route` updates its display when you invoke the `-s` option. This is useful for observing the degree of use of a particular routing entry.

`-f`

Flush all routes. You can use this option in combination with a routing file. With this combination, `x25route` flushes all routes, *then* adds the routes from the routing file.

routing_file

The full pathname of a routing configuration file, as that file is described in Section 3.1, “Routing File Syntax and Routing Algorithms,” on page 3-1. When invoked with this argument, `x25route` adds the routes contained in the specified file.

The following example shows an example routing file and the resulting output from a `x25route -s` command.

```
hostname% cat /etc/SUNWconn/x25/routes
# sample X.25 routing file
aef_host  571111404238510000    0
aef_host  370000404238510000   0  X.121=2345654367 MAC=08:00:20:12:34:56 PID=1234
aef_host  37000040423851000abcdef00  1  802=08:00:20:78:90:12,7e
x121_host 311067895401          0
x121_host 6789543267            1       802=1:2:3:4:5:6,7e
```

Tabs are included above only to improve readability.

```
hostname# x25route -f /etc/SUNWconn/x25/routes
hostname% x25route -s
Type Host/prefix Link X.121 MAC PID Use
XH 311067895401 0 0
XH 6789543267 1 01:02:03:04:05:06,7e 300
AH 571111404238510000 0 0
AH 370000404238510000 0 2345654367 08:00:20:12:34:56 1234 0
AH 37000040423851000abcdef00
1 08:00:20:78:90:12,7e 0
SO 37000012988841417777 164
SP 360000 0
SN 876a7fc9867e0
hostname%
```

The fields in the `x25route` display are as follows:

`Type`
Indicates the type of routing file entry. These entries are described in Section 1.1. The letters in the `Type` field are defined as follows:

`A*`
AEF entry

`X*`
X.121 address entry

`*H`
host entry

`*P`
prefix entry

`*D`
default entry

`Host/prefix`
Contains the AEF, or the X.121 or non-OSI address or address prefix.

`Link`
Contains the link number. This corresponds to the interface identifier for a routing file entry.

`X.121`
Contains an X.121 address, if present for a particular entry.

`MAC`
Contains a MAC or SNPA address, if present for a particular entry. (MAC addresses have six bytes; SNPA addresses have a seventh byte following a comma.)

`PID`
Contains a protocol identifier, if present for a particular entry.

`Count`
Displays the number of Call Request packets for which SunLink X.25 used a given entry.

Troubleshooting 4

This chapter contains information for troubleshooting possible problems with SunLink X.25. Section 4.5, “Resolving Common Problems,” on page 4-30 provides troubleshooting procedures for the most common SunLink X.25 problems. Check this section first to see if the procedures solve the problem. Otherwise, follow the complete troubleshooting procedure. In general it is best to take a “bottom up” approach to troubleshooting. The tests in this chapter are described in that order.

In summary, check:

- **The Physical layer**:
  Hardware
  Line status

- **The Datalink layer**
  Packet and link-level traces
  Protocol statistics
  Trace information
  Streams error messages
- **The Network Layer:**
  Protocol status
  Connectivity
  Network addresses
  Local routing tables
  Permissions
  Remote operations
  NIS operations (if applicable)

Perform the checks in the order given above.

You may also find it useful to perform a loopback test, to check your local configuration down to the link layer, and to perform a back-to-back test, to test your configuration against that of another machine. See the chapter on loopback testing in the *SunLink X.25 8.0.2 Configuration Guide* for instructions on performing these tests.

4.1 Checking the Physical Layer

First of all make sure that all of your modem and power cables are in good working order, and that they are all plugged-in, switched on, and tightly seated. Then carry out loopback tests. Finally, check the line status.

If you are using the onboard serial port, the most thorough hardware test you can do is to use `syncloop`, progressing through `test_type` options 1 through 3. If you are using a high speed interface, the most thorough hardware test you can do is to use `hsi_loop`, progressing through `test_type` options 1 through 3.

To check the line status, use the `syncstat` or `hsi_stat` command to observe the line over periods of ten seconds.

4.1.1 *Checking the Hardware Using* `syncloop`

If you are using the onboard serial port, use the `syncloop` command to perform a loopback test to check the following components of your communications link:

- Software configuration
- Correct operation of the serial port
- EIA-232 ports and cables
- Local and remote modems
- Transmission line

To run `syncloop`, you must have `/usr/sbin` in your path.

When you invoke `syncloop`, it reads incoming packets to check that they were transmitted and received correctly.

Caution – Do not run `syncloop` on a port that is currently being used. Ports in loopback mode cannot communicate with a remote host while `syncloop` is sending and receiving packets. Use `x25tool` to stop X.25 on the port you want to test.

`syncloop` uses the following syntax:

```
hostname# syncloop [options] portname
```

Table 4-1 lists the options for `syncloop`.

Table 4-1 `syncloop` Options

Option	Parameter	Description
-c	*packet_count*	A positive integer specifies the number of packets used for data transfer. The default is 100.
-l	*packet_length*	A positive integer specifies the length of the packet in bytes. The default is 100. The maximum packet length you can specify is 1152.
-s	*line_speed*	Bit rate in bits/sec.

Table 4-1 `syncloop` Options

Option	Parameter	Description
-t	*test_type*	Specifies the test environment.Options 1-4 (see the descriptions of test options in “test_type Options” on page 4-4).
-d	*hex_data_byte*	Specifies a hexadecimal number as the byte content of each packet. The default is for random data to be used.
-v		Sets verbose mode. If data errors occur, the *expected* and *received* data is displayed.

Enter numeric options as decimal numbers (for example, —`t 3`). If you do not specify the `test_type`, `syncloop` prompts for it, like this:

```
hostname# syncloop zsh0
Enter test type:
1: Internal Test
2: Test using loopback plugs
3: Test using local or remote modem loopback
4: Other, previously set, special mode
> 1
```

4.1.1.1 `test_type` Options

There are four `test_type` options. Some of them require equipment. Table 4-2 lists the equipment required for each option:

Table 4-2 Equipment Needed for `test_type` Options

Test Options	Equipment
Option1	None
Option 2	Loopback plug
Option 3	Modem(s)
Option 4	Previous setup

Option 1: Internal Testing

This option uses the internal clocking and internal loopback and runs the following `syncinit` command:

```
syncinit portname speed loop=yes txc=baud rxc=baud
```

The test data packet is sent to the specified serial port and looped back internally. When you are finished with the loopback test, run `syncinit`, specifying the same serial port you specified in your `syncloop` command, and enter `loopback=no` to take the port out of loopback mode.

Option 2: Using Loopback Plugs

This option uses internal clocking and runs the following `syncinit` command:

```
syncinit portname speed loop=no txc=baud rxc=rxc
```

Before using this option, install a loopback plug on the port you want to test. The test data packet loops between the CPU and the specified port through the loopback plug.

Option 3: Using Local or Remote Modem Loopback

This option uses the external clocking set by the modem and runs the following `syncinit` command:

```
syncinit portname speed loop=no txc=txc rxc=rxc
```

Before using this option, configure the local and remote modems for the tests you want. If the local modem is to be the loopback point, set it for local loopback. If the remote modem is the loopback point, set the local modem for normal mode and the remote modem for remote loopback.

Testing with a modem in local or remote loopback mode checks the operation of the modem as well as the integrity of the serial port and the external cables. Most modems support local loopback (sometimes called analog loopback) and remote loopback (sometimes called digital loopback). If you can control

modems at both ends of the phone line, you can carry out complete testing using the local SPARCsystem as the traffic generator. To carry out the most comprehensive test, use a local modem in normal mode, the transmission facility, and the remote modem in remote loopback mode.

`syncloop` treats both local and remote modem loopback testing the same way, since the modem provides the clocking in both cases. Whether the data is looped back through the local or remote modem depends on how the modem is set up. If the test fails on remote modem loopback, but succeeds on local modem loopback, check the phone line and the setup of both modems.

Option 4: Using Previously Set Mode

There is no automatic `syncinit` execution with this option. This allows you to use `syncinit` before running `syncloop` to specify clocking and loopback options for the port that are not possible with the other `syncloop` test options. After you complete the test using this option, you might need to run `syncinit` again to restore parameter settings appropriate for your use of the serial port.

4.1.1.2 `syncloop` *Output*

When the loopback test runs successfully, using any of the `test_type` options, `syncloop` reports the statistics shown in the following sample output:

```
hostname# syncloop zsh0
Enter test type:
1: Internal Test
2: Test using loopback plugs
3: Test using local or remote modem loopback
4: Other, previously set, special mode
> 1
speed=9600, loopback=yes, nrzi=no, txc=baud, rxc=baud
[ syncinit mcph1 9600 loop=yes txc=baud rxc=baud ]
[ checking for quiet line ]
[ Trying first packet ]
[ Trying many packets ]
100 packets sent, 100 received
0 CRC errors, 0 aborts, 0 overruns, 0 underruns
estimated line speed = 9476 bps
```

4.1.2 *Checking the Hardware Using* `hsi_loop`

If you are using a high speed interface, use the `hsi_loop` command to perform a loopback test to check the following components of your communications link:

- Software configuration
- CPU-to-card communication
- Correct operation of the serial port
- EIA-449 or EIA-232 ports and cables
- Local and remote modems
- Transmission line

To run `hsi_loop`, you must have `/opt/SUNWconn/hsis/utilities` in your path.

Caution – Do not run `hsi_loop` on a port that is currently being used. Ports in loopback mode cannot communicate with a remote host while `hsi_loop` is sending and receiving packets. Use `x25tool` to disable the port you want to test.

`hsi_loop` uses the following syntax:

```
hostname# hsi_loop [options] portname
```

Table 4-3 lists the options for `hsi_loop`

Table 4-3 `hsi_loop` Options

Option	Parameter	Description
-c	*packet_count*	A positive integer specifies the number of packets used for data transfer. The default is 100.
-l	*packet_length*	A positive integer specifies the length of the packet in bytes. The default is 100. The maximum packet length you can specify is 1152.
-s	*line_speed*	Bit rate in bits/sec.
-t	*test_type*	Specifies the test environment. Options 1-4 (see the descriptions of test options in "test_type Options" on page 4-9).
-d	*hex_data_byte*	Specifies a hexadecimal number as the byte content of each packet. The default is for random data to be used.

Enter numeric options as decimal numbers (for example, `–t 3`). If you do not specify the `test_type`, `hsi_loop` prompts for it, like this:

```
hostname# hsi_loop hih1
Enter test type:
1: Internal Test
2: Test using loopback plugs
3: Test using local or remote modem loopback
4: Other, previously set, special mode
> 1
```

4.1.2.1 `test_type` Options

There are four `test_type` options. Some of them require equipment:

Table 4-4 Equipment Needed for `test_type` Options

Test Options	Equipment
Option1	None needed
Option 2	Loopback plug
Option 3	Modem(s)
Option 4	Previous setup

Option 1: Internal Testing

This option uses the internal clocking and internal loopback and runs the following `hsi_init` command:

```
hsi_init portname speed loop=yes txc=baud rxc=baud
```

The test data packet is sent to the specified serial port and looped back internally. When you are finished with the loopback test, run `hsi_init`, specifying the same serial port you specified in your `hsi_loop` command, and enter `loopback=no` to take the port out of loopback mode.

Option 2: Using Loopback Plugs

This option uses internal clocking and runs the following `hsi_init` command:

```
hsi_init portname speed loop=no txc=baud rxc=rxc
```

Before using this option, install a loopback plug on the port you want to test. The test data packet loops between the CPU and the specified port through the loopback plug.

Option 3: Using Local or Remote Modem Loopback

This option uses the external clocking set by the modem and runs the following `hsi_init` command:

```
hsi_init portname speed loop=no txc=txc rxc=rxc
```

Before using this option, configure the local and remote modems for the tests you want. If the local modem is to be the loopback point, set it for local loopback. If the remote modem is the loopback point, set the local modem for normal mode and the remote modem for remote loopback.

Testing with a modem in local or remote loopback mode checks the operation of the modem as well as the integrity of the serial port and the external cables. Most modems support local loopback (sometimes called analog loopback) and remote loopback (sometimes called digital loopback). If you can control modems at both ends of the phone line, you can carry out complete testing using the local SPARCsystem as the traffic generator. To carry out the most comprehensive test, use a local modem in normal mode, the transmission facility, and the remote modem in remote loopback mode.

The `hsi_loop` command treats both local and remote modem loopback testing the same way, since the modem provides the clocking in both cases. Whether the data is looped back through the local or remote modem depends on how the modem is set up. If the test fails on remote modem loopback, but succeeds on local modem loopback, double-check the phone line and the setup of both modems.

Option 4: Using Previously Set Mode

There is no automatic `hsi_init` execution with this option. This allows you to use `hsi_init` before running `hsi_loop` to specify clocking and loopback options for the port that are not possible with the other `hsi_loop` test options. After you complete the test using this option, you might need to run `hsi_init` again to restore parameter settings appropriate for your use of the serial port.

4.1.2.2 `hsi_loop` *Output*

When the loopback test runs successfully, using any of the `test_type` options, `hsi_loop` reports the statistics shown in the following sample output:

```
hostname# hsi_loop hih1
Enter test type:
1: Internal Test
2: Test using loopback plugs
3: Test using local or remote modem loopback
4: Other, previously set, special mode
> 1
speed=9600, loopback=yes, nrzi=no, txc=baud, rxc=baud
[ checking for quiet line ]
[ Trying first packet ]
[ Trying many packets ]
100 packets sent, 100 received
0 CRC errors, 0 aborts, 0 overruns, 0 underruns
estimated line speed = 9476 bps
```

4.1.3 *Checking the Line Status Using* `syncstat`

The `syncstat` command monitors traffic that uses the onboard serial port. You must log in as root, or become superuser, before you can use `syncstat`.

Enter `syncstat` followed by the name of the serial port you want to monitor. For example:

```
hostname# syncstat zsh0
syncstat: control device: /dev/zsh, ppa=1
speed   ipkts opkts undrun ovrrun abort crc isize osize
64673 1355595 160791      0      0     1   3    40   113
```

`syncstat` reports cumulative statistics since system boot time. The `speed` field is the line speed entered in `syncinit`.

Note – To obtain accurate statistics, you must ensure that this value corresponds to the modem clocking speed when clocking is provided by the modem.

The output means:

Table 4-5 `syncstat` Fields

Field	Definition
ipkts	Total number of input packets
opkts	Total number of output packets
undrun	Number of transmitter underrun errors
ovrrun	Number of receiver overrun errors
abort	Number of aborted receive frames
crc	Number of frames received with CRC errors
isize	The average size in bytes of input packets
osize	The average size in bytes of output packets

You can also enter a second parameter indicating a number of seconds. In this case, `syncstat` samples and then displays data for the period you specify. The display below shows an example that updates every 10 seconds:

```
hostname# syncstat zsh0 10

ipkts opkts undrun ovrrun abort crc iutil outil
 12    10      0      0     0   0    5%    4%
 22    60      0      0     0   0    3%   90%
 36     4      0      0     0   1   51%    2%
```

The information about packet size is replaced by information about the percentage line-use for both input and output. If line-use is consistently near 100 percent, you might need a faster link. An overloaded link can cause spurious TCP time-outs. You should also watch for errors on the link. A small percentage of errors can reduce TCP throughput severely. These errors are almost always due to problems in the communication facilities. If the problem persists, contact your service provider.

If you see output packets but no input packets, then either the remote system is not initialized or the line is not properly connected to the remote system. If you see input packets with CRC errors, the transmission medium is causing errors. If you see neither input nor output packets, then the SunLink X.25 protocol module was not successfully initialized. Try restarting the device.

4.1.4 *Checking the Line Status Using* `hsi_stat`

The `hsi_stat` command monitors traffic over a high speed interface. You must log in as root, or become superuser, to run `hsi_stat`.

Enter `hsi_stat` followed by the name of the serial port you want to monitor. For example:

```
hostname% hsi_stat hih1
speed   ipkts opkts undrun ovrrun abort crc iutil outil
1536000 15716 17121      0      0     1   3    98    89
```

The `hsi_stat` command reports cumulative statistics since system boot time. The `speed` field is the line speed entered in `hsi_init`.

Note – To obtain accurate statistics, you must ensure that this value corresponds to the modem clocking speed when clocking is provided by the modem.

The output means:

Table 4-6 `hsi_stat` parameters

Field	Definition
ipkts	Total number of input packets
opkts	Total number of output packets
undrun	Number of transmitter underrun errors
ovrrun	Number of receiver overrun errors
abort	Number of aborted receive frames
crc	Number of frames received with CRC errors
isize	The average size in bytes of input packets
osize	The average size in bytes of output packets

You can also enter a second parameter indicating a number of seconds. In this case, `hsi_stat` operates in sampling mode, sampling and then displaying data for the period you specify. For example to display information about port `hih1`, updating every ten seconds, enter:

```
hostname# hsi_stat hih1 10
ipkts opkts undrun ovrrun abort crc iutil outil
 12    10      0      0     0   0    5%    4%
 22    60      0      0     0   0    3%   90%
 36     4      0      0     0   1   51%    2%
```

If line-use is consistently near 100 percent, you might need a faster link. An overloaded link can cause spurious TCP time-outs. You also need to watch for errors on the link. A small percentage of errors can reduce TCP throughput severely. These errors are almost always due to problems in the communication facilities. If the problem persists, contact your service provider.

If you see output packets but no input packets, then either the remote system is not initialized or the line is not properly connected to the remote system. If you see input packets with CRC errors, the transmission medium is causing errors. If you see neither input nor output packets, then the SunLink X.25 protocol module was not successfully initialized. Try restarting the device.

4.2 Checking the Datalink Layer.

If the problem is not at the physical layer, the next thing to check is the SunLink X.25 software and configuration. The most important thing is to try and work out in which layer—X.25, LAPB, LLC2, or WAN—the problem originates. In general you should do the following:

- Check the link and packet layers are up—use `x25stat`.
- Observe connection attempts and obtain clearing causes and diagnostic codes—use `x25trace`.
- Log protocol activity—use the `strace` command and the `strerr` daemon.
- Obtain an ASCII record of the values of the parameters for all of the layers in your X.25 configuration— use the `x25info` utility, in `/opt/SUNWconn/bin`. This is particularly useful when you need to send a description of your configuration by electronic mail.

Using one or more of the diagnostic tools described in the preceding paragraphs, you can usually obtain sufficient information to diagnose and correct your communications problem.

4.2.1 Obtaining Packet and Link-Level Traces

Use `/opt/SUNWconn/bin/x25trace` command to captures information about each packet and/or frame sent and received by SunLink X.25.

You can specify the layer you want to trace, the interface you want to trace, and the destination you want to trace. This lets you narrow down the information you receive.

The `x25trace` command takes the form shown below:

```
# /opt/SUNWconn/bin/x25trace [options] [-i interface] filter_expression
```

You must run it as root, in the foreground. If you want to capture its output in a file, use standard SunOS redirection to do so. This is useful if you intend to contact your supplier for help. `x25trace` runs until you enter a Ctrl-C.

You can use specific MAC addresses as filters. For example, you can enter a command that has the effect of saying, “Trace all packets that travel over interface A between address 1 and address 2.” Such commands can extend beyond the width of a command line. In this case, use the backslash (\) continuation character to go beyond a single line.

4.2.1.1 `x25trace` Devices

`x25trace` supports the following devices:

Table 4-7 Devices Supported by `x25trace`

Device Name	Description
/dev/llc2	Supports LLC2 interfaces.
/dev/lapb	Supports synchronous point-to-point interfaces.
/dev/x25	Supports the X.25 Packet Layer interface

4.2.1.2 `x25trace` *Options*

The following options are available. They are supported by all of the devices.

`-a`
By default, `x25trace` displays the user data in hexadecimal for the highest protocol specified. This option tells `x25trace` to only display the number of bytes of user data and not display the data in hexadecimal. For example, if you enter:

```
hostname# x25trace -a -i /dev/llc2 x25
```

`x25trace` displays only the number of bytes in X.25 packets sent and received over the `llc0` interface.

`-l` *number*
Specifies the link on which `x25trace` is to trace packets. By default, `x25trace` traces on all links and prints the link number in the traced information. (This option is useful only in the situation in which you have multiple links.)

`-u`
This option causes `x25trace` to buffer display output line-by-line, instead of the default operation of packet-by-packet.

`-x`
This option causes `x25trace` to display entire packets in hexadecimal, in addition to its default operation of decoding the packet. This option is useful in troubleshooting malformed packets. With such packets, you often see an error message starting with two asterisks (`**`).

4.2.1.3 `x25trace` *Expressions and Operators*

You can use the following filter expressions in an `x25trace` command line:

`betweenmac`
Trace only the packets or frames passing between the 802.*x* MAC addresses you specify.

`dstmac`
Trace only the packets or frames that have a destination address that is the MAC address you specify.

`lapb` (or `hdlc`)
Trace only LAPB frames.

`mac`
Trace packets and frames to/from the MAC address you specify. Use only when tracing on a LAN interface.

`multicast`
Trace only LLC2 packets that have multicast addresses.

`pdu_in`
Trace only incoming Protocol Data Units (PDUs).

`pdu_out`
Trace only outgoing Protocol Data Units (PDUs).

`srcmac`
Trace only the packets or frames that have a source address that is the MAC address you specify.

`x25`
Trace only X.25 Packet Layer Protocol packets.

`x25lcn [+|`*num*`>]`
Used with a plus sign (+), this expression means trace only the packets that travel on the next logical channel set up. Used with a number, it means trace only the packets that travel on the logical channel identified by *num*.

You can use the logical operators `and`, `or`, and `not` with the expressions defined above.

4.2.1.4 `x25trace` Examples

Below are some examples of using `x25trace` for tracing incoming and outgoing packets.

Tracing LAPB and X.25 on `/dev/lapb`***:***

To trace LAPB frames and X.25 packets as they are sent or received by LAPB, enter.

```
hostname# x25trace -i /dev/lapb hdlc (or x25)
```

The following two commands are equivalent:

```
hostname# x25trace -i /dev/x25 x25
hostname# x25trace
```

Tracing LLC2 and X.25 on `/dev/llc2`***:***

```
hostname# x25trace -i /dev/llc2 llc (or x25)
```

The command above captures all LLC frames, including Unnumbered Information frames used to carry CLNP and ES-IS PDUs. When tracing at the X.25 level on an LLC2 link, MAC addresses are displayed as `0:0:0:0:0:0`. Tracing at the LLC2 level on the same link returns the correct MAC addresses.

Tracing a single X.25 connection (logical channel number):

```
hostname# x25trace -i /dev/lapb x25lcn lcn_num x25
```

Tracing only the next X.25 connection being set up:

```
hostname# x25trace -i /dev/lapb x25lcn + x25
```

Tracing LLC2 frames on `/dev/llc2`***:***

```
hostname# x25trace -i /dev/llc2 llc
```

Tracing X.25 packets to/from specific MAC addresses on `/dev/llc2`***:***

```
hostname# x25trace -i /dev/llc2 srcmac 8:20:0:1:2:3 x25
hostname# x25trace -i /dev/llc2 dstmac 8:20:0:1:2:3 x25
hostname# x25trace -i /dev/llc2 betweenmac 8:20:0:1:2:3 9:0:2b:18:21:5 x25
```

Trace outgoing LLC2 frames that are not multicast:

```
hostname# x25trace -i /dev/llc2 pdu_out not multicast
```

Redirecting trace of X.25 packets over an LAPB link to a file:

```
hostname# x25trace -a -i /dev/lapb x25 > /var/adm/x25/packets.record
```

4.2.2 Displaying Protocol Statistics

The `x25stat` command displays statistics relating to the different protocol layers used by SunLink X.25. You can display statistics on a per-interface or per-link basis. By default, X.25 packet level protocol (PLP) statistics are shown:

There is a separate block of statistics for each protocol.

`x25stat` has the following options:

- `-l` *link*
  displays statistics on a per-link basis. The *link* variable can be an actual link identifier, or the name of the link, as specified in the `/etc/SUNWconn/x25/subnetworks` file. Statistics on a per-network basis are shown along with the default statistics unless the `-l` option is used in conjunction with the `-p` option, to specify the required protocol.
- `-p` *protocol*
  shows statistics for a specified protocol. The *protocol* variable can be one of `ixe`, `lapb`, `llc` or `x25`.
  Note that for `lapb` and `llc2`, `x25stat` displays both global and per-link statistics.
  For `ixe`, output is of the form:
  For `lapb`, output is of the form:
  For llc, output is of the form:
  If this option is used in conjunction with the -l option, then the link's underlying protocol must be the same as the one specified.
  For `x25`, output is the same as the default output (see above). Both global and per-virtual circuit statistics are displayed.
- `-w`
  display statistics relating to the WAN.

Output is of the form:

```
WAN:
Link       : 0
       10714 good frames transmitted
       10715 good frames received
           0 transmit underruns
           0 receive overruns
           0 CRC/frame errors received
           0 received frames with no buffer
           0 received frames with no flow control
           0 receive buffer overflows
           4 receive aborts
```

- `-z`
  resets the statistics on a per-protocol basis. It must be used with the `-p` option. This option is only available to the superuser. If an *interval* is specified, `x25stat` continuously re-displays the appropriate information or resets the statistics, pausing *interval* seconds between each action.

4.2.3 Logging Trace Information

The SunOS 5.x streams facility provides a mechanism for logging trace information. You can capture and print this information with the `strace (1M)` command. See the `strace` man page for further directions on the command's use.

You specify arguments to `strace` in sets of three:

module id
For SunLink X.25, this can be one of: 200, for the X.25 Packet Layer Protocol (PLP) driver; 201, for the LAPB driver; and 202, for the LLC2 driver.

link number
The number of the link over which the driver you are tracing is running.

level
A tracing level (specified by an integer) that allows you to receive more or fewer packets or frames. These levels vary among the three X.25 drivers supported by `strace` and are described in the following subsections.

For link number and level, specify `all`, to specify, respectively, all links (where you have multiple links) and all tracing levels. For example, the command:

```
# /usr/sbin/strace 200 all all
```

traces X.25 PLP packets on all links at all tracing levels.

Note that `strace` is owned by root and has 100 permissions, which means it is executable only by root.

The successful tracing of an *incoming* event does not mean that the packet or frame has been accepted by the driver at the layer you are tracing. This is because, for a given layer, the tracing of incoming events is triggered on

receiving data from the layer below. At this point, the packet or frame is not yet verified. If the packet or frame is subsequently found to be in error, it might be discarded or cause some further protocol action.

For tracing of an *outgoing* event, at the X.25 layer, successful tracing does not mean that the packet has been sent to the link layer. Following tracing, various consistency checks are performed on the link-level database. If these checks fail, the packet will be discarded. At the LAPB and LLC2 layers, successful tracing *does* mean that the frame was sent to the WAN or LAN driver. However, it does not mean that the frame will be transmitted on the line.

4.2.3.1 X.25 PLP Trace Levels

There are six trace levels available for the X.25 PLP driver. Specify these levels with the integers 1 through 6. These levels are defined as follows:

Level 1: call activity
Monitors incoming calls, outgoing calls, calls accepted and calls connected. For each event, `strace` logs a description, link number, Logical Channel Identifier (LCI), and General Format Identifier (GFI).

Level 2: clear activity
Monitors clear requests, clear indications and clear confirmations. For each event, `strace` logs a description, link number, and LCI. For clear requests and clear indications, the cause and diagnostic are also logged.

Level 3: reset activity
Monitors reset indications, reset requests, and reset confirmations. For each event, `strace` logs a description, link number, and LCI. For reset requests and reset indications, the cause and diagnostic are also logged.

Level 4: restart activity
Monitors restart indications, restart requests, and restart confirmations. For each event, `strace` logs a description and link number. For restart requests and restart indications, the cause and diagnostic are also logged.

Level 5: interrupt activity
Monitors interrupt data indications, interrupt data requests, and interrupt confirmations. For each event, `strace` logs a description, link number, and LCI.

Level 6: data activity
Monitors data indications and data requests. For each event, `strace` logs a description, link number, LCI, and the send and receive sequence numbers.

4.2.3.2 LAPB Trace Levels

Level 1: setup and disconnection activity
Monitors all link set up and disconnection events. For each event, `strace` logs a description and link number. For disconnection events, an indication of whether locally or remotely initiated is also logged.

Level 2: reset activity
Monitors all link reset events. For each event, `strace` logs a description, link number, and an indication of whether the reset was locally or remotely initiated.

Level 3: error activity
Monitors sending and receiving of FRMR and REJ frames. For each event, `strace` logs a description and link number. For FRMR frames, `strace` logs the error flag. For REJ frames, `strace` logs the send sequence number in error.

Level 4: busy activity
Monitors all link busy conditions. For each event, `strace` logs a description, link number, and an indication of whether the busy activity was locally or remotely initiated.

4.2.3.3 LLC2 Trace Levels

Level 1: setup and disconnection activity
Monitors all link set up and disconnection events. For each event, `strace` logs a description, link number, and connection identifier. For disconnection events, an indication of whether locally or remotely initiated is also logged.

Level 2: reset activity
Monitors all link reset events. For each event, `strace` logs a description, link number, connection identifier, and an indication of whether the reset was locally or remotely initiated.

Level 3: error activity
Monitors sending and receiving of FRMR and REJ frames. For each event, `strace` logs a description, link number, connection identifier, and an indication of whether error activity was locally or remotely initiated. For FRMR frames, `strace` logs the error flag. For REJ frames, `strace` logs the send sequence number in error.

Level 4: busy activity
Monitors all link busy conditions. For each event, `strace` logs a description, link number, a connection identifier, and an indication of whether the busy activity was locally or remotely initiated.

Level 5: Type 1 activity
The strace command monitors the sending and receiving of XID and TEST frames. For each event, `strace` logs a description, link number, and connection identifier.

4.2.3.4 Summary Table

Table 4-8 shows available `strace` tracing levels for the X.25, LAPB, and LLC2 drivers.

Table 4-8 `strace` Tracing Levels

Level	X.25 driver module ID 200	LAPB driver module ID 201	LLC2 driver module ID 202
1	call setup	link up/down	link up/down
2	call clearing	link reset	link reset
3	call reset	error activity	error activity
4	restart activity	link busy	link busy
5	interrupt packets	not available	Type 1 activity
6	data packets	not available	not available

4.2.4 Capturing Streams Error Messages

The SunOS 5.x streams facility provides a mechanism for capturing streams error messages, through use of the `strerr (1M)` daemon. This daemon receives error messages and appends them to log files in `/var/adm/streams`. Log file names are of the form `error.`*mm-dd*, where *mm* and *dd* indicate the month and day the messages were written to the file.

If you are experiencing problems with SunLink X.25 and are uncertain of the source, run `strerr`, as shown above. If you receive a streams error message, you should contact your local Sun customer service representative.

In SunLink X.25, the X.25, LAPB, and LLC2 drivers can generate streams error messages.

You must be root to run the `strerr` daemon. Start it like this:

```
hostname# /usr/sbin/strerr &
```

The daemon runs until you kill it.

See the `strerr` man page for a description of the syntax of the messages in the streams error message file.

4.3 Checking the Network Layer

Once you are sure that the physical and datalink layers are both working correctly, check to see whether the problem is at the network layer. Check the following:

- the state of the line, using `ifconfig`
- connectivity, using `ping`
- the network address, using `netstat –i`
- the routing tables, using `netstat –r`
- permissions in the `/etc/hosts.equiv` file
- remote operation, using `rlogin`
- NIS operation

4.3.1 Checking the Protocol Status

When SunLink X.25 is running, you can use `ifconfig` to monitor the current state of the line. Give the X.25 interface name as an argument. For example,

```
hostname# ifconfig ixe
ixe: 192.9.200.2 flags=51<UP,POINTOPOINT,RUNNING,PRIVATE>
```

If the words `UP` and `RUNNING` are displayed, then the connection is potentially intact. If the line is down, then only `POINTOPOINT` is displayed.

If `ifconfig` does not display `UP` and `RUNNING`, then either you did not configure the X.25 module correctly or the remote system cannot be contacted.

The `PRIVATE` flag, shown in the display above, is associated with SunLink X.25 devices. The flag means that the routing daemon does not broadcast the host route for the X.25 device to the local network.

Note – Wait 30 seconds after bringing the X.25 link up to check these statistics, as these flags can be up to 30 seconds out of date.

4.3.2 Checking Connectivity

Use `ping` to check that the connection is up:

```
hostname# ping –r gateway_a
gateway_a is alive
```

The —`r` option tells `ping` that the remote host is on a directly-connected interface, such as a X.25 link. If the remote host does not respond, a routing problem exists at some point between the local and remote hosts.

4.3.3 Checking the Network Addresses

Use the `netstat –i` command to check that the correct local and remote addresses are assigned to the SunLink X.25 interface:

```
hostname# netstat –i
```

Make sure that the IP addresses for the local and remote X.25 interfaces are the same in the `/etc/hosts` files or NIS host maps for the machines on both ends of the X.25 link.

4.3.4 Checking the Local Routing Tables

Use the `netstat –r` command to display the local routing tables:

```
hostname# netstat –r
```

The routing table looks like this:

```
Routing tables
Destination    Gateway    Flags    Refcnt    Use     Interface
host_a          sun-bb      UGH       0          0        ie1
host_b          sun-bb      UGH       0          0        ie1
gateway_b       gateway_a   UGH       1          12897    ppp0
route7          route7      UGH       0          0        ie0
eastgate        route71     UGH       0          158      ie0
backbone        alpha-bb    U         1          16087    ie1
dresdenpc       route1      UG        0          0        ie1
loopback        localhost   U         2          113436   lo0
beta-bb         alpha       U         4063       146044   ie0
dallas2         route7      UG        0          0        ie0
trainingpc      route62     UG        0          0        ie1
```

Make sure there is a routing table entry for each possible destination network. In particular, SunLink X.25 devices, listed under `Interface`, should be matched with the appropriate host names listed under `Gateway`. The `Gateway` entry should, in turn, be matched with the correct entry under `Destination`.

If it isn't, and you are using *static routing*, add the appropriate static routes. If you are using *dynamic routing* with `in.routed`, do the following:

1. **Check that** `in.routed` **is running by typing:**

```
# ps –ef | grep route
  root  process_id 1 80 Feb 22  1:55 /usr/sbin/in.routed -q
```

   If the routing tables still are not correct, become superuser, and continue with the next steps.

2. **Kill** `in.routed` **and flush the routing tables:**

```
#kill –9 process_id
#/usr/sbin route –f
```

   where *process_ID* is the process ID displayed by the `ps –ef` command.

3. **Restart** `in.routed` **as follows:**

```
#/usr/sbin/in.routed
```

4.3.5 Checking Permissions

If you attempt to use `rsh` or `rlogin` and receive the message `Permission denied`, it is because the remote system's `/etc/hosts.equiv` or `/.rhosts` does not contain the sending system's host name or does not contain the line '+'. For example, if `gateway_a` is to have permissions for `gateway_b`, then `gateway_a` should appear in `gateway_b`'s `/etc/hosts.equiv` file.

4.3.6 Checking Remote Operations

Check that remote operations are working correctly by using `rlogin` or `rsh` to reach the remote host over the X.25 link. If this fails, it probably indicates that the machines on each end of the link have different MTU sizes.

4.3.7 Checking NIS Operations

If your network or the network at the opposite side of the X.25 link run NIS, you should ensure that NIS operation is working correctly. Type `ypwhich` at the command line. You should receive the name of an NIS server on the internetwork as a response. If you don't, this indicates problems with NIS over the X.25 link.

On devices where the interface running SunLink X.25 is the only network interface, you need to perform a few extra steps if you want to get NIS service from across the link. You can do either of the following:

1. Make the remote machine the NIS server.
2. Assign an NIS server for the local machine.

If you choose the second option, do the following:

1. Become superuser.

2. Run `ypbind` **as follows:**

```
# ypbind –ypsetme
```

3. Assign a known NIS server to the local X.25 routing gateway, as follows:

```
# /usr/sbin/ypset server_addr
```

where `server_addr` is the IP address of an NIS server on the local network.

4.4 Licensing Problems

SunLink X.25 only runs when a license is available. If you are using SunLink X.25, and its license ceases to be available, the following message is printed to the console:

```
SunLink X.25, waiting to get license
```

If, after three attempts, the license is still unavailable, SunLink X.25 prints the following message to the console and closes down:

```
Unable to regain license, X.25 closing down
```

The most likely cause is a network problem between the device running SunLink X.25 and the license server.

4.5 Resolving Common Problems

This section provides information for resolving common problems. These problems are most likely to appear when you bring up SunLink X.25 for the first time. If you cannot resolve the problem using the procedures given here, carry out the full set of tests described in this chapter.

4.5.1 SunLink X.25 will not come up

1. A message such as `Cannot bring up network`, may mean that you made a mistake in entering data in `x25tool`. For example, you might have configured only one LAPB link, with the result that `x25tool` only configures a single set of LAPB kernel drivers. If you then attempted to run a second X.25 link you would have no support for such a link in your configuration. Re-check your configuration.

2. If your X.25 network does not come up, it might indicate that your cable and modem are incorrectly matched to your machine. Another possibility is that you specified the wrong serial port when you ran `x25tool`. Check your WAN configuration in `x25tool`. Make sure you specify the serial port(s) (`zsh`<*n*>) over which you plan to run SunLink X.25. If your port specifications in `x25tool` are correct, try replacing the cable between the serial port and modem. If replacing the cable does not correct the problem, you might need to use a different modem.

3. If your X.25 network does not come up and you receive a message such as, `x25netd: failed to link stream 7 under driver 1 (Bad file number [9])`, it indicates that you configured more links than are specified in the in `x25tool`'s Kernel Parameters window. Use Advanced

Configuration➤Parameters... to set the value of Network Links parameters to match the number of links (including loopback links) in the Define/Modify Interfaces➤Interface Configuration window.

4.5.2 The X.25 link layer will not come up or will not stay up

1. Make sure all cables are properly seated.
2. If you still have a connection, check the Transmit and Receive Data lights on your modem: with LAPB transmission, these should always be on.
3. If you have a connection, use a breakout box at the Sun (not the modem) end of the connection to check that (RS-232-C) pins 2, 3, 4, 5, 6, 7, 8, 15, 17, and 20 are functioning. Pay particular attention to the Transmit Clocking and Receive Clocking pins, 15 and 17. If the lights corresponding to these pins are not lit, it indicates that the local and/or remote modems are not supplying clocking. Notify the remote end and use your modem's documentation to perform troubleshooting.
4. If you are operating over an LAPB link, make sure that you are using a cable that is designed for synchronous use. If you have a spare cable, replace your existing cable and retry the connection.
5. Contact your PSDN (or LAN administrator for LLC2 links) to verify that your parameter settings are correct. In particular, for LAPB links, check that the link is configured as a DTE if communicating over a PSDN. If you discover errors, rerun `x25tool` to make changes to your link configuration file.
6. If you are using a null modem connection, one side should be a DTE, the other a DCE and one or both sides must supply clocking. See the section on Cabling in the *SunLink X.25 8.0.2 Configuration Guide* for instructions on setting up a null modem connection.
7. If you are confident that your parameter settings match those of the PSDN, observe the number of packets being sent and received over a port and whether errors are being detected at the hardware or port driver level—use `syncstat` for a synchronous interface, `hsi_stat` for a high speed interface. If there are errors, use `syncloop` or `hsi_loop` to perform a loopback test. At a minimum, carry out a loopback through your local modem, to verify the integrity of the link from your machine through the modem. If you use `syncloop` or `hsi_loop` to test your link up through the

local modem (option 1), be sure to use `syncinit` or `hsi_init` afterwards to take the link out of loopback mode. These utilities are described in Section 4.1, "Checking the Physical Layer," on page 4-2."

8. Use `/opt/SUNWconn/bin/x25trace` to check the LAPB or LLC2 level. Use a command such as the following:

```
hostname# x25trace -i /dev/lapb lapb
```

For an LLC2 link, use:

```
hostname# x25trace -i /dev/llc2 llc2
```

The `x25trace` command is described in Section 4.2.1, "Obtaining Packet and Link-Level Traces," on page 4-15.

4.5.3 Unable to establish a packet-level connection

1. Try to evaluate the call clearing code returned from the PSDN. See Appendix B, "Error Messages and Error Codes" for complete lists of clearing codes and possible causes.

2. If, while using the PAD program, you receive a message:

```
Connecting...
Call Cleared - Out of Order (0900)
```

there may be a mismatch in logical channel number ranges between you and your PSDN or you and the remote end in back-to-back or LLC2 connections.

Logical channel number mismatches can be difficult to diagnose, especially if you are viewing output from `x25trace`. You see a Call Request packet going out, but absolutely no response at the X.25 Packet Layer. In a facilities mismatch, for example, you receive a Clear Indication from the remote end. The Clear Indication contains an error code that is occasionally helpful in pinpointing the problem.

3. Facilities and other parameter mismatches, between your machine and the PSDN, can prevent the establishment of virtual circuits. A mistake in a single item in `x25tool`, such as specifying Yes instead of No (the default, which is correct for 90% of PSDNs) in the Negotiate Toward Defaults item in the Create/Modify configuration files➤X.25➤Throughput window can prevent you from completing a call.

4. If you receive an error code of the form 00 *nn*, the leading zeroes indicate the call-clearing request originated with the remote host. If the first two digits are not 00, it indicates the call-clearing request originated in the PSDN. See Appendix B, "Error Messages and Error Codes", for a complete list of error codes that can be returned from the PSDN or the remote host.

5. Two commonly received error codes are 0x00 24 and 0x00 43. If you receive an error code of 0x00 24, check that the logical channel number ranges specified in `x25tool` are within the range specified by your PSDN. If you receive an error code of 0x00 43, check that your X.121 address is specified correctly in `x25tool` file. If it is, check to see whether there is a process listening for an incoming call.

6. If you receive error code 0x00 42, it is likely that your maximum I-frame size, an LAPB-layer parameter, is set incorrectly for your link. The maximum I-frame size is a subscription option to the PSDN. You must set this parameter to be eight bytes larger than the default packet size parameter at the packet level. (Eight bytes when LAPB is in extended mode; five bytes when LAPB is in normal mode.) If SunLink X.25 receives a Call Request with a packet size that is within eight bytes of the maximum I-frame size parameter, the X.25 software clears the call with the 0x00 42 diagnostic. Use `x25tool` to modify your LAPB parameters as necessary.

7. If you can find out about the remote host, check that it is still up.

8. If you are running IP over X.25, run `ifconfig` commands to check on your `ixe` device (for example, `zsh0`). Use of `ifconfig` is described in Section 4.3.1, "Checking the Protocol Status," on page 4-26. If the response from `ifconfig` is `UP`, `POINTOPOINT`, and `RUNNING`, check with your PSDN to see if there is a problem at the network end.

9. Run `x25trace` to trace the exchange of X.25 packets across the link. People who are familiar with the X.25 Packet Layer Protocol can interpret the output from `x25trace` to determine where errors are occurring. The `x25trace` command is described in Section 4.2.1, "Obtaining Packet and Link-Level Traces," on page 4-15.

10. If you receive a message from PAD such as, `i/o error, open /dev/x25 failed`, it might indicate that the X.25 network daemon is down. Check the status of the daemon in `x25tool`. You might also receive such a message if there is contention for a serial port, for example, between a printer and SunLink X.25.

4.5.4 Link is up, but not responding correctly

1. If you experience intermittent disconnections or resets, check for configuration errors in your link configuration file. At the packet level, make sure that the window and packet size parameters agree, between your machine and the PSDN.

2. Bizarre and unpredictable X.25 behavior can result from an incorrect network profile choice. In `x25tool`, ensure that you have selected an appropriate choice for the Profile item in the Create/Modify configuration files➤X.25➤Network Profile window. In particular, make sure you have selected a LAN-type profile if you are running X.25 over LLC2 or a WAN-type profile if you are running X.25 over LAPB. Within the LAPB realm, check that you are using the correct profile in terms of the X.25 recommendation year of your network and the DTE/DCE role of your machine.

3. If you experience poor response times using SunLink X.25, it might be because you are communicating over a series of physical links, one or more of which might be shared with other users. Your throughput will be limited by the slowest link among the links that make up your connection to the remote host.

4. If you recieve repeated RESETS, there may be a window size mismatch.

If you establish but cannot maintain a connection and none of the preceding steps uncovers your problem, run `x25trace`, as described in Section 4.2.1, "Obtaining Packet and Link-Level Traces," on page 4-15. Output from this command is valuable in helping trained technical personnel find and correct problems.

4.5.5 Local System Panics

If you attempt to read from or write to the network while you are not attatched to a network, or the network is down, your local system may panic. If this happens, have the latest version of patch number 101318 installed.

4.5.6 PAD Calls Fail

Check these parameters: “Max PAD connections” on page 2-87 and “Maximum number of XTY devices” on page 2-87. You may have run out of PAD devices or exceded the maximum number of PAD connections allowed by your configuration. This is certainly the case if this error message appears:

```
PAD: i/o error, push XXX module failed
PAD: Out of stream resources
```

SunNet Manager Agent A

The current release of SunLink X.25 is shipped with a SunNet Manager agent that is compatible with, in addition to the current release, releases 6.0 and 7.1 of SunLink X.25. You can use this agent from console machines running release 1.1 and 2.0 of SunNet Manager. The agent and associated files are:

- `/opt/SUNWconn/x25/snm/na.x25`: agent software
- `/opt/SUNWconn/x25/snm/schema.x25`: SunNet Manager schema file
- `/opt/SUNWconn/x25/snm/man/man8/na.x25.8`: man page for X.25 agent

Listed below are the steps you use to install the agent. You perform all steps as root.

1. **As root, copy** `/opt/SUNWconn/x25/snm/na.x25` **into** `/usr/snm/agents` **on the machine running SunLink X.25.**
2. **As root, copy** `/opt/SUNWconn/x25/snm/schema.x25` **to** `/usr/snm/agents` **on the SunNet Manager console machine.**
3. **Have your system administrator add the following line to the NIS** `rpc.bynumber` **map.**

```
x25          100114          na.x25
```

   If your site does not use NIS, add the line above to the `/etc/rpc` file on the machine running SunLink X.25 and the SunNet Manager console machine.

4. **As root, edit the** `/etc/inetd.conf` **file on the machine running SunLink X.25 to add the line shown below.**

```
x25/10  dgram  rpc/udp  wait  root  /usr/snm/agents/na.x25
na.x25
```

5. **On the SunLink X.25 machine, obtain the process number of the** `inetd` **process from the** `ps -e` **command. Then, as root, enter a** `kill -HUP` **command to restart the** `inetd` **daemon. For example:**

```
hostname# ps -e | grep inetd | grep -v grep (no need to be root here)
120 ? 0:02 inetd (only an example; you need the number in the first field)
hostname# kill -HUP 120
```

On the SunNet Manager Console machine, to retrieve information on an X.25 virtual circuit from a target SunLink X.25 machine, use the "quick dump" or "data report" SNM requests. The following is an example of output received from the X.25 agent:

```
Wed Jul 15 05:20:32 1992 [ fullmoon ] : Quick Dump: x25.circuit
pid lcn  linkid  in/out  hdlc_state  pkt_lev  state          opkts ipkts address
 0  4095  2      IN      UP          UP       Data Transfer  25    39    222210101
```

The fields in the agent output are explained as follows:

`lcn`
logical channel number of virtual circuit being reported on

`linkid`
link number on which the virtual circuit takes place

`in` or `out`
direction of virtual circuit (either the initiator or receiver of call)

`hdlc_state`
state of the LAPB link, up or down

`pkt_lev`
state of the X.25 layer, up or down

`state`
state of the X.25 network software, unknown, up, or down

`opkts`
Number of packets sent (valid only if connection is up; reset to zero when connection is up)

`ipkts`
Number of packets received (valid only if connection is up; reset to zero when connection is up)

`address`
X.121 address of remote host

If you use SunNet Manager 2.0, consult the *SunNet Manager 2.2.2 User's Guide* for details on using the SNM Console for extracting data from agents.

A

Error Messages and Error Codes B

Error Messages are generated by the SunLink X.25 software, and tell you that you have made a mistake in configuration. Error Codes are generated by your communication service and may indicate a problem with the remote host.

B.1 Error Messages

`A ':' character is invalid in the Banner or Command fields.It has been replaced with '-'.`

Informational only.

`Address Invalid or not unique`

Check and re-enter the address.

`Address contains invalid character`

Check and re-enter the address.

`Address extension has invalid character or length`

Check and re-enter the address.

`Address or User Data contains invalid character`

Check and re-enter the address.

`Address too long`

Check and re-enter the address.

`Call User Data contains non-hexadecimal character`

Re-enter the CUD.

`Called Address or User Data contains invalid character`

Re-enter the CUD .

`Can't get parameters from selected link.`

Try again. If it still fails, get the parameters from Working instead of Active.

`Can't load working data for link. Link may not be configured yet.`

The working data has not been saved. Load the parameters From File and save them to Working.

`Can't open LAPB device. X.25 may not be running`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Can't open LLC2 device. X.25 may not be running`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Can't open LLC2 device. X.25 may not be running`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Can't open WAN device. X.25 may not be running`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Can't send parameters to selected link.`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Can't set baud rate for selected link.`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Can't set frame size for selected link.`

Stop and restart X.25. If this does not work, try rebooting the device running X.25.

`Cannot Allow and Disallow Extended options`

Choose only one of these options.

`Cannot create file chooser for LAPB`

Stop and restart `x25tool`. If the problem persists, this may indicate a memory leak.

`Cannot create file chooser for LLC2`

Stop and restart `x25tool`. If the problem persists, this may indicate a memory leak.

`Cannot create file chooser for WAN`

Stop and restart `x25tool`. If the problem persists, this may indicate a memory leak.

`Cannot create file chooser for X252`

Stop and restart `x25tool`. If the problem persists, this may indicate a memory leak.

`Cannot open file <filename>, continuing`

Check that <filename> has appropriate permissions.

`Cannot start statistics program`

If you have installed X.25 in a non-default location, check and update the PATH.

`Defaults files (prefixed 'def') may not be changed`

The “def” prefix indicates a default file, that connot be changed. Save your changes to a differently named file.

`Drop source unavailable or of illegal type`

`Duplicate IP Address`

Check and re-enter the IP address.

`Duplicate Link Number` *number*

Choose a unique link number.

`Each xty device requires an s_xxx module. Each additional PAD connection also requires an s_xxx module`

`uucp` and `tip` make PAD calls. The number of `s_xxx` modules you set must exceed the maximum number XTY devices you set by at least four.

`Error adding route` *route*

Check that your route file has not become corrupted and that it has appropriate permissions.

`Error at line` *linenumber* `of` *string* `PVC refers to non-existent link`

If you have manually edited the configuration files, this error menas that you have corrupted the format. Use `x25tool` to re-create the file.

`Error creating backup of` *filename*

Check that the named file has appropriate permissions. Check that you started `x25tool` as root.

`Error opening routing file` *filename*

The file is either missing or has the wrong permissions.

`Error opening x29profile file, profiles not loaded.`

The file is either missing or has the wrong permissions.

`Error or EOF while reading profile file`

The file has become corrupt or truncated during a manual edit.

`Error or EOF while reading template file`

The file has become corrupt or truncated during a manual edit.

`Error or EOF while reading template file`

The file has become corrupt or truncated during a manual edit.

`Error reading device details from x_info and/or torx_info`

The file is missing or has inappropriate permissions. If it is missing you must restore it. You may need to re-install SunLink X.25 in order to do so.

`Error updating ipconf file`

The file is missing or has inappropriate permissions. Use `x25tool` to re-create it.

`Error while opening world profile file`

The file is missing or has inappropriate permissions. If it is missing you must restore it. You may need to re-install SunLink X.25 in order to do so.

`Error while opening world_networks.profile file`

The file is missing or has inappropriate permissions. If it is missing you must restore it. You may need to re-install SunLink X.25 in order to do so.

`Error writing subnetworks file`

Check that the named file has appropriate permissions. Check that you started `x25tool` as root.

`Error writing x25conf file or template stack file`

Check that the named file has appropriate permissions. Check that you started `x25tool` as root.

`Hostname/Alias(es) invalid or Hostname empty`

Check and re-enter the information.

`Hostname/Alias(es) not unique`

Enter a unique hostname.

`IXE hash table size must be at least 2x address table size`

Re-enter the IXE hash table size.

`Incoming and Outgoing LCN overlap`
Logical channel ranges must not overlap

`Incoming and Two-Way LCN overlap`
Logical channel ranges must not overlap

`Invalid Address Extension`
Check and re-enter the information.

`Invalid Character in RPOA`
Check and re-enter the RPOA.

`Invalid DNIC`
Check and re-enter the DNIC.

`Invalid Full Address`
Check and re-enter the Full Address.

`Invalid Incoming LCN range`
Check and re-enter the Logical Channel Range

`Invalid Local Address`
Check and re-enter the Local Address.

`Invalid Local SAP`
Check and re-enter the Local SAP.

`Invalid Loop SAP`
Check and re-enter the Loopback SAP.

`Invalid Outgoing LCN range`
Logical channel ranges must not overlap

`Invalid PVC range`
The minimum must be smaller than the maximum.

`Invalid RPOA in IXE map file`

The file has been changed, check and correct it.

`Invalid Two-way LCN range`

Logical channel ranges must not overlap.

`Invalid entry in x29profile file, line` *linenumber* `ignored`

The file has been changed, check and correct it.

`LCN values out of range or overlapping`

Logical channel ranges must not overlap.

`Local Address must be given`

Enter a local address.

`MAC address has invalid character or length`

Check and re-enter the MAC address.

`Must specify a non-WAN protocol for the Clear function`

You cannot Clear WAN statistics

`No LCNs specified`

Enter a valid Logical Channel Range. Note that Logical Channel Ranges cannot overlap.

`No PVC selected`

Specify a valid PVC.

`No protocol has been specified`

Select at least one protocol to display statistics on.

`PAD: i/o error, push XXX module failed`
`PAD: Out of stream resources`

The number of PAD calls has exceeded the number of virtual circuits available. See Section 2.5.2.3, “s_xxx (PAD) Module,” on page 2-87 for instructions on increasing the available number.

`PID has invalid character or length (must be even)`

Check and re-enter the PID, using Create/Modify configuration➤Routing.

`PVC and Incoming LCN overlap`

Logical channel ranges must not overlap.

`PVC and Outgoing LCN overlap`

Logical channel ranges must not overlap.

`PVC and Two-Way LCN overlap`

Logical channel ranges must not overlap.

`PVCs cannot be specified for LLC links`

This parameter is not relevant to an LLC link.

`Program error: Invalid mode, must be LOAD or STORE`

Contact your support organisation for help.

`RPOA string must be a multiple of 4 digits in length`

Check and re-enter the RPOA string.

`Some changes applied to the stored parameters have not been saved.`

You have not pressed Save or Apply for some of your changes.

`Sorry, the PAD Parameter window is already in use`

You cannot display more than one copy of the PAD Parameter Window.

`The number of IFD devices can be no greater than the number of LAPB links`

Check and re-enter the information.

`There are changes in the subwindow which have not been applied to the stored parameters`

You have not pressed Save or Apply for some of your changes.

`There are no current links of the required type`

Configure From File, then save to Working.

`There is already a PVC of that number`

Enter a unique PVC number.

`There seems to be another copy of x25tool running with PID %d. If there isn't, delete file <filename> and try again`

Close down the other copy of `x25tool`, or delete the indicated file and try again.

`Two-Way and Outgoing LCN overlap`

Logical channel ranges must not overlap.

`Unable to Insert`

This may indicate a memory leak. Alternatively, the list may be full.

`Unable to create link from` *filename* `to` *filename*

Check the permissions of the indicated files.

`Unable to execute command`

Check you PATH, if you have installed SunLink X.25 in a non-default location.

`Unknown Device or board not configured`

You must configure the board before continuing.

`Unknown route type, X.121 Host assumed`

The routing file is corrupt.

`Unmatched entry in x29profile file on line:`

The X.29 profile file is corrupt.

`Value of parameter 1 out of range Must be 0, 1 or 32-126`

See Table 2-3 on page 2-69 for a list of valid parameters.

`Value of parameter 19 out of range Must be 0, 1, 8 or 32-126`

Enter a valid parameter.

`Window size default > maximum`

Set a default size that is less than or equal to the maximum.

`Window size invalid for Modulo 8 network`

Set a value between 1 and 7.

`X.121 address has invalid character or length`

Check and re-enter the address.

`You must not specify both X.121 and MAC addresses for an AEF route`

Delete one of the addresses

`routing file: <message>`

Make the change indicated in the message.

`routing file: source_aef not supported, ignored`

This is a difference between the 7.0 and the 8.0 software. If your scripts expect to find this file, ammend them.

B.2 Error Codes

A problem with an X.25 application might be a result of a problem communicating with the PSDN or a problem with the remote host. When you encounter a problem that causes your call to be cleared, you receive a diagnostic code in the form of two pairs of digits. The first pair indicates why the call was cleared; the second pair gives additional diagnostic information. The tables on the following pages specify meanings for these numeric codes. Table B-1 specifies reasons for call-clearing. Table B-2 specifies diagnostic information in addition to the call-clearing cause.

If you receive any of these error codes, you should contact your service-providor.

If your connection is cleared unexpectedly and you receive a four-digit code, first look up the first pair of digits in Table B-1, then look up the second pair in Table B-2. A zero (`00`) call-clearing code indicates that the call-clearing request originated in the remote host. A non-zero call-clearing code indicates the call-clearing request originated in the PSDN.

For example, your call is cleared with a code `03 42` . As specified in Table B-1, `03` indicates an invalid facility request. Table B-2 tells you that `42` (hex) means that a facility parameter (that you used) is not allowed. This combination of messages tells you that:

1. The problem was detected by the PSDN, not by the remote host.
2. One or more parameter settings that you made in `x25tool` are unacceptable to the PSDN.

Often, a diagnostic gives only a general clue as to the source of a problem. For example, your call might be cleared with the code `00 42`, indicating an invalid facility parameter setting. You might, in fact, have a facility parameter set to a value outside of the range of what you subscribed to. However, you can also receive this message if the maximum I-frame size is set to a size lower than the PSDN expects. SunLink X.25 clears the call rather than allow it to start and possibly fail later.

If you receive error code `00 42` and are not subscribing to any facilities, or are confident that your facilities parameters settings are correct, confirm that you and your PSDN agree on the maximum I-frame size. Remember that any

adjustment of the maximum I-frame size, a LAPB parameter, might also require a change to the default packet size parameter, at the X.25 Packet Layer. Use `x25tool` to modify your link configuration as necessary.

Table B-1 Causes for Call Clearing

Hexadecimal Code	Decimal Code	Meaning
00	00	Originated by remote DTE
01	01	Number busy
09	09	Out of order
11	17	Remote procedure error
19	25	Reverse charging acceptance not subscribed
21	33	Incompatible destination
29	41	Fast select acceptance not subscribed
03	03	Invalid facility request
0B	0B	Access barred
13	19	Local procedure error
05	05	Network congestion
0D	13	Not obtainable
15	21	RPOA out of order

In Table B-1 note the four categories of codes, separated by the double horizontal lines:

- The first category, code `00`, indicates that the call-clearing request originated with the remote host. The remaining codes, in all other categories, indicate that the call-clearing request originated within the PSDN.
- Codes in the second category (hexadecimal code 01 through 29) indicate problems between the PSDN and the remote host.
- Codes in the third category (hexadecimal code 03 through 13) indicate problems between the local host and the PSDN.

- Codes in the fourth category (hexadecimal codes 05 through 15) indicate problems within the PSDN.

Table B-2 X.25 Diagnostic Codes

Hexadecimal Code	Decimal Code	Meaning
00	**00**	**No additional information**
01	01	Invalid P(S) (send-packet sequence number)
02	02	Invalid P(R) (receive-packet sequence number)
10-1F	**16-31**	Invalid packet type
20	**32**	Packet not allowed
21	33	Unidentifiable packet
22	34	Call on one-way logical channel
23	35	Invalid packet type on a permanent virtual circuit
24	36	Packet on an unassigned logical channel
25	37	Reject not subscribed to
26	38	Packet too short
27	39	Packet too long
28	40	Invalid general format identifier
29	41	Restart with nonzero in bits 1-4, 9-16
2A	42	Packet type not compatible with facility
2B	43	Unauthorized interrupt confirmation
2C	44	Unauthorized interrupt
30	**48**	Timer expired
31	49	For incoming call
32	50	For clear indication
33	51	For reset indication
34	52	For restart indication
40	**64**	Call setup problem
41	65	Facility code not allowed

Table B-2 X.25 Diagnostic Codes

Hexadecimal Code	Decimal Code	Meaning
42	66	Facility parameter not allowed
43	67	Invalid called address
44	68	Invalid calling address

Note in the table above that hexadecimal codes 0, 20, 30, and 40 (decimal 0, 32, 48, and 64) stand for general messages that include the specific conditions indicated by the codes that follow them. Your PSDN might return only the codes that stand for the general messages.

Table B-3 lists X.25 diagnostic codes that you might receive when you are running SunLink X.25 over the Connection-Oriented Network Service (CONS).

Table B-3 CONS Diagnostic Codes

Hexadecimal Code	Decimal Code	Meaning
Sent by CONS		
E0	224	Unspecified
E1	225	Disconnect—transient
E2	226	Disconnect—permanent
E3	227	Reject—transient
E4	228	Reject—permanent
E5	229	QOS not available—transient
E6	230	QOS not available—permanent
E7	231	NSAP unreachable—transient
E8	232	NSAP unreachable—permanent
E9	233	Unspecified Reset
EA	234	Reset due to congestion
EB	235	Unknown NSAP
Sent by CONS user (TP0/TP2)		
F0	240	Unspecified

Table B-3 CONS Diagnostic Codes

Hexadecimal Code	Decimal Code	Meaning
F1	241	Normal disconnect
F2	242	Abnormal disconnect
F4	244	Reject—transient
F5	245	Reject—permanent
F6	246	No QOS—transient
F7	247	No QOS—permanent
F8	248	Incompatible NS user data
FA	250	User Reset

Note that you receive the reset codes, hexadecimal numbers E9, EA, and FA, in Reset Request/Indication packets. You receive the remaining codes in Clear Request/Indication packets.

B

Running IP over X.25 C

The aim of the information in this section is to give you an idea of the kind of configuration you need to carry out in order to run IP over X.25, and to help you to find the information you need to do so. *Internetworking with TCP/IP: Principles, Protocols, and Architecture*, by Douglas Comer is a useful source of information on IP routing. The SunOS 5.0 manual *Administering TCP/IP and UUCP* has information on routing that is applicable to your needs within your own autonomous system.

C.1 Configuration Overview

The following is a summary of what you need to do if you if you plan to use IP routing:

- Obtain and allocate IP addresses.
  Every IP network that you intend to connect with other IP networks must have a unique IP network number. To obtain new IP network numbers, contact:

  DDN Network Information Center
  14200 Park Meadow Drive
  Chantilly, VA 22021

  or email `registrar@nic.ddn.mil` or phone 800-365-3642.

- Decide whether to use dynamic or static IP routing.
  You need to weigh the cost of running a dynamic routing protocol such as RIP across and X.25 connection, against the cost of network downtime caused by out of date static routing tables. This decision will be influenced by the size and complexity of your network, as well as by the importance of maintaining connections.

  If you decide to use dynamic routing, you need to initiate RIP, the Routing Information Protocol. This is provided in the file `in.routed`. The contents of the file are broadcast every 30 seconds. You can also use `gated`, if it is available on your system.

  If you decide to use static routing, you need to configure the IP routing table. To do this, you need to add entries to the routing table, using the `route add` command.

  A good compromise between using dynamic and static routing is to configure a static route to a routing gateway that is not attached to the X.25 network. The routing gateway can then handle the dynamic routing of traffic that does not need to cross the X.25 network.

  To look at the contents of the routing table, enter `netstat –r`.
- Provide address resolution information, to allow IP addresses to be translated into X.25 adresses, and vice versa. You do this using the Application Configuration➤IP window. You do not need to do this if you are attaching to the DDN.

C.2 DDN Overview

The DDN differs from other IP over X.25 networks, in that the IP address is used to generate the X.25 address, and there is a mathematical relationship between the two.

SunLink X.25 supports both the DDN X.25 Standard and Basic Services. Connection to the DDN is via the `ixe` or `ixp` interface.

C.2.1 Interfaces Supported

SunLink X.25 suppports all three recommended types of synchronous serial interfaces.

RS-232-C
The CPU ports support the maximum signaling rate specified when using a modem eliminator (9.6 Kb/sec.) or when using a modem (14.4 Kb/sec.). These rates are also supported by the RS-232-C ports on the MCP board.

MIL-188-114 balanced (equiv. to RS-449/RS-422)
The MCP RS-449 ports support a rate of 64 Kb/sec., which is the highest rate supported without a local cable connection to the PSN. The HSI RS-449 ports support a rate of 100 Kb/sec., which the DDN makes available *with* a local cable connection.

V.35
The SunLink HSI product requires a third-party converter to support the V.35 interface. With such a converter, the HSI V.35 ports support the DDN's maximum available rate of 100 Kb/sec.

C.2.2 Standard Service Support

SunLink X.25 supports both the Standard and Basic Services. The DDN Program Management Office has indicated that X.25 Standard Service is the protocol of choice for access to the DDN. In the future, its use will be a requirement for a DDN connection.

X.25 Standard Service is the DDN's intended replacement for the 1822/HDH protocol option. Hosts running X.25 Standard Service can interoperate with all other hosts using X.25 Standard Service, plus hosts using the 1822/HDH Service, provided that all hosts use compatible protocols above the network-access protocols.

X.25 Standard Service is used only as a DTE-DCE (host-PSN) protocol, not an end-to-end (host-to-host) protocol. For end-to-end addressing beyond the DDN, X.25 Standard Service relies on the DoD-standard Internet Protocol (IP). Sun's implementation (as do other X.25 Standard Service implementations) converts the destination IP address in an outgoing packet, obtained from the SunOS IP routing table, to an X.121 address for transmission to the PSN and

across the DDN. After traversing the DDN, the packet's IP address allows it to traverse multiple DoD-protocol gateways as it proceeds toward its ultimate destination.

With X.25 Standard Service, a virtual circuit is established only between the local host (e.g., the Sun X.25 machine) and the PSN. After the host and PSN have established the virtual circuit, the host can establish a TCP/IP connection to *any* host accessible from the PSN.

The X.25 Standard Service implementation is compliant with the CCITT X.25 standard and FIPS 100/Federal Standard 1041.

Compatibility with version 7.0 D

SunLink X.25 version 8.0.1 contains a number of features that allow it to be backwards compatible with version 7.0. You have no need of these features if you do not use SunNet X.25 7.0. The backwards compatibility features are:

- The sockets programming interface
  This is described in the *SunLink X.25 8.0.2 Programmer's Guide.*
- The `vcstat` command.
  This is described below.
- Direct access to layer two (HDLC)
  A variety of communications applications use HDLC. It is therefore possible to run layer two as a standalone protocol.

This appendix also contains a section of "Compatibility Tips", to help you make the most efficient use of your configuration.

D

D.1 The `vcstat` Command

Note – This command has been included as it is familiar to users of SunNet X.25 7.0. In general, use `x25stat`, see Section 4.2, “Checking the Datalink Layer.,” on page 4-14.

The `vcstat` command allows you to monitor link and virtual circuit statistics, on a cumulative or periodic basis. The command has the following syntax

```
% /opt/SUNWconn/bin/vcstat [-L] [-n] [-l interface] [-i interval ] [-p period]
```

The `vcstat` options are explained as follows:

`-L`
Display link-related statistics instead of virtual circuit statistics. By default, `vcstat` displays virtual circuit statistics. Examples of displays for each type of statistics are shown below.

`-n`
Display only cumulative (since reboot) statistics, instead of periodically updated display. By default, `vcstat` displays current statistics at 30-second intervals.

`-l` *interface*
Display statistics for the link specified by *interface*. This *interface* corresponds to the number specified for the `interface` parameter in your link configuration file.

`-i` *interval*
Sampling interval for display of cumulative statistics. If you omit this and the `-n` options, `vcstat` displays cumulative statistics at 30-second intervals.

`-p` *period*
Specifies the length of time, in minutes, `vcstat` will run when it is displaying current statistics. By default, `vcstat` displays statistics for 1440 minutes (24 hours).

D.1.1 Virtual Circuit Statistics

Without the `-L` option (that is, by default), `vcstat` displays statistics for all currently active virtual circuits, rather than for links. For example:

```
hostname% /opt/SUNWconn/bin/vcstat -i10
Tue Sep 18 16:24:23 1990
   If LCN    State Substate Sent Recv Remote address MAC address
O 1 0x200 Data 0/0/0/0 130 130 129.144.133.2
O 1 0x201 Data 0/0/0/0 679 5180 10002244
I 2 0x202 Data 0/0/0/0 501 641 20009988       08:00:20:07:11:a1,0e
```

The fields and headings in the above example display are explained as follows:

Column 1 (no heading)
In the first column you see either `O`, for an outgoing call; `I`, for an incoming call; or `P`, for a permanent virtual circuit.

`If`
Identifies the link over which the call was made. Corresponds to the value of the Link Number parameter in the Define/Modify interfaces➤Interface Configuration window in `x25tool`.

`State`
Displays `Data` when the call is in the data transfer phase of the connection.

`Substate`
Displays four toggles (1 is true, 0 false). From left to right these are:

- Sent Receive Not Ready
- Sent Interrupt
- Received Interrupt
- Received Receive Not Ready

`Sent` and `Recv`
Displays the number of frames sent and received since the last reboot. (These counts are not reset if you stop and restart your link.)

`Remote Address`
This field displays the following types of addresses:

- IP addresses for virtual circuits used for IP connections

- AEFs. This type of address is accompanied by a string, `osi`, `partial-osi`, or `non-osi`, indicating the type of AEF.
- X.121 addresses

`MAC Address`
An LSAP address is present for virtual circuits running over LLC2.

D.1.2 Link Statistics

With the `-L` option, `vcstat` displays link-related, rather than virtual-circuit-related, statistics. It displays statistics for all currently active links. For example, to see link-related statistics, updated every 10 seconds, you enter:

```
hostname% /opt/SUNWconn/bin/vcstat -L -i10
Wed Sep 19 08:56:52 1990
If Type State SABM   Recv   Sent   Abort Crc Over Under
 0 hdlc UP     3      1112   1141   8     20   13 21
 1 hdlc UP     3      239    268    17    45   4   4
 2 llc UP     1      601    589    4     12   0   0
```

The fields in the `vcstat` output are explained as follows:

`If`
Identifies the link number over which the call was made. Corresponds to the value of the Link Number parameter in the Define/Modify interfaces➤Interface Configuration window in `x25tool`.

`Type`
Can be `lapb` or `llc`, identifying the type of connection. The designator `lapb` indicates a serial-link connection, while `llc` indicates an LLC2 connection over a LAN.

Note – For LLC2, `vcstat` collects statistics on a per-physical-link basis, not per dynamic LLC2 link.

`State`
Displays `UP` when the call is in the data transfer phase of the connection and `DOWN` when the call is being set up or taken down. Further, displays `DOWN-SABM` when the link is down and a SABM has been sent; `DOWN-FRMR`, when a link is down and a Frame Reject has been sent; and `DOWN-DISC`, when a link is down and a Disconnect has been sent.

`SABM`
Indicates the number of Set Asynchronous Balanced Mode frames that have been sent. This type of frame is used to establish a frame-layer connection.

`Recv` and `Sent`
Displays the number of frames sent and received since the last reboot. (These counts are not reset if you stop and restart your link.)

`Abort`
Displays the number of aborted received frames. Occurs when the local serial port received a sequence of eight consecutive ones, in violation of LAPB framing rules. Abort errors result from an interruption in the service provided by the link or from clocking problems. Such errors might also be caused by the software running over SunLink X.25. A small number of abort errors probably indicates a software problem rather than a broken link or a persistent clocking problem.

`Crc`
Reports the number of received frames with CRC (Cyclical Redundancy Check, an error detection method) errors. A CRC error is recorded when the checksum on a received frame is incorrect. CRC errors occur when there is a clocking problem (different rates on each side) or a noisy line.

`Over`
Reports the number of receiver overrun errors. Such errors occur when the local system is unable to accept data fast enough and the port hardware buffers overflow. A frame that is not completely received is aborted, triggering error recovery. Underrun errors can occur when the signaling rate in use on a link is too fast for the local system.

`Under`
Reports the number of transmitter underrun errors. Such errors occur when the local system is too busy to service the serial port hardware. A frame that is not completely sent is aborted, triggering error recovery. Underrun errors can occur when the signaling rate in use on a link is too fast for the local system.

D.2 High-Level Data Link Control

Note – The SunLink X.25 8.0 LAPB driver implements an interface that is compatible with SunNet X.26 7.0's HDLC interface. This has been included for backward-compatibility with SunNet X.25 7.0 only. This implementation does not support `hdlcconf`.

SunLink X.25 8.0 supports the Application Program interface that was available in SunNet X.25 7.0. An application program can open HDLC as a file and can control HDLC through SunOS system calls.

Before starting X.25, you need to associate the HDLC driver with the relevant WAN port. To do so, enter:

```
hostname#: iflayer ifdn portname
```

D.2.1 Application Program

You can access HDLC from a program with the same interface used at the user level, the ifnet device. A program can perform all the user-level tasks presented above with standard system calls.

Note – This description assumes that you are familiar with the system calls `open(2)`, `close(2)`, `read(2)`, `write(2)` and `ioctl(2)`. It also assumes that the ifnet device has been initialized and layered.

All of the contents and structures used are in the following include files:

```
#include <stdio.h>
#include <fcntl.h>
#include <errno.h>
#include <sys/ioctl.h>
#include <sundev/syncstat.h>
#include nethdlc/hdlc_ioctl.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <net/if.h>
```

Access HDLC by opening the `ifd` device attached to it. In the examples, this is `/dev/ifd0`. For example:

```
fid = open (“/dev/ifd0”, )_RDWR);
```

To configure HDLC, invoke `ioctl(2)` as follows:

```
int fid, error;
struct hdlc_param_req hpr;
struct hdlc_param *hdlc_param

hdlc_param = &hpr.hp:
/* set fields in structure pointed to by hdlc_param */
error = ioctl(fid, HDLC_SET_PARAM, (caddr_t) &hpr);
```

where `fid` is the value returned by open, `HDLC_SET_PARAM` is the call to set the parameters, and `hdlc_param` is a structure defined as follows:

```
struct hdlc_param {
     u_short hp_t1;        /*T1 - P-bit timer (msec) */
     u_short hp_t2;        /*T2 - max delay before ACK (msec) */
     u_short hp_t3;        /*T3 - max idle link time (msec)
     u_short hp_t4;        /*T4 - LLC2 busy timer (msec) */
     u_short hp_t5;        /*T5 - LLC2 reject timer (msec) */
     u_short hp_t6;        /*T6 - Ack timer (msec) */
     u_short hp_tick; /* resolution of timer (msec/tick) */
     u_short hp_n1;        /*N1 - max frame size - bytes */
    u_char hp_n2;        /*N2 - max retries (used with T1, T4) */
     u_char hp_xcntl; /* extended control - mod 128 */
     u_char hp_k;      /* K - window size */
     u_char hp_addr;   /* address */
```

The value `hp_t1` corresponds to the `–t1` flag parameter of `hdlcconf` command and the values `hp_t2`, `hp_t3`, `hp_tick`, `hp_n1` and `hp_n2` correspond similarly. The `hp_xcntl` is a boolean value. If it is set, then the implementation will operate in Asynchronous Balanced Mode Extended. Otherwise, it will run in Asynchronous Balanced Mode. The window size is set with `hp_k`. Lastly, set the HDLC address with `hp_addr` and the following values:

```
#define LAPB_ADDR_A   0x03   /* commands to DTE secondary */
                             /* responses from DTE secondary */
#define LAPB_ADDR_B   0x01   /* commands to DCE secondary */
                             /* responses from DCE secondary
```

D.2.1.1 Setting Parameters

The kernel does not check the parameters, it assumes they are set to reasonable values. Take care when setting them, as wrong parameters can affect the operation of the HDLC link.

Before setting the parameters, it is advisable to *get* them first with the `ioctl` call `HDLC_GET_PARAM`. The `HDLC_SET_PARAM` and `HDLC_GET_PARAM` calls have the same parameter format.

After setting the HDLC parameters, start HDLC by making the following call:

```
int fid;
error = ioctl (fid, HDLC_INIT, 0);
```

In SunLink X.25 8.0 this is equivalent to executing `hdlcstart` in SunNet X.25 7.0.

D.2.1.2 Data Transfer

To transfer data to or from HDLC, use `read (2)` and `write (2)`. Each operation corresponds to an HDLC frame, which means that each `read` call will return only one packet, even if there is more data waiting and room in the buffer. If there is not enough room in the buffer for the current frame, `read` fails, and the frame is discarded. The buffer passed to a `write` call corresponds to a single HDLC frame. Calls to `write` with a length greater than the maximum frame size (`hp_n1`) fail.

D.2.1.3 Statistics

Note – The command `x25stat` returns more complete statistics than those returned by the procedure shown below.

To get the same statistics as those returned by `hdlcstate` in SunNet X.25 7.0, your program should run the `HDLC_STATS` ioctl call as follows:

```
int fid, error;
struct hdlc_stats_req hsr;
struct hdlc_stats *hdlc_stats;

hdlc_stats = &hsr.he;
error = ioctl(fid, HDLC_STATS, (caddr_t) &hsr);
/* results are in structure pointed to by hdlc_stats */
```

where hdlc_stats is of type struct hdlc_stats shown below:

```
struct hdlc_stats {
      u_short        hs_state;     /* hdlc state */
      u_short        hs_sentsabms; /* sabms sent */
      struct ss_dstats hs_data;    /* data stats */
      struct ss_estats hs_errors; /* error stats */
```

The value hs_sentsabmns is the cumulative total of SABMS that were transmitted, including retry attempts. The field hs_state can be any one of the following:

```
#define HDLCLINK_DOWN 0 /* initial state */
#define HDLCLINK_SABM 1 /* SABM outstanding
#define HDLCLINK_FMR 2 /* FRMR outstanding */
#define HDLCLINK_DISC 3 /* DISC outstanding */
#define HDLCLINK_UP   4 /* information transfer state */
```

The structures ss_dstats and ssestats are defined in the file <sundev/syncstat.h> as follows:

```
struct ss_dstats {
     long ssd_spack;    /* input packets */
     long ssd_opack;    /* output packets */
     long ssd_ichar;    /* input bytes */
     long ssd_ochar;    /* output bytes */
];

struct ss_estats {
     long sse_abort;    /* abort received */
     long sse_crc;      /* CRC error */
     long sse_overrun; /* receiver overrun */
     long sse_underrun; /* xmitter underrun */
```

Their values correspond to the `Total` bytes and `Errors` lines of the `hdlcstate` display.

D.2.1.4 Shutdown

Normally, HDLC remains up for as long as the remote host is physically connected to the local port. For this reason, `close (2)` does not affect the state of HDLC, and any packets queued for output are transmitted.

To shut down HDLC, execute the following ioctl:

```
int fid;
error = ioctl(fid, HDLC_RESET, 0);
```

This puts the line into the `HDLCLINK_DOWN` state. Calls to `read` and `write` will fail, and `errno` is set to `ENETDOWN`. This is the same call that `hdlcstop` uses.

D.3 Compatibility Tips

Follow the tips in the section to make the best possible use of a network that has systems running both SunNet X.25 7.0 and SunLink X.25.

D.3.1 Point-to-Point Configurations

If you configure an IP point-to-point link between a machine running the current release of SunLink X.25 and a machine running 7.0 SunNet X.25, configure the 7.0 machine as the “caller”, rather than “called”. This role is determined by the value of the `mode` parameter in the `x25mgr` configuration file. See page 118 of the 7.0 *SunNet X.25 System Administration Manual* for a description of the `mode` parameter. Also, you should set the Disconnection Timer to a high value

The reason for this is the different treatment of IP point-to-point links by 7.0 SunNet X.25 and the current release of SunLink X.25. The 7.0 product keeps switched virtual circuits up all of the time in support of point-to-point links, while the current release drops the virtual circuits after a specified period of inactivity. If a 7.0 machine is configured as “called”, rather than “caller”, it is

not able to establish an IP connection with a current-release machine until the latter machine sends a Call Request. This does not occur until the current-release machine has IP packets to send to the 7.0 machine. If the 7.0 machine is configured as “caller” (as it should be), there remains the problem that the current-release machine drops the virtual circuit upon inactivity. When this occurs, the 7.0 machine immediately calls to re-establish the virtual circuit. If your PSDN charges for call setup (as many do), such behavior becomes very expensive. To avoid this, change the Disconnection Timer to a figure that will keep the virtual circuit up long enough to outlast periodic gaps in IP traffic.

D.3.2 Setting the Max. NSDU

If you have an IP/X.25 link between a current-release SunLink X.25 machine and a machine running 7.0 SunNet X.25, set Max NSDU to at least 1024. Otherwise IP connections can hang when a high volume of data is sent from the 7.0 machine. If you have two current-release machines on each side of the link, set Max NSDU to be the same on both sides. It can be as high as 8192.

Glossary

CCITT

See **Consultative Committee for International Telephony and Telegraphy.**

Consultative Committee for International Telephony and Telegraphy (CCITT)

An international organization of communication carriers, most of which are government telephone and telegraph agencies. The CCITT develops telecommunication standards through the use of their recommendations. The X.25, X.3, and X.29 standards originated as CCITT recommendations.

Closed User Group (CUG)

A PSDN-provided service that permits the DTEs belonging to the group to communicate with each other, but precludes communication with other DTEs. A single DTE can belong to multiple CUGs. The PSDN, not the caller or called parties, enforce the limitation inherent in a CUG.

CUG

See **Closed User Group**.

Data Circuit-terminating Equipment (DCE)

The network side of the user-to-network interface. Commonly corresponds to a modem or other device used to connect to a PSDN.

Data Network Identification Code (DNIC)

A four-digit number that identifies a specific PSDN. The DNIC is the first component of a complete X.121 address and is comparable to the exchange portion of a telephone number used for switched telephone service. In a

DNIC, the first three digits make up a data country code, which identify a country, while the remaining digit can be used to distinguish up to 10 different networks within the specified country.

DCE

See **Data Circuit-terminating Equipment**.

DNIC

See **Data Network Identification Code**.

DTE

See **Data Terminal Equipment.**

Data Terminal Equipment (DTE)

The device at the user's side of a user-to-network interface. This might be a computer system (packet-mode DTE) or a character-mode terminal (DTE-C), and is both a source and destination for data.

DTE-C

See **Data Terminal Equipment-Character Mode**.

Data Terminal Equipment-Character Mode (DTE-C)

A character-mode (asynchronous) terminal that uses a PAD to connect to a remote host across a PSDN. Part of the SunLink X.25 software plays the role of a DTE-C when you use the PAD application that is shipped with the product.

NTN

See **Network Terminal Number**.

Network Terminal Number (NTN)

The component of a complete X.121 address that identifies a specific DTE.

packet

A sequence of bits representing data and associated control information. Is self-contained in that it has routing and packet-sequence information. Commonly used to refer to the structure and format defined by the X.25 recommendation.

packet switching

A data transmission technique in which user information is broken up into discrete, self-contained units called packets. Packet switching has two distinctive characteristics: 1) it allows a communication channel to be shared

by many users, each using the circuit only for the time required to transmit a single packet and 2) it allows for the individuals packets that make up a message to be routed over the optimal path of a given moment. See **packet**.

Packet Assembler/Disassembler (PAD)

A device that resides between one or more character-mode devices, such as asynchronous terminals (or terminal emulation software), and a PSDN. On the terminal side, the PAD accepts asynchronous characters, assembles packets from these characters, and forwards the packets to the PSDN. On the PSDN side, the PAD accepts packets, disassembles the packets into asynchronous characters, and forwards the characters to the terminal(s).

Packet-Switched Data Network (PSDN)

A more general term than **Public Data Network**, refers to any public or private packet-switching network that provides X.25-compliant interfaces to its users.

PAD

See **Packet Assembler/Disassembler**.

PDN

See **Public Data Network**.

permanent virtual circuit

A permanent, logical association between two physically separate DTEs that does not require call set-up or clearing procedures. Analogous to a leased line in a circuit-switched telephone network.

PSDN

See **Packet-Switched Data Network.**

Public Data Network (PDN)

A data communications network whose services are available to any user willing to pay for them. Tymnet and Telnet are examples of PDNs in the United States; the public telephone and telegraph agencies of European and Asian nations are also examples of PDNs. SunLink X.25 product documentation usually uses the term “Packet-Switched Data Networks” in preference to “Public Data Network”, as the former is more general than the latter.

PVC

See **permanent virtual circuit**.

Recognized Private Operating Agency

An X.25 user facility that provides for user specification of a particular RPOA transit network through which a call is to be routed internationally when more than one RPOA transit network exists at an international gateway.

RPOA

See **Recognized Private Operating Agency.**

subaddress

An optional component of an X.121 address that identifies a specific application on a DTE.

SVC

See **switched virtual circuit.**

switched virtual circuit

A temporary logical association between two physically separate DTEs that exists only for the duration of the data transfer. Call setup and call clearing procedures are required with a switched virtual circuit. Analogous to an everyday phone call on a circuit-switched telephone network.

X.21*bis*

A set of CCITT recommendations that define the physical interface between a DTE and a DCE of a public data network. Access to the DCE is through synchronous modems and voice-band lines. Equivalent to RS-232-C and V.24/V.28.

X.25 client

An application layered above X.25.

X.28

Defines the format of the terminal user's instructions to the PAD—referred to as PAD command signals—and the format of the PAD's responses to the terminal—referred to as PAD service signals.

X.29

Defines the interface between PADs and packet-mode DTEs or other PADs.

X.3

Describes the functions of the PAD and the various parameters used to specify its mode of operation.

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