

# *Managing SunLink<sup>®</sup> X.25 9.0*



*SunSoft*

A Sun Microsystems, Inc. Business

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## *Preface*

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This guide covers the configuration, use, and troubleshooting of SunLink X.25 9.0. It also provides reference material. This guide does not cover the installation and licensing of SunLink X.25 9.0. For this, refer to *Installing and Licensing SunLink X.25 9.0*. It also does not cover the use of the Packet Assembler/Disassembler delivered as part of the product. For this, refer to the *SunLink X.25 9.0 PAD User's Guide*.

### *How This Book Is Organized*

This book contains the following chapters and appendices:

**Chapter 1, “About SunLink X.25,”** is an overview of the SunLink X.25 9.0 product.

**Chapter 2, “About X.25,”** provides background information on the X.25 Recommendations.

**Chapter 3, “Planning your SunLink X.25 Configuration,”** covers some points you may wish to consider when planning your configuration.

**Chapter 4, “Configuring SunLink X.25 using x25tool,”** introduces the GUI tool x25tool and provides a walk-through of carrying out a basic configuration using it.

**Chapter 5, “Configuring SunLink X.25 by Editing the Configuration Files,”** introduces the configuration fields and provides a walk-through for carrying out a basic configuration by editing them.

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**Chapter 6, “Configuring SunLink X.25 Applications,”** covers the configuration of the PAD and IP applications.

**Chapter 7, “Configuring uucp and tip to run over SunLink X.25,”** is a description of how to configure `uucp` and `tip` to run over X.25.

**Chapter 8, “A Server to Receive PAD Calls,”** is an example of configuring an X.25 server to receive PAD calls from a number of remote machines.

**Chapter 9, “A Server as an IP Router,”** is an example of configuring an X.25 server to act as an IP router.

**Chapter 10, “A Server with Multiple WAN Links,”** is an example of configuring an X.25 server with multiple WAN links to use X.25 routing.

**Chapter 11, “A Dial-up Configuration,”** is an example of configuring a machine using X.25 to dial into a PSDN.

**Chapter 12, “A Workstation attached to a LAN,”** is an example of configuring a machine attached to an X.25 LAN.

**Chapter 13, “An MLP Configuration,”** is an example of configuring a machine to use the MultiLink Protocol (MLP).

**Chapter 14, “A PC running X.25 on the LAN and on the WAN,”** is an example of configuring a PC with the Solaris x86 operating system to use SunLink X.25.

**Chapter 15, “Test Configurations,”** covers the configuration of back-to-back and loopback configurations, both of which are useful for testing.

**Chapter 16, “Parameter Reference,”** provides reference information on all available parameters.

**Chapter 17, “Cabling,”** describes the cables that you may need to make or buy.

**Chapter 18, “SunLink X.25 Command Line Utilities,”** lists the available command line utilities.

**Chapter 19, “Troubleshooting,”** contains information to help you deal with common problems.

**Appendix A, “Configuration File Format and Values,”** lists the available keywords and parameters for the configuration files.

**Appendix B, “Error Messages and Error Codes,”** lists and explains error messages.



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**Appendix C, “SunNet Manager Agent,”** provides the information you need to manage SunLink X.25 using SunNet Manager.

**Appendix D, “Compatibility with version 7.0,”** provides some information you need if you require SunLink X.25 9.0 to co-exist on a network with SunNet X.25 7.x.

**Glossary** is a list of words and phrases found in this book and their definitions.

## What Typographic Changes Mean

The following table describes the typographic changes used in this book.

Table P-1 Typographic Conventions

Typeface or Symbol	Meaning	Example
AaBbCc123	The names of commands, files, and directories; on-screen computer output	Edit your <code>.login</code> file. Use <code>ls -a</code> to list all files. <code>machine_name%</code> You have mail.
<b>AaBbCc123</b>	What you type, contrasted with on-screen computer output	<div><code>machine_name% su</code> <code>Password:</code></div>
<i>AaBbCc123</i>	Command-line placeholder: replace with a real name or value	To delete a file, type <code>rm filename</code> .
<b><i>AaBbCc123</i></b>	Book titles, new words or terms, or words to be emphasized	Read Chapter 6 in <i>User's Guide</i> . These are called <i>class</i> options. You <i>must</i> be root to do this.

---

## *Shell Prompts in Command Examples*

The following table shows the default system prompt and superuser prompt for the C shell, Bourne shell, and Korn shell.

*Table P-2*    Shell Prompts

<b>Shell</b>	<b>Prompt</b>
C shell prompt	machine_name%
C shell superuser prompt	machine_name#
Bourne shell and Korn shell prompt	\$
Bourne shell and Korn shell superuser prompt	#

# About SunLink X.25

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1 

<i>SunLink X.25 9.0 Product Contents</i>	<i>page 3</i>
<i>SunLink X.25 9.0 Features</i>	<i>page 6</i>

The information in this section is specific to the SunLink X.25 9.0 product. For general X.25 information, refer to Chapter 2, “About X.25.” For information on other releases of the SunLink X.25 product, refer to the release specific documentation.

SunLink X.25 9.0 is an implementation of the ITU-T's (formerly CCITT) X.25 Recommendations, together with some other, related software. Using SunLink X.25 9.0, you can make connections to a Packet Switched Data Network (PSDN), and connect to remote devices that are running any standard-compliant implementation of X.25.

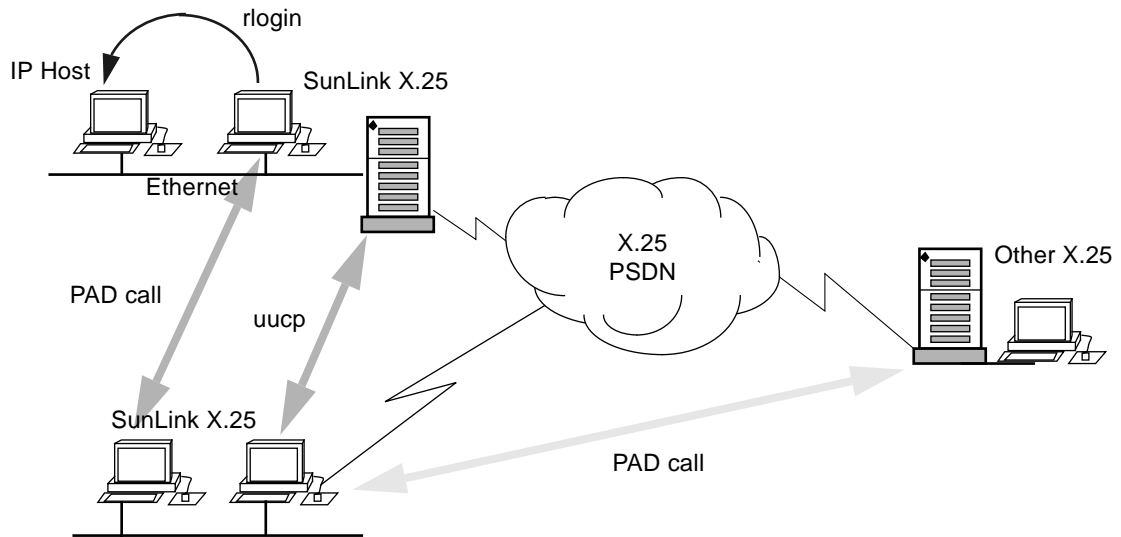


Figure 1-1 SunLink X.25 Overview

Figure 1-1 shows some of the ways you can use SunLink X.25 to make connections with remote devices:

- PAD calls from Sun workstations running SunLink X.25 to Sun workstations and servers running SunLink X.25 and to remote systems running other implementations of X.25.
- PAD calls from one X.25 device to another, from where the user can `rlogin` to a non-X.25 IP host.
- `uucp` connections with remote X.25 devices.
- route IP between TCP/IP networks

---

**Note** – All of the connections shown in the diagram are made across the X.25 PSDN. Also, more than one user can connect to a remote device at a time.

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## SunLink X.25 9.0 Product Contents

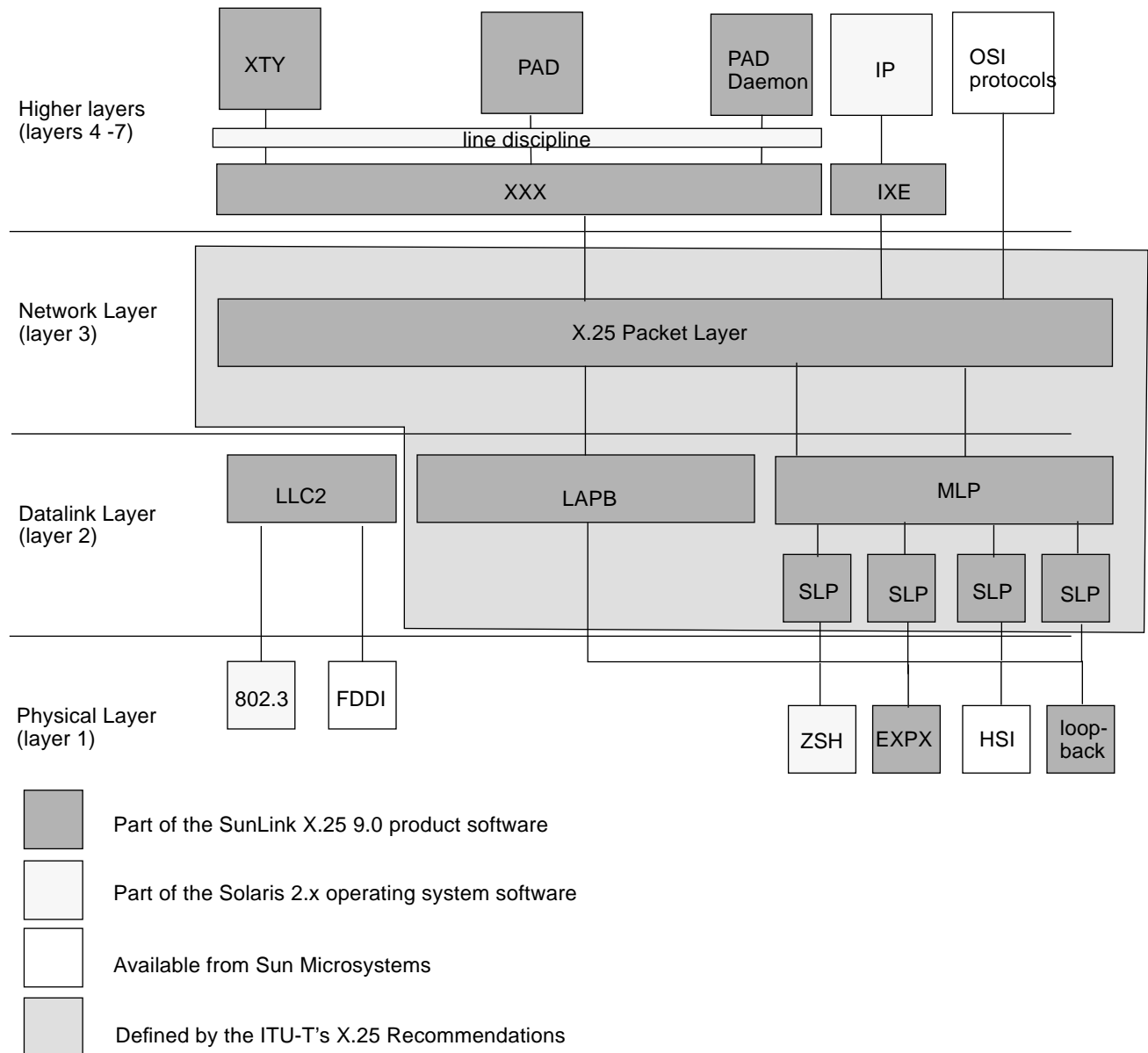


Figure 1-2 SunLink X.25 product contents

Figure 1-2 summarizes the contents of the SunLink X.25 9.0 product.

The SunLink X.25 9.0 product, together with the software provided with the Solaris 2.x operating software, is enough to make full use of the facilities offered by X.25. You can also interwork with the other Sun products shown in the diagram.

## *Components of the SunLink X.25 9.0 Product*

The SunLink X.25 9.0 product contains the following components:

### **XTY**

A pseudo-device that lets applications access the PAD software to make outgoing calls.

### **PAD software**

The Packet Assembler/Dissassembler software. This allows you to make PAD calls to remote machines that are running X.25.

### **PAD Daemon**

The software that listens for incoming PAD calls and determines how they are to be treated.

### **XXX**

The three ITU-T recommendations that control operation of the PAD—X.3, X.28 and X.29—are commonly referred to as the triple X standards.

### **IXE**

Software providing an interface between IP, the Internet Protocol and the X.25 Packet Layer.

### **X25 Packet Layer Protocol**

Layer 3 of the ITU-T's X.25 Recommendation is known as the X.25 Packet Layer. Sometimes this is shortened to just X.25.

### **LLC2**

Logical Link Control Class 2. This provides the datalink layer for 802 LANs, such as Ethernet, Token Ring and FDDI.

**LAPB**

Link Access Procedure Balanced. Provides the datalink layer over WAN interfaces.

**MLP**

MultiLink Procedure. Provides the datalink layer allowing a DTE and a DCE to connect using more than one WAN interface.

**SLP**

Single Link Procedure.

**EXPX**

The driver for the SCiiExpress-X card used by the x86 version of the product.

**Loopback**

The driver for the loopback interface.

## *Solaris System Software used with SunLink X.25*

The SunLink X.25 9.0 product uses the following software that is supplied as part of the Solaris 2.x system software:

**IP**

The Internet Protocol. The TCP/IP protocol suite is the de facto standard for networking. IP, the Internet Protocol, can be run above X.25, creating a Wide Area Network using TCP/IP. This allows for the use of `rlogin`, `ftp` and other useful facilities. The TCP/IP protocol suite is delivered as part of the Solaris 2.x system software

**Line Discipline**

The standard STREAMS line discipline modules.

**802.3**

The Ethernet interface.

**ZSH**

A Sun workstation's onboard serial port.

## *Products that interwork with SunLink X.25*

SunLink X.25 9.0 forms part of a complete networking solution. As such, it interworks with other products—both from Sun and from other vendors. In addition to IP routing, you can use the following software, available from Sun Microsystems, with the SunLink X.25 9.0 product:

### **OSI**

You can run the OSI protocol stack, using the SunLink X.25 9.0 product as the bottom 3 layers.

### **FDDI**

You can run SunLink X.25 9.0 on an FDDI network.

### **HSI**

This is the High Speed Interface, available as a separate product from Sun Microsystems. This provides 4 WAN interfaces and allows for higher speeds and better performance than the onboard serial port.

## *SunLink X.25 9.0 Features*

This section summarizes the features provided by SunLink X.25 9.0.

### *New in this Release*

The following features have been added in release 9.0:

- A revised `x25tool`  
`x25tool` has been simplified. The kernel parameters screen has been removed, as these parameters are now handled automatically by the SunLink X.25 software. The network master files are created automatically when you start the network.
- New configuration files  
You can also configure SunLink X.25 9.0 by editing the new configuration files delivered with the product. This allows users who do not have access to a Graphical User Interface such as the OpenWindows or Motif environments to carry out a full configuration of the X.25 software.



- **MultiLink Procedure**  
This allows for more than one physical interface to be used to connect a DTE and a DCE.
- **DLPI**  
The Data Link Provider Interface is a standard way of writing application programs directly above the datalink layer.
- **X.32**  
A client-only implementation of X.32, which provides authentication and is most useful for dial-up calls.
- **V.25**  
V.25 allows SunLink X.25 to be used in dial-up configurations. V.25 is not available if you are using the Solaris 2.3 operating system. Contact your supplier to arrange an upgrade if necessary. To use V.25 with the Solaris 2.4 operating system, contact your supplier for a patch for the `zsh` driver.

### *Feature Summary*

- The software allows for up to 4095 virtual circuits. Machine resources and the configuration of your X.25 network may constrain you to a 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 1356.
- 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 daemon
- APIs: STREAMS-based Network Layer Interface and sockets module for backward compatibility with 7.0 SunLink X.25. DLPI interface.

- 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, and up 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.

## *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
- MLP

SunLink X.25 does not support:

- on-line facility registration
- the hunt group facility



## About X.25



<i>Dial-Up and Leased Lines</i>	<i>page 14</i>
<i>Permanent and Switched Virtual Circuits</i>	<i>page 15</i>
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<i>X.25 Packet Layer Protocol</i>	<i>page 22</i>

This section provides an overview of X.25 concepts. None of the information in this chapter is specific to SunLink X.25 9.0—it applies to any implementation conforming to the X.25 Recommendations. Understanding the concepts explained here will help you make better use of the SunLink X.25 9.0 product.

The X.25 protocol suite enables the exchange of data between X.25 systems across Packet Switched Data Networks, and Local Area Networks. Systems running one implementation of X.25, for example SunLink X.25, can exchange data with systems running any other implementation of X.25.

It is conventional to represent an X.25 network as a cloud, as in Figure 2-1. What is going on inside the cloud?

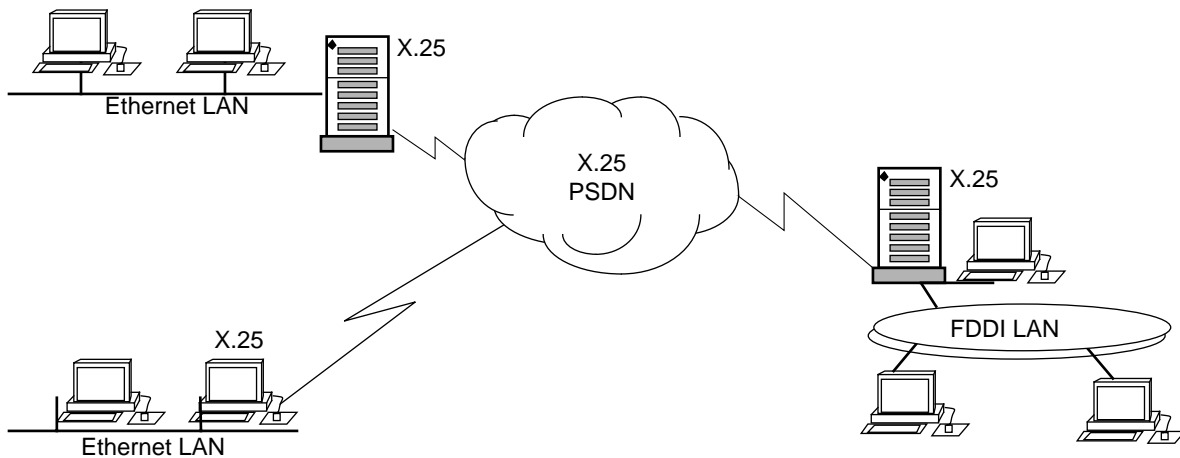


Figure 2-1 X.25 Overview

As Figure 2-2 shows, X.25 defines the way the interface between a system running X.25 (often referred to as a DTE) and a system providing a network connection (often referred to as a DCE) works. There is almost always a modem between the DTE and the DCE to handle the physical connection. However, this is transparent to X.25. X.25 does not define the means of transmission that should be used between the two DCEs.

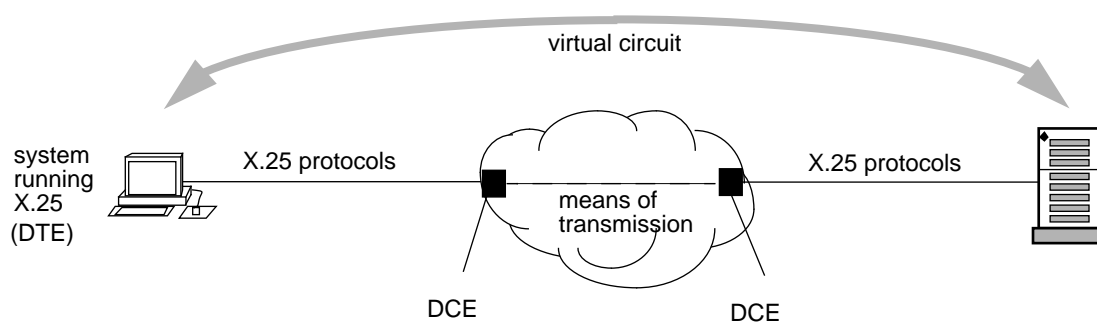


Figure 2-2 X.25 Detail

### *Dial-Up and Leased Lines*

When connecting to a public network, for example one administered by a PTT, you must choose between using dial-up access and using leased lines.

A leased line is a line allocated to you by the network's administration. You pay for exclusive use of this line and for it to be configured to your specification. You can only change the characteristics of this line in consultation with your network provider. For leased lines, the service provider typically provides a suitable modem for connecting your DTE to the network.

Dial-up access means that there is no particular line allocated for your use. When a DTE needs to access the public network, it uses a modem to place a call to the network. This means that there are no rental or set-up charges as there are with a leased line, charging is done on a per-call basis. Most dial-up services use the X.32 protocols to provide a degree of authentication, so the network knows the call is coming from an approved user.



---

## *Permanent and Switched Virtual Circuits*

The end-to-end (DTE to DTE) connection provided by the X.25 Recommendations is called a virtual circuit. This is *not* a physical connection between the DTEs, it is a *logical* communication path. Public networks offer two types of virtual circuit—permanent and virtual. Typically a subscription consists of a mixture of the two.

A permanent virtual circuit (PVC) is a permanent association between two DTEs that is established when a user subscribes to a public network. Many providers charge a flat rate per month for a PVC in addition to the charge per unit of data.

A switched virtual circuit (SVC) is a temporary association between two DTEs that exists only for the duration of a call. Most providers charge per minute for an SVC in addition to a charge per unit of data.

In general, SVCs work out cheaper than PVCs unless two end-points need to be in constant communication, but this varies between providers depending on their tariff structure.

SVCs and PVCs can both be used across both Dial-up and Leased Lines. However, using a PVC with a Dial-up Line is unlikely to be useful.

### *The X.25 Recommendations*

X.25 is defined in a series of documents issued by the International Telecommunication Union—Telecommunication Standardization Sector. These documents are called the X.25 Recommendations and specify the following:

- X.25 Physical Layer
- X.25 datalink layer - LAP, LAPB and MLP
- X.25 Packet Layer Protocol

The X.25 Recommendations were first specified in 1976. They were revised in 1980, 1984, 1988 and 1993. It is common to refer to versions of the X.25 Recommendation by the year in which they were issued—for example X.25(1984). In practice the 1980, 1984 and 1988 versions are the most widely used.

The component layers of X.25 fit together as shown in Figure 2-3:

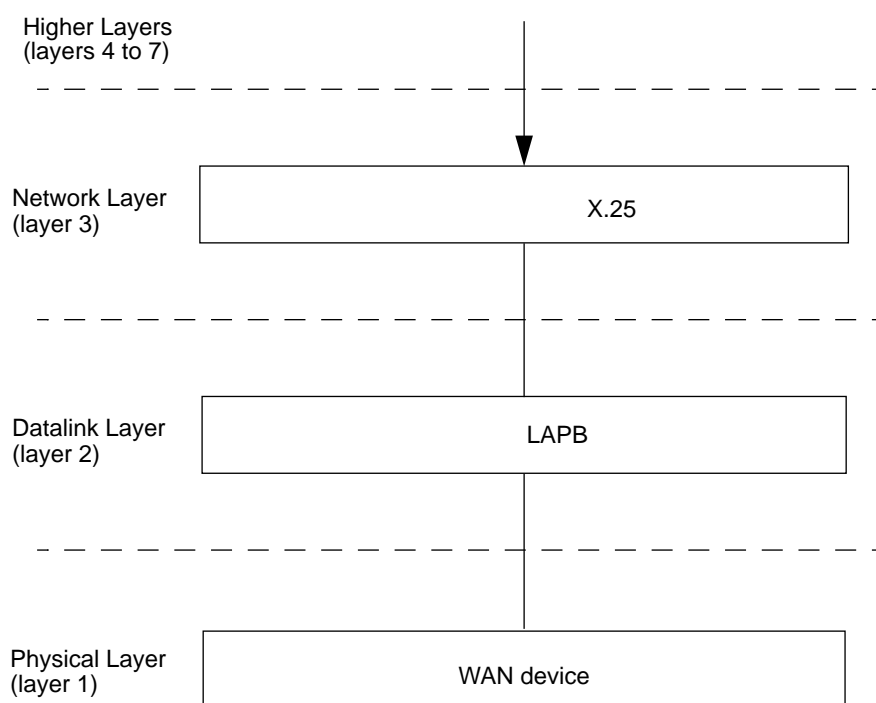


Figure 2-3 X.25 Protocol Layers—Overview

### *X.25 Physical Layer*

As with any protocol stack, the physical layer specifies the mechanical, electrical, functional, and procedural characteristics that are necessary to activate, maintain, and terminate a physical connection between the DTE and DCE.

The ITU-T X.25 Recommendation does not itself specify how the physical layer should work. Instead, it refers to other ITU-T Recommendations, and specifies which of these may be used. The Recommendations specified are: X.21, X.21 bis, X.31 and the V-series interfaces, that is V24 and V25bis.

## X.25 Datalink Layer

The *datalink layer's* role is to specify the link access procedure for the exchange of data across the physical link. This layer acts as an envelope for data provided by higher layers, and must ensure that all data transmitted at one end of a link reaches the other end intact and in sequence.

This means that as well as mechanisms for transmitting data, the datalink layer must provide ways of telling whether data has reached its destination correctly, and retransmitting if it has not.

The X.25 Recommendation defines two possible datalink layers: LAP and LAPB. In practice, LAP is rarely used. A Multilink Procedure (MLP) allows for multilink operations. It is used along with LAPB.

### Single Link Operations

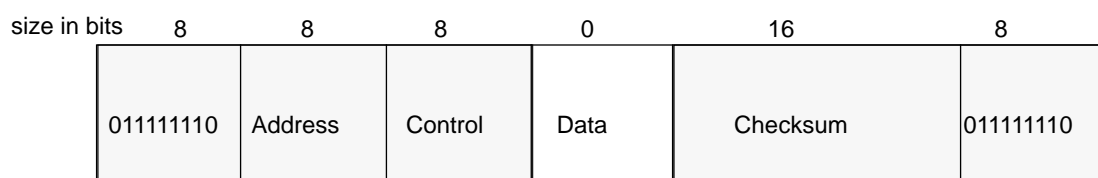


Figure 2-4 Datalink layer frame structure

Figure 2-4 shows the standard frame structure for a bit-oriented datalink layer Frame. The shaded parts are supplied by the datalink layer. The Data field contains the data supplied by higher layer protocols. datalink layer Frames are structured as follows:

#### Flag

Frames are delimited at each end by a flag, with the value 01111110. This is necessary because X.25 is synchronous - in other words, data is transmitted as a continuous stream.

## Address

This is one octet. The value varies, depending on the direction of data flow, and on whether this is a single or multilink operation.

## Control

The control octet defines the type of frame this is: an I(nformation)-frame containing data, a S(upervisory)-frame, which is a response frame, or an U(nnumbered)-frame, which performs control functions.

## Checksum

The two-octet checksum follows the data, and is derived from the contents of the data packet. It is usually generated automatically by the hardware.

## Multilink Operations

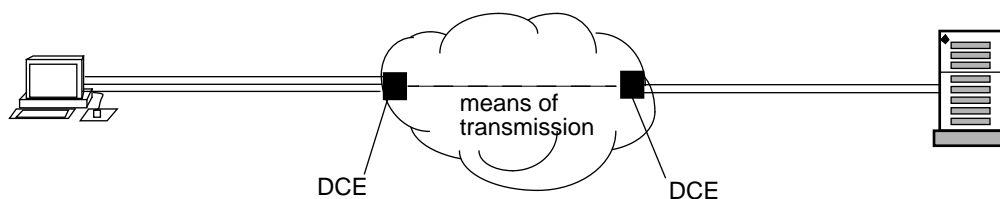
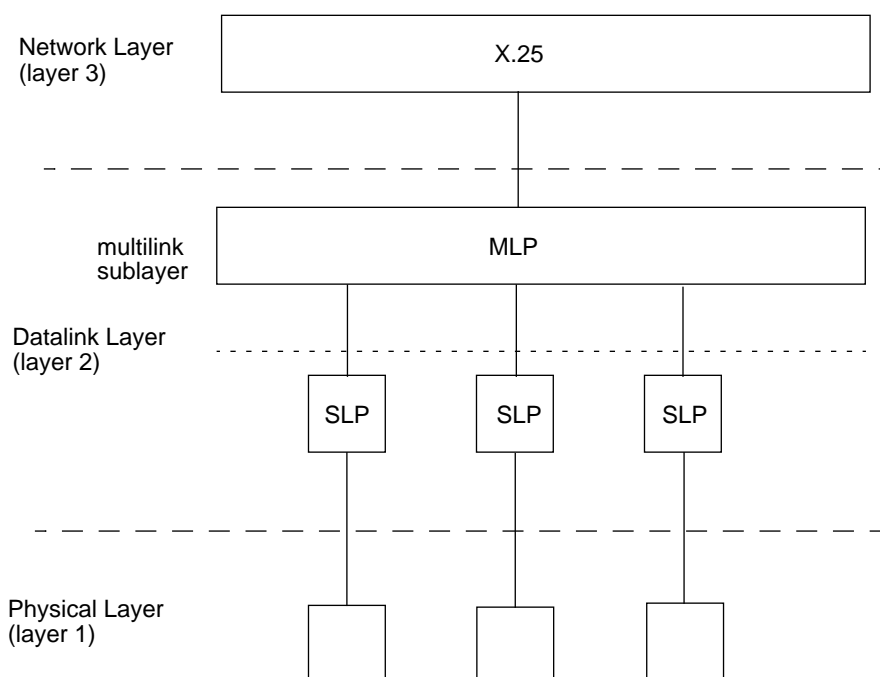


Figure 2-5 Multilink Operation

The Multilink Protocol (MLP) lets you use more than one *physical* connection to make a single *logical* connection. This increases the amount of bandwidth available between the DTE and DCE improving response times and increasing traffic levels. An MLP connection does not provide a multiple channel end to end connection to remote DTEs. Not all of the DTEs attached to the PSDN need to use MLP and not all need to use the same number of physical connections.

The internal structure of X.25 when using MLP is shown below:

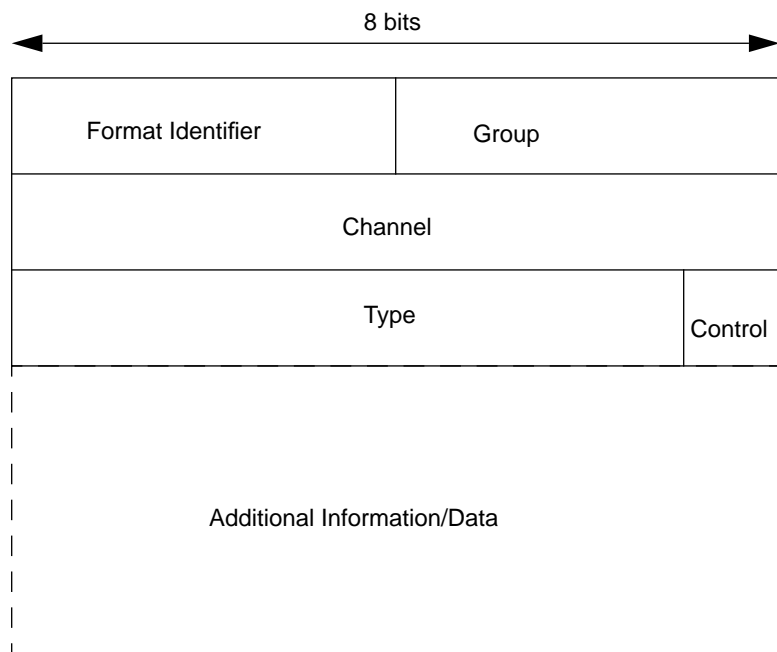


MLP frames have two octets that are not present in the standard datalink frame shown in Figure 2-4 on page 19. They allow each frame to have a sequence number so that they can be reassembled in the correct order at the receiving end. They are placed between the control octet and the data.

## *X.25 Packet Layer Protocol*

Layer 3, the Packet Layer Protocol, manages the exchange of data packets between DTE and DCE. This layer establishes, maintains, and terminates user sessions, handles addressing and carries out fault-management.

The general format of an X.25 packet-header is shown below:



The components are:

### General Format Identifier

This specifies the format of the rest of the header, which varies according to packet-type.

### Group and Channel

Together, the Group and Channel fields identify the virtual circuit to be used for a call.



### Type

In a control, that is a non-data, packet, the type field identifies the type of the packet. In a data packet, the type field is used for setting flow control, sequencing, and piggybacking information.

### Control


The Control field specifies whether this is a control or a data packet. It is set to 1 for control packets and 0 for data packets.

In data packets, the header is followed by data. In control packets, the header is followed by additional information that specifies, among other things, addressing and any special facilities that are to be used.



## *Planning your SunLink X.25 Configuration*

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3 

<i>Connecting to a Public Network</i>	<i>page 26</i>
<i>Connecting to a Private Network</i>	<i>page 27</i>
<i>Planning an IP over X.25 Configuration</i>	<i>page 27</i>

Before you install and configure SunLink X.25 9.0, you need to decide how it will be used and how it will interact with other software present on your network.

## *Connecting to a Public Network*

If you want to connect to a public network, for example one managed by a PTT, you need to provide the network administering body with information about the kind of connection and configuration you would like. Typically, when you contact the administering body, you are sent a network subscription form. Use this to specify what you want. Public networks vary in the services they offer and in the information they require. You may need to supply some or all of the following information:

- **Do you want dial-up line or a leased line**  
Consider the tariff structure of the public network you are attaching to and the type of use you intend to make of your network connection.
- **Do you want a single connection or an MLP connection?**  
You can only use MLP across a public network if you have subscribed to an MLP type line.
- **What mix of Permanent and Switched Virtual Circuits do you need?**  
A Permanent Virtual Circuit (PVC) is a permanent association between two specified end-points. A Switched Virtual Circuit (SVC) is a temporary association between two endpoints, established for the duration of a call. Compare the tariff structures for PVCs and SVCs before deciding how many of each you need. Some network providers charge a flat rate per month for PVCs and a charge per minute for SVCs, as well as a charge per unit of data on either type of virtual circuit. In general, SVCs tend to be cheaper unless two end-points need to be in permanent communication, but this may not be true for all networks.
- **What line speed would you like?**  
This is worth investigating carefully, as line speed can have a significant impact on network performance and on the price you will pay for your connection. Consider factors such as the volume of data you expect to transfer, the level of interactive traffic, the type of virtual circuits you plan to have, the expected duration and frequency of connections, the types of modems you have available, and so on.
- **What is the maximum size of I-Frame you need?**  
This must be larger than the maximum possible packet size on your network.

- **How many times should a frame be retransmitted before an error is reported?**  
A large value increases the chance of data getting through correctly. A small value allows fast detection of errors.
- **What is the maximum packet size you require?**  
In most cases, use the default value of 128 is appropriate.
- **What is the maximum window size you require?**  
In most cases, use the default value of 2. A larger window size increases throughput but may also have cost implications.
- **Which throughput class do you require?**  
The throughput class determines the amount of resources allocated to a virtual circuit. In most cases, it is determined by the line speed.
- **Do you need non-standard flow control?**  
If you have chosen non-default packet and window sizes, you may need to use non-standard flow control.
- **Do you want local or remote packet acknowledgment?**  
Local packet acknowledgment is simpler, unless a particular application requires remote packet acknowledgment.

## *Connecting to a Private Network*

If you are connecting to or creating a private network, you need to consider all of the issues described in “Connecting to a Public Network,” although cost is not an issue in this case. If you are creating a new network, you may find it simpler to use the default values provided by the SunLink X.25 9.0 software, at least in the first instance. You can tune the configuration later.

## *Planning an IP over X.25 Configuration*

This section gives 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.

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 addresses, 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. The DDN uses an automatic address translation mechanism, defined in RFC 1236.

# Configuring SunLink X.25 using x25tool

4 

<i>x25tool Overview</i>	<i>page 29</i>
<i>Configuring a Single WAN Link</i>	<i>page 33</i>

This chapter introduces `x25tool` and provides a walk-through showing how it is used.

## `x25tool` Overview

`x25tool` provides a graphical interface to the parameters required to configure and maintain the SunLink X.25 software. The parameters are held in a group of configuration files.

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**Note** – To run `x25tool` you require a window system, such as OpenWindows™ or Motif®. If you do not have access to such a system, you can edit the configuration files directly, see Chapter 5, “Configuring SunLink X.25 by Editing the Configuration Files.”

---

Using `x25tool`, you can:

- Make changes to the *working* configuration. This is the configuration information held in the startup files. Changes you make here will come into effect the next time you stop and restart the SunLink X.25 software.

- Make changes to the *active* configuration. Changes made affect existing X.25 connections and may disrupt users, so this should be done with care. Changes to the active configuration are made in the kernel. They are lost the next time you restart the SunLink X.25 software. To keep them, copy them either to the working configuration, so they are kept on next restart, or to a named configuration file.
- Save changes to a named file, or read in the configuration contained in a named file. You might want to keep a backup, for example, or create a template file suitable for your particular network. Changes saved to a named file do not come into effect until you copy the file to either the working or active configuration.

Changes take effect immediately and are lost on next restart. Changes affect the kernel.

Changes stored in start-up file and take effect on next restart.

Changes stored in named file. Take effect when copied to Active or Working.

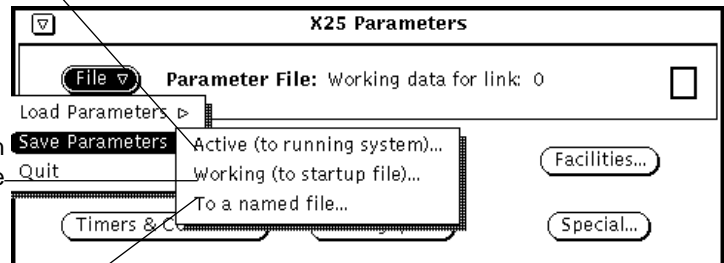


Figure 4-1 Saving your changes



`x25tool` is organized into menus giving access to the following parts of the configuration:

*Table 4-1* `x25tool` menu summary

Menu	Menu Item	Description
Control	Start X.25 Network	Create the network master files and start SunLink X.25.
	Stop X.25 Network	Stop all the daemons associated with the X.25 system software.
	Network Statistics	Gather and displays statistics on traffic.
	Start X.25 automatically when booted	Restart SunLink X.25 every time the machine is rebooted.
	Do not start X.25 automatically	Cancel the automatic restart.
	Quit config tool	Quit the configuration tool.
Links	Create/Modify	Create a new physical link, or modify or delete an existing one.
	WAN link status	Display a summary of the available links and packet and datalink layer.
	WAN link control	Start, stop or reset an individual link, without affecting the SunLink X.25 software as a whole.
Parameters	Packet (X25) parameters	Configure the packet layer (PLP) parameters used on a link or links. These are presented in six subscreens: Network Profile, Link Modes, Facilities, Timers and Counters, Throughput and Special.
	Datalink (LAPB/MLP/LLC2) parameters	Configure the datalink layer and physical layer parameters used by a link or group of links.
	Routing	Configure X.121 routing.
	X.32 authentication	Configure X.32 authentication

*Table 4-1* x25tool menu summary

Menu	Menu Item	Description
Applications	Network User ID map	Configure the Network User ID map
	PAD	Configure the PAD Hosts Database and PAD Listen Database
	IP	Configure X.25 to handle IP running above it.

There is also a Help menu. This provides a summary of the configuration process. To get help on a particular item while using `x25tool`, place the pointer on the item you'd like help on, and press the Help key on your keyboard.

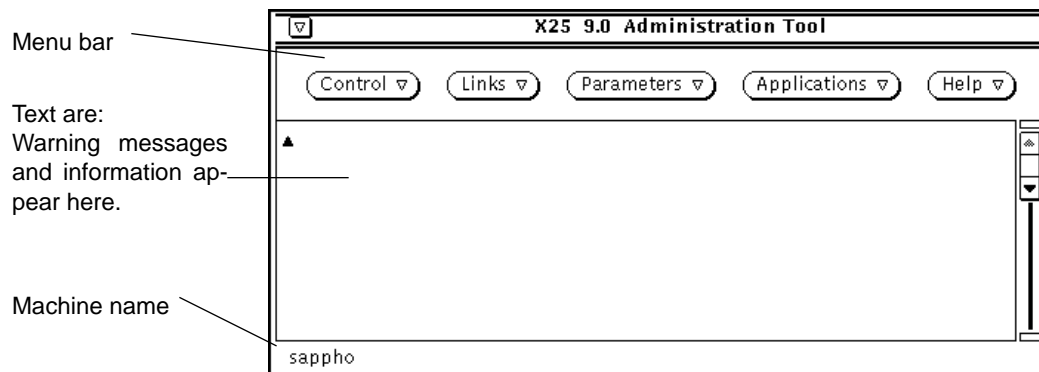
**Note** – The Kernel parameters screen that was present in SunLink X.25 8.x is no longer needed as this configuration is now handled automatically.

To start `x25tool` with read and write permission, log in as `root` or become superuser and, enter:

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

Starting `x25tool` without `root` permission gives you read-only access.

The `x25tool` base window appears. It looks like this:



You can access all of the configuration parameters from the `x25tool` base window, by pulling down the menus in the menu bar. To display a menu, click the MENU button of your mouse (often the rightmost button) on the menu button. To choose a menu item, click the SELECT button of your mouse (often the leftmost button) on the item.

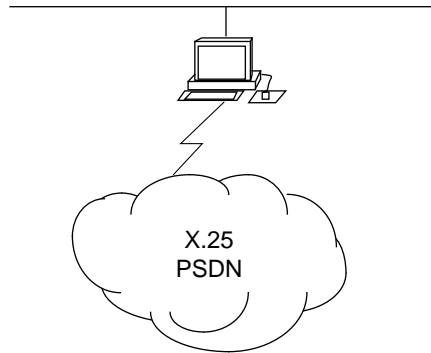
## Configuring a Single WAN Link

This section describes how to configure a single dedicated WAN link for SunLink X.25. The configuration described in this chapter uses the default values provided with the product. It should work in the majority of situations, although it will not necessarily make the best possible use of the product's capacities. Once you have a link that works, you can go on and fine-tune it.

The example uses the SPARC™ version of the product. The process is almost identical for all versions of the product, but the device names change. Refer to Chapter 14, "A PC running X.25 on the LAN and on the WAN," for an example using the x86 version of the product.

The procedure for setting up a dial-up link is slightly different from that for setting up a leased line, and involves some extra considerations. Refer to Chapter 11, "A Dial-up Configuration," for an example.

This section describes the following configuration:



The workstation's onboard serial port `zsh0` is connected to a modem using a straight-through cable. When you subscribe to a PSDN, your supplier almost always provides a modem. If this is not the case, contact the supplier to find out what kind of modem you need.

To configure SunLink X.25, you need to:

- configure some information about the link
- change the logical channel ranges used by the SunLink X.25 software to match those used by your PSDN

Before you start, make sure you know the following information. Your PSDN supplier should have provided it:

- the version of the X.25 Recommendation used on the PSDN
- the X.121 address of the port you intend to use
- the logical channel ranges used by the PSDN

In the `x25tool` base window, pull down the Links menu and select the Create/Modify item. The Interface Configuration window appears:

Link	Device	Description
0	ZSH-0	Internal serial port
2	LE-0	Ethernet Interface

Create Edit PVC Options...

Link Number: 0 Link Type: WAN (1988)  
 Device: ZSH Port Number: 0  
 Local Address: 0011  
 Description: Internal serial port Alias: Alias  
 Local SAP: 7E Loopback SAP: 7D Max. Coins: 1  
 LAP Mode: LAPB Interface: DTE DCE  
 Full Address: 1234  
 Extended Address: None Extension:  
 Apply Reset Cancel

By default, there are two template links already configured, one WAN link and one LAN link. To configure a single WAN link, follow these steps:

#### 1. Set the Link Number.

This is a number you assign to the link to identify it, both in `x25tool` and in the configuration files.

## 2. Set the Link Type.

Pull down the Link Type menu and choose the version of the X.25 recommendation used by your PSDN. You can also choose LAN or a multi-link option—see Chapter 12, “A Workstation attached to a LAN,” and Chapter 11, “A Dial-up Configuration,” for examples of these types of configuration.

## 3. Set the Device type and Port Number.

The example uses the default `zsh0` device. If this is not the case, pull down the menu of available device types and select the relevant one, then type in the port number:

Choose the relevant device type

Type in the port number

## 4. Set the Local Address.

Type in the address of port 0 in this field. This is the X.121 address assigned to you by your supplier. This address is often referred to as an X.25 address. Your service supplier should tell you this address.

**Note** – The Full Address and Extended Address parameters are not used when the product is in normal operation. You only need to enter these if you are using an application that expects to read them. If this is the case with your PSDN, your service provider will tell you what you need to enter here.

**5. Set the LAP Mode to LAPB, unless you are sure your PSDN uses a different LAP Mode.**

LAP and LAPBE are used very rarely.

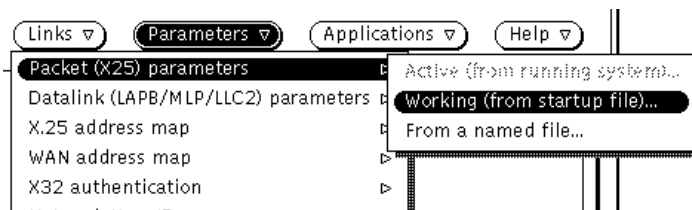
**6. Make sure the Interface is set as DTE.**

You only need to set the Interface as DCE if you are running two machines back-to-back, for example for testing.

**7. Click on Apply to confirm your changes.**

Once you have created the link itself, you need to configure the parameters used by traffic over the link. The default parameters are adequate for most situations, however, you usually need to change the logical channel ranges to match those used on your PSDN. To do this

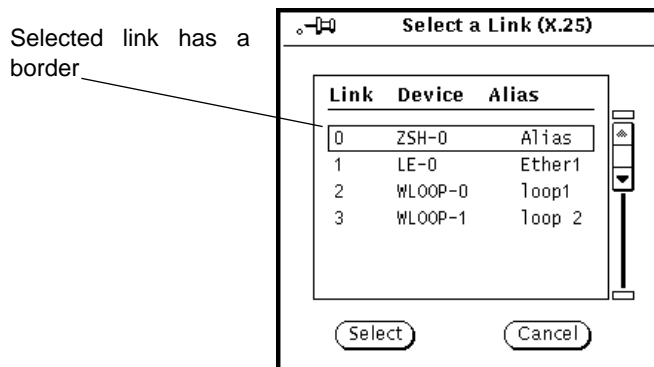
**1. Pull down the Parameters menu and select the Packet (X25) Parameters item. In the submenu, click SELECT on the Working(from startup file) option:**



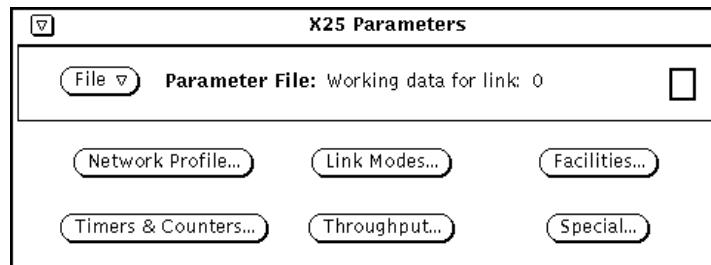
Using the Working option means that the parameters set in the file that will be used the next time X.25 is restarted on the link is used.

**2. Choose the link you are working with from the Select a Link window.**

In the example, this is link 0, using device zsh0:



### 3. The X25 Parameters screen appears.



Due to the large number of X25 Parameters, there are 6 subscreens. They have the following content:

Table 4-2 X.25 Parameters subscreens

Window	Description
Network Profile	Set the logical channel ranges, the X.25 Recommendation year, Modulo 8 or 128 and DTE or DCE.
Link Modes	Parameters affecting packet format and size.
Facilities	Parameters affecting closed user group operation and use of optional X.25 facilities.
Timers and Counters	Transmission, retransmission and delay timers.
Throughput	Throughput class and packet and window sizes.
Special	D-bit control and throughput class packet/window mapping.

In general, you do not need to change to majority of these parameters, the default values are appropriate for almost all situations. However, you almost certainly need to edit the logical channel ranges, as each public network uses different settings.



4. Click **SELECT** on the **Network Profile** button to display the **Logical Channel ranges**:

The screenshot shows a dialog box titled "Network Profile". Inside, there is a section titled "Logical Channel ranges". It contains four rows of input fields for minimum and maximum values, each with up and down arrow buttons. The values are: PVC - Minimum: 0, Maximum: 0; Incoming - Minimum: 0, Maximum: 0; Two Way - Minimum: 1, Maximum: 40; Outgoing - Minimum: 0, Maximum: 0. Below these are two more fields: "Version:" with a dropdown menu showing "1988", and "Modulo:" with two input boxes containing "8" and "128". At the bottom, there is a checkbox labeled "DTE/DCE operation:" which is checked, with the text "Matches Link" next to it. At the very bottom are "Apply" and "Cancel" buttons.

Your PSDN will tell you which values to use here. Contact them if you require this information. If you are configuring a private network, all machines on the network must use the same logical channel ranges. In this case, you can choose any values you like as long as they comply with the X.25 Recommendations.

5. Click **SELECT** on **Apply**.
6. In the **X25 Parameters** screen, press **MENU** on the **File** menu button and then press **MENU** on the **Save parameters** option. In the submenu, click **SELECT** on **Working(to startup file)**

The screenshot shows a dialog box titled "X25 Parameters". At the top, there is a "File" button with a dropdown arrow. To its right, it says "Parameter File: Working data for link: 0". Below the "File" button is a list of options: "Load Parameters", "Save Parameters", and "Quit". The "Save Parameters" option is highlighted, and a submenu is open showing three options: "Active (k-running system)...", "Working (to startup file)...", and "To a named file...". The "Working (to startup file)..." option is highlighted. To the right of the submenu are three buttons: "Facilities...", "Special...", and "Timers & Control...".

This makes sure your changes will be used next time you start X.25.

---

**Note** – For a default configuration, you do not need to configure the datalink layer parameters, the defaults should be adequate.

---

**7. Start X.25 by pulling down the Control menu and clicking SELECT on Start X.25 Network.**

To check that the configuration is valid, make a PAD call to yourself. To do this, enter the `pad` command at a command line, followed by your own X.121 address:

```
hostname% pad X.121 address
```

Once you have created a link that works, you can go on and fine-tune it, or configure the application(s) you want to run over it.

# Configuring SunLink X.25 by Editing the Configuration Files

5 

<i>Configuration File Overview</i>	<i>page 41</i>
<i>Configuring a Single WAN Link</i>	<i>page 44</i>
<i>Editing the Configuration Files</i>	<i>page 45</i>

## Configuration File Overview

You can configure SunLink X.25 by directly editing the configuration files, as well as by using `x25tool`. Editing the configuration files lets you configure a machine that does not have a windowing system such as OpenWindows or Motif installed.

These configuration files are new in SunLink X.25 9.0. If there is a version of SunLink X.25 8.x installed on a machine on which you install SunLink X.25 9.0, the software automatically converts the 8.x configuration files into the 9.0 format. This happens as part of the installation process.

The configuration files are contained in the `/etc/SUNWconn/x25/config` directory. The contents of the directory when you install the software are:

```
hostname% ls /etc/SUNWconn/x25/config
Samples/          link_config_0000.cfg
link_config_0001.cfg
```

File `link_config_0000.cfg` configures link 0. In the default configuration, this is a WAN link. File `link_config_0001.cfg` configures link 1. In the default configuration, this is a LAN link.

There is a separate configuration file for each link. The filename is of the format `link_config_n.cfg`, where *n* is the link number. These are the files that will be read when the SunLink X.25 is next started. Editing them is equivalent to editing the *working* configuration using `x25tool`. Use a different naming convention if you want to save changes without using them on the next restart.

---

**Note** – You cannot make changes to an active link by editing the configuration files. If you need to make changes to an active link, use `x25tool` to edit the *active* configuration.

---

To create a new WAN link use file `link_config_0000.cfg` as a template. Copy it and giving the new file the correct name for the link you want it to apply to. For example, to configure port 3 as a WAN link, call the file `link_config_0003.cfg`.

To create a new LAN link, copy and rename the file `link_config_0001.cfg`. Then edit the new file to use the values you want.

The configuration file consists of a series of keywords and values, divided into sections according to function. The example below shows the `identification` and `link` sections of a file:

```
IDENTIFICATION
  PRODUCT_NAME      SunLink X.25
  PRODUCT_VERSION   9.0alpha
  FILE_TYPE         config
  MODIFIED_BY       username
  FILE_DATE         Fri Jan 13 11:41:13 1995

SECTION LINK
  device            /dev/zsh0
  local_address     0011
  type              WAN
  version           1988
  mode              DTE
  protocol          LAPB
  alias             switch
  description       Link to switch
```

The `IDENTIFICATION` section is the top section of every file. Updating the `MODIFIED_BY` field every time you make changes lets you keep track of who made changes. The `FILE_DATE` field updates automatically when you save the file, showing when the last changes were made.

Chapter 16, “Parameter Reference” specifies the keyword and valid arguments for each parameter.

---

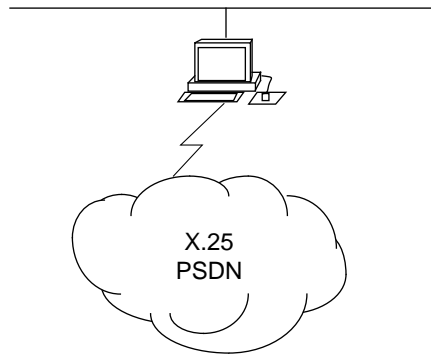
**Note** – You cannot modify either the PAD or the IP configuration by editing the configuration files.

---

## Configuring a Single WAN Link

This section describes how to configure a single WAN link for SunLink X.25 by editing the configuration files. The configuration described in this chapter uses the default values provided with the product. It should work in the majority of situations, although it will not necessarily make the best possible use of the product's capacities. Once you have a link that works, you can go on and fine-tune it.

This section describes the following configuration:



The workstations onboard serial port `zsh0` is connected to a modem using a straight-through cable. The example uses the SPARC™ version of the product. The process is almost identical for all version of the product, but the device names change. Refer to Chapter 14, “A PC running X.25 on the LAN and on the WAN” for an example using the x86 version of the product.

---

**Note** – When you subscribe to a PSDN, your supplier almost always provides a modem. If this is not the case, contact the supplier to find out what kind of modem you need.

---

To configure SunLink X.25, you need to:

- configure some information about the link
- change the logical channel ranges used by the SunLink X.25 software to match those used by your PSDN

Before you start, make sure you know the following information. Your PSDN supplier should have provided it:

- the version of the X.25 Recommendation used on the PSDN
- the X.121 address of the port you intend to use
- the logical channel ranges used by the PSDN

## *Editing the Configuration Files*

To configure a single link to a PSDN across using the onboard serial port:

1. **Open the file** `/etc/SUNWconn/x25/config/link_config_0000.cfg` **for editing.**

This is the file that configures link 0.

2. **Scroll down to** `SECTION LINK`.

This is the first section below the identification section, and looks like this:

SECTION LINK

```
IDENTIFICATION
  PRODUCT_NAME    SunLink X.25
  PRODUCT_VERSION 9.0alpha
  FILE_TYPE       config
  MODIFIED_BY     smckinty
  FILE_DATE       Fri Jan 13 11:41:13 1995

SECTIONLINK
  device          /dev/zsh0
  local_address   0011
  type            WAN
  version         1988
  mode            DTE
  protocol        LAPB
  alias           switch
  description     Link to switch
```

3. **Change the** `local address` **parameter to your local X.121 address.**

This is the X.121 address of your modem. Your service supplier should tell you what it is.

**4. If necessary, change the `version` parameter to the year of the X.25 Recommendations used by your PSDN.**

**5. Optionally, set an `alias` and `description`.**

**6. Scroll down to `SECTION X25` and find the **Logical Channel Range** parameters.**

These are called `pvc_range`, `inc_range`, `out_range`, and `two_range` and are near the top of `SECTION X25`:

```
SECTIONX25
    network      X25_88
    plpmode      Normal
    pvc_range    0-0
    inc_range    0-0
    out_range    0-0
    two_range    1-30
```

**7. Set the appropriate Logical Channel Ranges by editing the existing entries.** Don't leave any spaces between the values and the hyphen. Your service supplier will tell you the appropriate LCR values to use.

**8. Save and exit the file.**

**9. Start X.25 by entering the following as root:**

```
# /etc/init.d/x25.control start
```

This starts all the necessary daemons running and brings up the software.

To check that the configuration is valid, make a `pad` call to yourself. To do this, enter the `pad` command at a command line, followed by your own X.121 address:


```
hostname% pad X.121 address
```

Once you have created a link that works, you can go on and fine-tune it, or configure the application(s) you want to run over it.



## Configuring SunLink X.25 Applications

---

6 

<i>Configuring the PAD</i>	<i>page 47</i>
<i>Configuring SunLink X.25 to route IP</i>	<i>page 52</i>

Once you have a working connection to a network, you can use it to make PAD calls using the PAD software delivered with the SunLink X.25 software and to route IP, which is delivered as part of the Solaris operating system.

### *Configuring the PAD*

Users can make PAD calls without you carrying out any configuration. However in order to do so, they need to know addressing and configuration information for their destination. You can use `x25tool` to create a database of remote hosts containing relevant addressing and configuration information. This lets users make calls using aliases instead of addresses.

You can also set up a database of parameters to be applied to incoming calls. This is particularly useful if you have a server that receives a large number of calls.

Finally, you can configure the parameters defined in the ITU-T's X.3 recommendation. Refer to "X.3 Parameters" on page 160 for information on these parameters.

## *Configuring the PAD Hosts Database*

To access the PAD Hosts Database, pull down the Applications menu and choose PAD►Hosts:



The PAD Hosts Database window looks like this:

The screenshot shows the 'PAD Hosts Database' window. It features a table with two columns: 'Host' and 'Alias(es)'. The table contains three entries: 'host6', 'a\_b', and 'host5'. Below the table are 'Create' and 'Edit' buttons. To the left of the table, there are labels: 'Click SELECT here' pointing to the table, 'Set the hostname' pointing to the 'Host Name' field, and 'Add any aliases' pointing to the 'Alias(es)' field. The 'Host Name' field contains 'Hostname'. Below it is the 'Alias(es)' field. To the right of the 'Host Name' field is the 'Link Selection' dropdown, which is set to 'Specified'. Below it is the 'Link Number' field, set to '0'. To the right of the 'Link Number' field is the 'Remote Address' field, with a label 'Enter the remote address' pointing to it. Below the 'Remote Address' field is the 'Extension' field. To the left of the 'Link Selection' field is the 'X29 Type' dropdown, set to 'Default'. Below it is the 'Extended Address' dropdown, set to 'None'. To the right of the 'Extended Address' field is the 'Packet Size (in)' and 'Packet Size (out)' fields, both set to '128'. Below these are the 'Window Size (in)' and 'Window Size (out)' fields, both set to '2'. To the right of the 'Window Size (out)' field is the 'Reverse Charge' dropdown, set to 'No'. Below these are the 'Fast Select' and 'CUG Type' dropdowns, both set to 'None'. To the right of the 'CUG Type' field is the 'CUG Number' field. Below these are the 'Call User Data' and 'PAD Profile' dropdowns, both set to 'Simple'. To the right of the 'PAD Profile' field is the 'RPOA Numbers' field. At the bottom of the window are 'Apply' and 'Cancel' buttons. A label 'Click SELECT on Apply' points to the 'Apply' button.

To add an entry:

1. Click **SELECT** on **Create**, to display the template entry shown above.
2. Change the **Hostname** to the name you want to use.
3. Change the **Link Selection** parameter to **Automatic**.  
This uses the SunLink X.25 routing link selection feature.

**4. Add any Aliases you want to use to call this destination.**

**5. Specify the Remote Address**

For a WAN link, this is the DTE address of the remote host. A valid DTE address has 15 or fewer decimal digits.

For a LAN link, this is the LSAP of the remote host. A valid LSAP (MAC plus SAP) address is 14 hexadecimal digits in length. In most cases, the last two digits of an LSAP address are 7e. You can use ARP-style notation, with colons separating the bytes within an LSAP address. Within a colon-delimited byte, you can omit a leading zero.

**6. Change any other applicable parameters**

In most cases you do not need to do this. Refer to “PAD Hosts Database” on page 154 for information on the other available parameters.

**7. Click SELECT on Apply to add the new entry to the database.**

## *Configuring the PAD Listen Database*

The PAD Listen Database determines how incoming PAD calls are handled. You can set global default values that are used for all incoming calls and optional values that apply to calls with particular characteristics. To access the PAD Hosts Database, pull down the Applications menu and choose PAD►PAD Daemon. Set the Global Defaults, in the top third of the screen, first:

**1. Configure a Welcome Banner.**

This is the message that someone logging in to this machine using a PAD call will see when the connection is made. It might be useful to give the machine name or any particular information about this machine that users need. If you don't want a welcome banner, enter a single space.

**2. Enter the Initial Command.**

This determines what happens when a user connects to this machine using a PAD call. By default, the command `/bin/login` executes, prompting for the user's name and password.

**3. If necessary, change the Global Parameters.**

You can also set the parameters described above so that they applied differently to calls. There are two ways to distinguish which calls they can apply to—using the Called Address and using the Calling Address. The Called Address is the

address of the local machine. If you use sub-addressing a remote host can call the local machine using any one of these sub-addresses. You can configure the local machine to behave differently depending on the sub-address called—for example, on machine with several applications, you could use a different sub-address to call each one, using a combination of the Called Address and Initial Command parameters to set this up. The Calling Address is the address of the machine making the call, the remote machine. Again, you might want to use a different Initial Command, depending on where the call is from. You might also need to use different X.3 parameters if the remote host has a non-default configuration.

To set parameters applying to a particular Called Address choose Matches and enter the exact address. To apply the parameters to a particular group of Called Addresses, use Starts With to affect all addresses starting in the same way, or Pattern to use wildcards.

To set parameters applying to a particular Calling Address choose Matches and enter the exact address. To apply the parameters to a particular group of Called Addresses, use Starts With to affect all addresses starting in the same way, or Pattern to use wildcards.

To set parameters applying to calls using specific Call User Data, choose Starts With to affect all calls with CUD starting the same way and Matches to affect all calls using identical CUD.

---

**Note** – The SunLink X.25 software uses the first 2 bits of the call user data (CUD) field to distinguish between PAD and IP calls. The CUD field of a PAD call always begins with 01. The CUD field of an IP call always begins CC. If you want to add any further CUD to be used in outgoing PAD calls, make sure you append it to the 01. Do not delete the 01—if you do, the X.25 software receiving the call will not know which application to pass it to and the call will fail.

---

### *Configuring SunLink X.25 to route IP*

The TCP/IP protocol suite is delivered as part of the Solaris system software. You can route IP over SunLink X.25, but first you must set up a mapping between the X.121 addresses used by the X.25 software and the IP addresses used by the IP software. The IP over X.25 Configuration window contains many parameters, but you only need to use a few of them. You can configure information about your local system, mapping its X.121 address to an IP address and setting any necessary parameters, and about remote systems. The IP over X.25 Configuration window looks like this:

local IP address  
IP subnet mask  
local X25 address  
X25 version

Click Insert here

remote IP address  
remote X25 address

Click Insert here

Click Apply here

### IP over X.25 Configuration

#### IP Network configuration for X.25

**Network**

Local IP address:	Link: 0
IP Subnet Mask: 255.255.255.255	Point to: <input checked="" type="checkbox"/> Multipoint
Local X25 Address:	
Extended Address: <input checked="" type="checkbox"/> None	Extension:
X25 version: <input checked="" type="checkbox"/> 1968	Address Mapping: <input checked="" type="checkbox"/> CCITT
Disconnection Timer: 30	Max NSDU: 576
Pre-emption Timer: 30	Hold Down Timer: 0
Reset Action: <input checked="" type="checkbox"/> Acknowledge and discard	
Expedited Data Action: <input checked="" type="checkbox"/> Acknowledge and discard	
Lower PVC: 0	Upper PVC: 0
Accept Unknown Hosts: <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes	

**Listen Information**

Called Address  
☒ Starts with

Call User Data  
☒ Starts with

Address is: ☒ DTE ☐ NSAP

**Remote IP Host to X.25 Address map**

**Remote Hosts**

129.157.191.20	(hamster-x25)
129.157.191.21	(speedy-x25)

**Remote IP Address:** 129.157.191.20 **Link:** 0

**Remote X25 Address:** 0018

**Extended Address** ☒ None **Extension:**

**Packet Size:** ☒ 512 **Window Size:** 6

**Maximum VCs:** 1 **Reverse Charge:** ☒ No ☐ Yes

**CUG Type** ☒ None **RPOA Numbers:**

**CUG Number:** 0

**Buttons:** Create Edit Apply Reset Cancel

First, configure information about your local system. To do so:

1. **Click SELECT on the top Create button to display the template entry.**
2. **Enter the IP address of the interface you are configuring.**  
Enter either an address in IP dotted notation, or a hostname.
3. **Enter the link number for the interface you are configuring.**
4. **Enter the IP subnet mask, if your network is subnetted.**
5. **Enter the local X.121 Address.**
6. **Select the appropriate X.25 version for your network, 1980, 1984 or 1988.**
7. **Configure any other relevant parameters.**  
See “IP over X.25” on page 164 for information about the available parameters.
8. **Click SELECT on Apply.**

You also need to add information about remote hosts to the IP Host to X.25 Address Map. This lets the SunLink X.25 software translate IP addresses it receives into X.25 addresses that it can use. To do this:

1. **Click SELECT on the bottom Create button to display the template entry shown above.**
2. **Enter the IP Address of the remote system.**
3. **Enter the X.121 (X25) address of the remote system.**
4. **Specify the link to be used for traffic to this destination.**
5. **Configure any other relevant parameters.**  
See “IP over X.25” on page 164 for information about the available parameters.
6. **Click SELECT on Apply.**

Once you have carried out the configuration described above, you should be able to use the TCP/IP protocol suite over your X.25 connection. To check that all is working properly, make sure that you can `ping` and `rlogin` to the hosts you added to the IP Host to X.25 Address Map.



## Configuring `uucp` and `tip` to run over SunLink X.25

7 

Configuring <code>uucp</code>	page 55
Configuring <code>tip</code>	page 58

The configuration described in this chapter is not strictly speaking part of the SunLink X.25 configuration. It is provided here for your convenience.

An `xtty` device emulates a `tty` device, and is required to make outgoing calls using `uucp` or `tip`. By default, SunLink X.25 provides 16 `xtty` devices. This is sufficient for most purposes. If you require more than 16 `xtty` devices, edit the `/etc/system` file. Incoming calls are handled directly by the PAD daemon which executes the `login` process.

### Configuring `uucp`

You need to modify a number of files before `uucp/cu` type calls can be made over the `xtty` driver. All of the files are in the directory `/etc/uucp`. For more detail, refer to the *SunOS 5.x Administering TCP/IP and PPP* guide. The files you need to modify are:

- `Devices`  
Specifies which `xtty` devices are available for outgoing calls.
- `Dialcodes`  
Specifies a number of host to X.25 address mappings.

- **Permissions**  
Specifies permissions that remote users have when sending files, whether local users can request files, and which commands users are allowed to use. Read the section in the *SunOS 5.x Administering TCP/IP and PPP* guide that tells you how to configure this file. Incorrectly configuring this file can compromise system security.
- **Dialers**  
Specifies the command that `uucp` issues to the PAD to make a `uucp` call.
- **Systems**  
Specifies the hosts that `uucp` knows about. It includes the login names and character sequences that `uucp` sends and expects to receive.

### *Editing the Devices File*

Typically, there is one line for each of the `xy` devices you specified using `x25tool`. The `xy` device numbers should match those generated by `kernelcreate`, and should number from one upwards. Add lines like the following to the file:

```
Pad    xty1    -    Any    pad
Pad    xty2    -    Any    pad
```

### *Editing the Dialcodes File*

Add entries to the `Dialcodes` file to specify name to X.25 address mapping. The names you specify here are used in the `Permissions` and `Systems` files. Add lines like the following to the file:

```
hostname1 x.25-address
hostname2 x.25-address
```

Enter the X.25 address in one of the following formats:

- *link number.x121 address* (for example `0.23433140831`)
- *link number.MAC address* (for example `1.12345678907E`)

## Editing the Permissions File

Add lines like the following to this file:

```
MACHINE=hostname1:hostname2 \  
REQUEST=yes \  
SENDFILES=yes \  
READ=/ WRITE=/ \  
COMMANDS=ALL  
LOGNAME=nuucp \  
REQUEST=yes \  
SENDFILES=yes \  
READ=/ WRITE=/ \  
COMMANDS=ALL
```

It is not mandatory to use `nuucp` as the `LOGNAME`, however this is the most common practice.

---

**Note** – You may want to set more restrictive permissions than those shown above. For more detail, refer to the *SunOS 5.x Administering TCP/IP and PPP*.

---

## Editing the Dialers File

You need to tell `uucp` the command to issue to the PAD to allow outgoing calls. Add the following line to this file:

```
pad    ""    "" P_ZERO    "" CALL\040\T
```

## Editing the Systems File

You need to add lines like this to the Systems file:

```
systemname Any Pad Any hostname ""\r\d\r in:--in: logname word: password
```

The *hostname* is the hostname you mapped to an address in the `Dialcodes` file. Alternatively, enter the X.25 address here.

Use the `LOGNAME` that you set in the `Permissions` file. In most cases this is `nuucp`.

## Configuring `tip`

In order to use `tip`, you need to add the name of the remote node you want to reach to your `/etc/remote` file. The entry you add needs to contain the device type and specify the `pad` command needed to reach the remote device. Provided the remote destination is in the hosts database, you can give the hostname you entered there. The entry looks like this:


```
hostname:\
      :dv=/dev/xydevice:cm=CALL x25.address:
```

Use the `xy` device you set using `x25tool`.

Enter the X.25 address in one of the following formats:

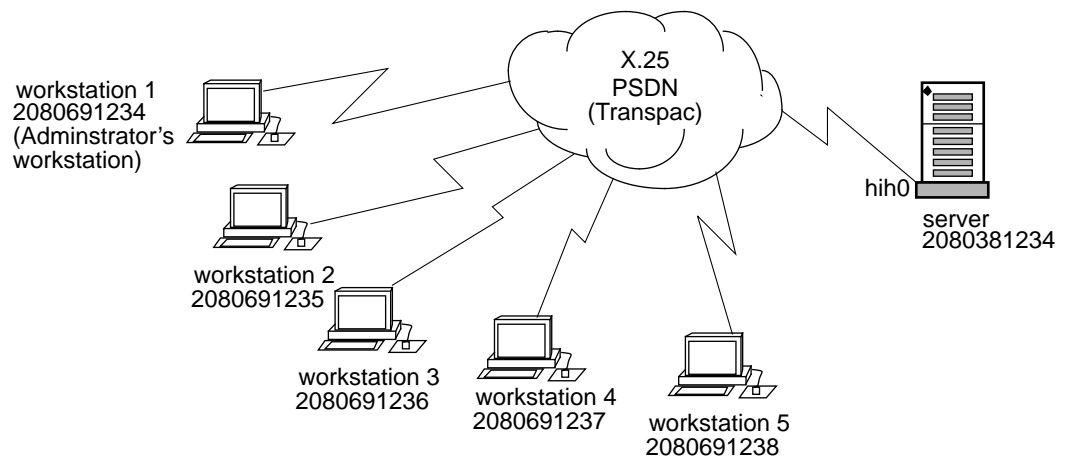
- *link number.x121 address* (for example `0.23433140831`)
- *link number.MAC address* (for example `1.12345678907E`)

## A Server to Receive PAD Calls

8 

<i>Configuring the WAN Link</i>	<i>page 60</i>
<i>Configuring Parameters</i>	<i>page 61</i>
<i>Configuring the PAD Listen Database</i>	<i>page 64</i>

In this example, a server is attached to a PSDN. It needs to be configured so that remote machines can access it using the PAD.



In the example, all remote workstations are running SunLink X.25 and can access the server. The server must be configured to use SunLink X.25 and to receive PAD calls from both workstations.

Workstation 1 is used by the system administrator when at the remote site. It needs full terminal-type access to the server.

The other machines are used by employees at the remote site. The system administrator has written an application to drop calls to the server straight into a menu system that gives them access only to the information they need.

To create this kind of configuration you need to:

- Create a link between the server and the PSDN.
- Configure the logical channel ranges, and any other optional parameters, used by each PSDN.
- Configure the PAD Listen Database.

---

**Note** – The workstations must also be configured so that they can access the server. Refer to “Configuring the PAD Hosts Database” on page 48 for instructions.

---

## *Configuring the WAN Link*

First create a link between the server and the PSDN:

1. **Start `x25tool`. Log in as `root` or become `superuser`, then enter this command:**

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

2. **Pull down the Links menu and select the Create/Modify item. The Interface Configuration window appears.**

### 3. Create a link to the PSDN.

Click SELECT on Link 0, the default WAN link, then edit the default values to match those required by the PSDN:

Click SELECT here

Set Link Number here

Specify the HSI device here

Add the X.121 address here

Add a description here

Click SELECT here

Set the X.25 revision here

Set the port number here

Add an alias here

Keep interface as DTE

Link	Device	Description
1	LE-0	Ethernet interface
0	HSI-0	link to Transpac

Create Edit PVC Options...

Link Number: 0 Link Type: WAN (1988)

Device: HSI Port Number: 0

Local Address: 2080381234

Description: link to Transpac Alias: transpac

Local SAP: 7E Loopback SAP: 7D Max. Counts: 20

LAP Mode: LAPB Interface: DTE DCE

Full Address:

Extended Address Extension:

None

Apply Reset Cancel

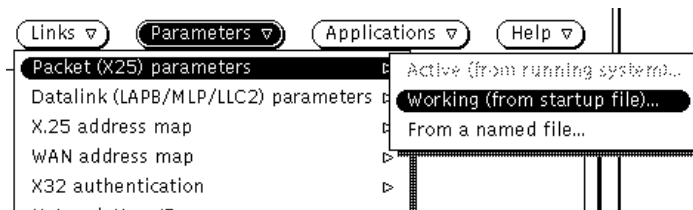
### 4. Click SELECT on Apply.

## Configuring Parameters

Once you have created the link, you need to adjust the logical channel ranges to match those used by the PSDN. You may also need to configure other packet layer and LAPB layer parameters.

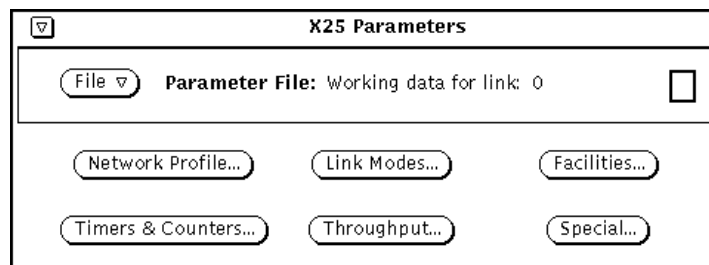
To change the logical channel ranges:

1. Pull down the Parameters menu and select the Packet (X25) Parameters item. In the submenu, click SELECT on the Working(from startup file) option:



Using the Working option means that the parameters set in the file that will be used the next time X.25 is restarted on the link is used.

2. The X25 Parameters screen appears.



Due to the large number of X25 Parameters, there are 6 subscreens.



3. Click **SELECT** on the **Network Profile** button to display the **Logical Channel ranges**:

The screenshot shows a dialog box titled "Network Profile". Inside, there is a section titled "Logical Channel ranges". It contains four rows of input fields for minimum and maximum values, each with up and down arrow buttons. The values are: PVC (Min: 0, Max: 0), Incoming (Min: 0, Max: 0), Two Way (Min: 1, Max: 40), and Outgoing (Min: 0, Max: 0). Below these are two more fields: "Version:" with a dropdown set to "1988" and "Modulo:" with two input boxes containing "8" and "128". At the bottom, there is a checkbox for "DTE/DCE operation:" which is checked and labeled "Matches Link". At the very bottom are "Apply" and "Cancel" buttons.

Enter the values assigned by your PSDN. In the example, there are 40 two way SVCs, numbered from 1 to 40, inclusively. Since there are no PVCs, or one way SVCs, these fields are left as 0.

4. Click **SELECT** on **Apply**.
5. In the **X25 Parameters** screen, press **MENU** on the **File** menu button and then press **MENU** on the **Save parameters** option. In the submenu, click **SELECT** on **Working(to startup file)**

The screenshot shows a dialog box titled "X25 Parameters". At the top, there is a "File" button with a dropdown arrow. Below it, the text "Parameter File: Working data for link: 0" is displayed next to a checkbox. A menu is open under the "File" button, showing options: "Load Parameters", "Save Parameters", and "Quit". The "Save Parameters" option is highlighted, and a submenu is open below it, showing "Active (to running system)...", "Working (to startup file)...", and "To a named file...". The "Working (to startup file)..." option is highlighted. To the right of the menu are buttons for "Facilities..." and "Special...". At the bottom left, there is a button for "Timers & Control".

This makes sure your changes will be used next time you start X.25.

You can change any relevant LAPB and WAN values in a similar way. To access them, pull down the Parameters menu and choose the Datalink parameters option. Which you need to change depends on the PSDN you are attaching to and on your own configuration.

## Configuring the PAD Listen Database

Next configure the PAD Listen Database. This determines how the server will handle incoming PAD calls.

**1. Pull down the Applications menu and choose the PAD option and then the PAD Daemon Listen Database.**

**2. First configure the Global default values.**

These will be used for incoming calls from all machines except the one reserved for the administrator's use. In the top part of the screen, specify that all incoming calls are to start the menu application immediately:

PAD Daemon Listen database	
Global Defaults	
Accept PAD calls: <input type="checkbox"/> Yes <input type="checkbox"/> No	Log PAD calls: <input type="checkbox"/> Yes <input type="checkbox"/> No
Welcome banner: <input type="text" value="Welcome user – the menu application is starting"/>	
Initial command: <input type="text" value="&lt;command to start application&gt;"/>	
PAD Parameters	
Native	<input type="button" value="Use defaults"/> <input type="button" value="Customize"/>
Non-native	<input type="button" value="Use defaults"/> <input type="button" value="Customize"/>

---

**Note** – The SunLink X.25 9.0 system software does not include a menu driven application program. You need to write the application, then use the Initial Command parameter to call it.

---

### 3. Add a new “perhost” entry for the system administrator’s workstation.

In the lower part of the screen, add an entry to the scrolling list for the machine used by the system administrator. Click SELECT on Create to add an entry, then use the Calling Address Matches parameter to specify the remote machine and the Welcome Banner and Initial Command parameters to specify what should happen when a call is received from that address.

The screenshot shows the 'Listener Criteria' dialog box. It contains a table with two columns: 'Called Address' and 'Calling Address', and a 'User Data' column. The table has two rows: one with 'X' in both columns and 'S01' in User Data, and another with 'X' in the first column and 'ID2080691234' in the second column, also with 'S01' in User Data. To the right of the table are 'Per-Call PAD Parameters' for 'Native' and 'Non-native' calls, each with 'Use Defaults' and 'Customize' buttons. Below the table are 'Create' and 'Edit' buttons. At the bottom are 'Called Address', 'Calling Address', and 'Call User Data' fields, each with a dropdown menu and a text input. The 'Called Address' field has a dropdown menu with 'Don't care' selected. The 'Calling Address' field has a dropdown menu with 'Don't care' selected. The 'Call User Data' field has a dropdown menu with 'Starts with' selected and '01' in the text input. Below these are 'Welcome banner:' and 'Initial command:' text input fields. At the bottom right are 'Apply' and 'Cancel' buttons. Annotations on the left point to the 'Called Address' field, the 'Welcome banner:' field, and the 'Initial command:' field.

Entry applies to calls received from this address

Welcome banner

Launch this command on receiving a call from specified address

**Note** – If you leave the Initial command line blank, /bin/login is launched by default.

### 4. Click SELECT on Apply to save your changes.

Once you have finished configuring the PAD Listen Database, you are ready to start SunLink X.25. Start X.25 by pulling down the Control menu and choosing Start X.25 Network.

You can check your configuration is working correctly by trying to make a PAD call from a remote machine.

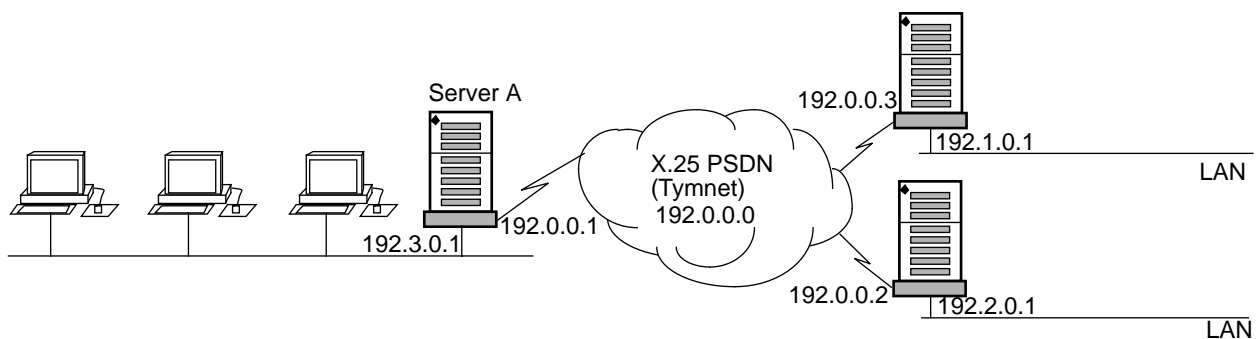


## A Server as an IP Router

9

<i>Configuring the WAN Link</i>	<i>page 68</i>
<i>Configuring Parameters</i>	<i>page 70</i>
<i>Configuring IP Routing</i>	<i>page 72</i>

In this example, Server A has SunLink X.25 installed. This lets it route the TCP/IP protocol suite and provide a connection to the X.25 PSDN for any machine attached to the same LAN. The other machines on the LAN do not need to run X.25 themselves in order to connect to remote devices across the WAN.



---

**Note** – A machine does not need to have X.25 configured on its LAN interface in order to be able to act as a router between a LAN and a WAN. IP will handle sending traffic to the router. X.25 is needed in order to provide the logical connection to the WAN.

---

To make a configuration like this, you need to:

- Configure the link between the server and the WAN.
- Configure the logical channel ranges, and any other optional parameters, used by the PSDN.
- Configure the values used for routing IP.

## *Configuring the WAN Link*

First configure the link between the server and the WAN. In the example this uses a High Speed Interface.

- 1. Log in as root or become superuser and start `x25tool`:**

```
hostname% su
Password: xxxx
# /opt/SUNWconn/bin/x25tool
```

- 2. Bring up the Interface Configuration window.**

Click SELECT on the Link button in the `x25tool` main window.

- 3. Edit Link 0, the default WAN link.**

Click SELECT on the entry for Link 0 in the scrolling list to display the default WAN link values.

**4. Change the other values as shown in the snapshot below.**

Refer to “x25tool Overview” on page 29 for help if you do not know how to change values:

First, click SELECT here

Keep Link Number as 0

Set Device to HSI for both ports

Type in X.121 address (*not* the IP address) here

Optionally, add a description

Keep LAP Mode as LAPB

Last, click SELECT here

Set Port Number

Keep Interface as DTE

Link	Device	Description
0	HSI-0	Connection to Tymnet (high speed)
1	LE-0	Ethernet interface

Create Edit PVC Options...

Link Number: 0 Link Type: WAN (1984)

Device: HSI Port Number: 0

Local Address: 31011111

Description: Tymnet (high speed) Alias: Tymnet

Local SAP: 7E Loopback SAP: 7D Max. Conns: 16

LAP Mode: LAPB Interface: DTE DCE

Full Address:

Extended Address: None Extension:

Apply Reset Cancel

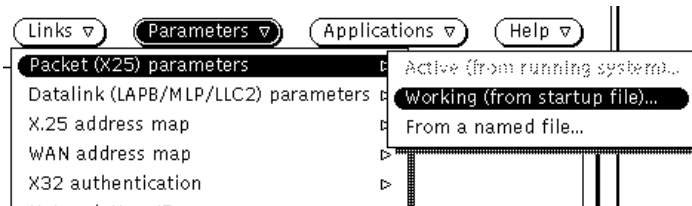
**5. Click SELECT on Apply to update the configuration.**

## Configuring Parameters

Once you have created the link, you need to just the logical channel ranges to match those used by the PSDN. You may also need to configure other packet layer and LAPB layer parameters.

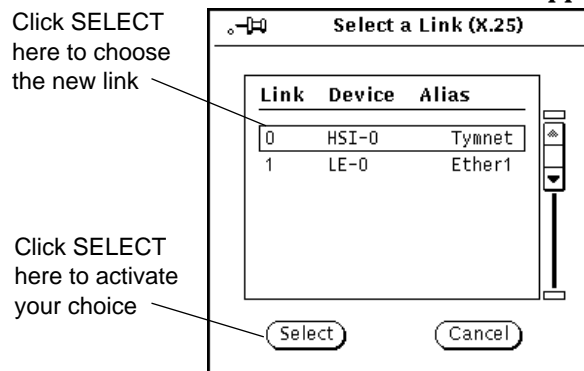
To change the logical channel ranges:

1. Pull down the Parameters menu and select the Packet (X25) Parameters item. In the submenu, click SELECT on the Working(from startup file) option:



Using the Working option means that the parameters set in the file that will be used the next time X.25 is restarted on the link is used.

2. The Select a Link window appears:



Choose the new HSI link.



**3. The X25 Parameters screen appears:**

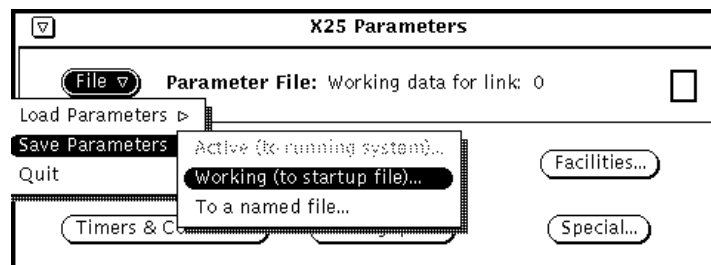
Due to the large number of X25 Parameters, there are 6 subscreens.

**4. Click SELECT on the Network Profile button to display the Logical Channel ranges:**

Enter the values assigned by your PSDN. In the example, there are 40 two way SVCs, numbered 1 to 40.

**5. Click SELECT on Apply.**

6. In the X25 Parameters screen, press MENU on the File menu button and then press MENU on the Save parameters option. In the submenu, click SELECT on Working(to startup file)



This makes sure your changes will be used when you start X.25.

You can change any relevant LAPB and WAN values in a similar way. To access them, pull down the Parameters menu and choose the Datalink parameters option. Which you need to change depends on the PSDN you are attaching to and on your own configuration.

## Configuring IP Routing

Now you are ready to set up the values that will be used for routing IP.

1. Pull down the Applications menu and choose IP, the IP over X.25 Configuration window appears.
2. Configure information about the IP network this router can attach to.

Use the top half of the screen to do this. Click **SELECT** on the Create button below the top scrolling list. The snapshot below summarizes the changes you need to make for this example configuration:

Click SELECT here to update

Click SELECT on Create to start

Don't delete CC, this specifies call is IP

IP address of interface

Link: 0

Point to Multipoint

X.121 address of interface

Provides security

You always need to specify the local IP and X.25 (X.121) addresses as well as the IP subnet mask. Enter a "+" for the subnet mask to use the network default. You should also specify the X.25 version you are using. Unless you are connecting to the Defense Data Network (DDN), specify CCITT address mapping. If you are using PVCs, rather than the SVCs used in the example, give the PVC channel numbers. To restrict access, adding a measure of security, you can choose not to accept calls from unknown hosts, that is hosts who addresses are not in the Remote Host to X.25 Address Map. Refer to "IP over X.25" on page 164 for details on the use of the timers and other parameters.

When you are happy with the information you have entered, click **SELECT** on the entry in the scrolling list to update it.

The Listen Information below the scrolling list is useful if the machine you are configuring has more than one address. You can use it to restrict which address(es) will respond. You can also filter incoming calls based on their Call

User Data (CUD). Take care not to delete the initial CC if you are using this parameter—this specifies that calls are for IP. Without the initial CC, calls will fail. Refer to “IP over X.25” on page 164 for more detail.

### 3. Configure information mapping remote IP addresses to remote X25 addresses.

Do this in the bottom half of the screen. Click SELECT on the Create button below the lower scrolling list to add a new entry. The snapshot below summarizes the information you need to add. Again, you can keep most of the default values:

Lastly, click SELECT here to update.

Click SELECT here to start

Remote Hosts

192.0.0.3  
192.0.0.2

Create ▾ Edit ▾

Remote IP Host to X.25 Address map

Remote IP Address: 192.0.0.3

Remote X25 Address: 31011112

Extended Address

☐ None

Packet Size: 128

Maximum VCs: 1

CUG Type: None

CUG Number: 0

Link: 0

Extension:

Window Size: 2

Reverse Charge: No Yes

RPOA Numbers:

Apply Reset Cancel

IP address of remote machine

Link used to reach this address

X.121 address of remote machine

You can enter a host name defined in `/etc/hosts` in place of the remote IP address.

Clicking SELECT on an entry in the scrolling list updates it without you clicking on Apply.

### 4. Once you have finished configuring IP routing, click select on Apply.

Once you have created a link and configured the system to route IP over it, you are ready to save your changes and bring up the X.25 software. Start X.25 by pulling down the Control menu and clicking SELECT on Start X.25 Network.

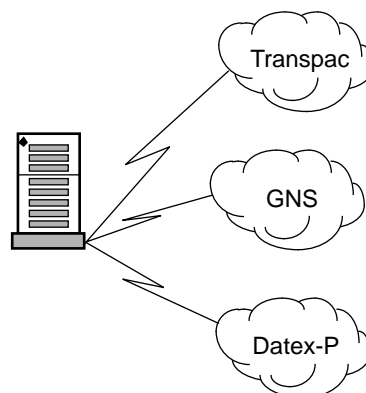
To check that the configuration works, try to ping the remote machine or to rlogin.

## *A Server with Multiple WAN Links* 10

---

<i>Configuring Three WAN Links</i>	<i>page 76</i>
<i>Configuring Parameters</i>	<i>page 77</i>
<i>Configure X.25 Routing</i>	<i>page 78</i>

In this example configuration, the server is connected to three different PSDNs. It will be used primarily by users who wish to make PAD calls to machines on the remote network.



To set up a configuration like this, you need to:

- Create a link to each PSDN.
- Configure the logical channel ranges, and any other optional parameters, used by each PSDN.
- Set up X.25 routing, so that traffic can automatically be sent out on the correct link.

## Configuring Three WAN Links

The screenshot shows the 'Interface Configuration' window. It contains a table with columns 'Link', 'Device', and 'Description'. Below the table are buttons for 'Create', 'Edit', and 'PVC Options...'. Further down are fields for 'Link Number', 'Device', 'Link Type', 'Port Number', 'Local Address', 'Description', 'Alias', 'Local SAP', 'Loopback SAP', 'Max. Coins', 'LAP Mode', 'Interface', 'Full Address', 'Extended Address', and 'Extension'. At the bottom are 'Apply', 'Reset', and 'Cancel' buttons.

Annotations and their corresponding fields/buttons:

- Click SELECT on Create to bring up a new template (points to the 'Create' button)
- Each link must have a unique link number (points to the 'Link Number' field)
- Choose the correct device type here (points to the 'Device' dropdown)
- Enter the X.121 address here (points to the 'Port Number' field)
- The description is optional (points to the 'Description' field)
- LAP mode is LAPB for most PSDNs (points to the 'LAP Mode' dropdown)
- Click on Apply when done (points to the 'Apply' button)
- Clicking here updates the list item (points to the 'Create' button)
- Set the year of the X.25 revision here (points to the 'Link Type' dropdown)
- Device plus port number must be unique (points to the 'Port Number' field)
- Alias is optional (points to the 'Alias' field)
- Interface is DTE for connecting to a PSDN (points to the 'Interface' dropdown)

The first step in creating this configuration is to create the three WAN links. Start `x25tool` and click SELECT on Links to bring up the Interface Configuration window. Create 3 links, using the appropriate values for each. In the snapshot,

the links to Transpac and GNS have already been created and appear in the scrolling list. The parameter values apply to Datex-P, and will be added to the list when the administrator clicks SELECT on the template entry.

**Note** – The example uses 3 HSI interfaces. You can mix links that use the onboard serial port (zsh) and links that use high speed interfaces, however, you cannot run SunLink X.25 on more than two onboard serial ports on the same machine.

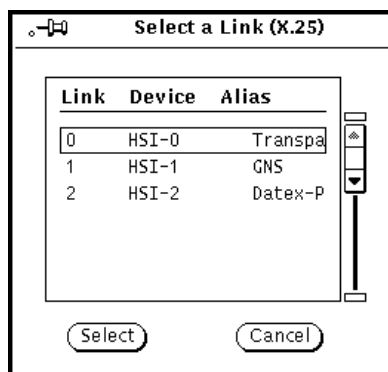
## Configuring Parameters

Once you have created the three WAN links, you need to configure the parameters used by each of them. You almost certainly need to configure the logical channel ranges, which will be different for each PSDN you are connecting to. You may also need to configure other packet layer and LAPB layer parameters.

To change the logical channel ranges:

1. Pull down the Parameters menu and choose Packet (X25) Parameters. Choose the Working (from startup file) option.

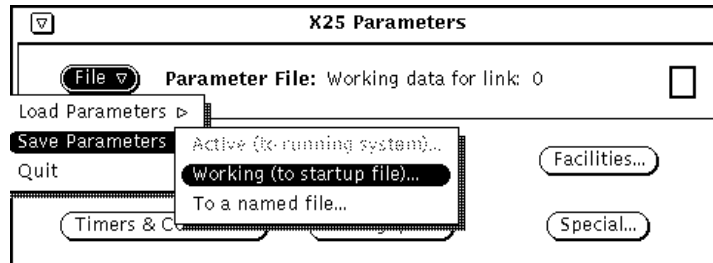
A select a link window containing the three new links appears:



2. Select the first link to configure. In the example, this is link 0 that connects to Transpac.

The X25 Parameters screen appears.

3. Click **SELECT** on **Network Profile**, to display the **Logical Channel Ranges**. Type in the values used by the PSDN that link 0 attaches to and click **SELECT** on **Apply**.
4. **Change any other X25 Parameters for this link.**  
Different PSDNs may require you to change different packet layer parameters.
5. **Save your changes to the working configuration:**



6. **Repeat steps 1 to 5 for the remaining links.**  
Pay particular attention when setting the logical channel ranges. Different PSDNs allocate different values. Make sure you set the correct values for each link

In the same way, change any relevant LAPB and WAN values. Which you need to change depends on the PSDN you are attaching to and on your own configuration.

## Configure X.25 Routing

When you have multiple links, you must tell your machine which traffic should go out on which link. There are several ways of doing this. Which one you use depends on which applications you are running over your X.25 links. The advice given below applies to the PAD program supplied with SunLink X.25 and to IP routing. You can determine the link to use as follows:

- When making PAD calls, the user can specify the link to use as part of the address. For example, to call the address 2080381111 using link 0, the user could enter:

```
% pad 0.2080381111
```



---

If your users are calling only a small number of remote machines this may be the easiest option, as it does not require any special configuration. Other applications may also allow you to specify a link when making a call.

- For PAD calls, you can make entries in the PAD Hosts Database that specify the address and link number of a remote machine, and provide an alias that users can use when making calls. Refer to “Configuring the PAD Hosts Database” on page 48. This option saves users from remembering remote addresses and link numbers.
- For IP, when you make an entry in the Remote IP Host to X.25 Address Map, you must specify the link to use to reach each remote IP address. See “Configuring SunLink X.25 to route IP” on page 52.
- For PAD calls and other applications, you can use the X.25 Routing table. This is the most practical option where there are a large number of remote machines. Making a PAD Hosts Database entry for each one could quickly become unwieldy. The rest of this section looks at how to configure X.25 routing.

---

**Note** – The X.25 Routing table is also used in dial-up configurations. Refer to “Configuring the X.25 Routing Table” on page 91.

---

To display the X.25 Routing table, pull down the Parameters menu and choose Routing. You can configure either the Active configuration, or the Working configuration that will be used on next startup. This example uses the Working configuration.

When you choose Working, the Routing Entries window appears immediately. There is no Select a Link window, as the X.25 Routing table applies across all links. When the window first appears, the parameters are all grayed out. Click SELECT on Create to create a new template entry. The completed Routing Entries window for this example looks like this:

To begin, click SELECT here

Type	Link	Address
XP	2	2624
XP	1	2342
XP	0	2080

Create Edit

Route Type: X.121 Prefix Link: 2

X.121 Address: 2624

Address Extension

MAC Address: PID:

Telephone Number:

Comment: route to Datex-P

To fill it in:

1. Click SELECT on Create to bring up a new template entry.  
By default, this is placed at the top of the list.

2. Configure the Route Type.

The route can apply to an individual remote host—choose X.121 Host or AEF Host—to a group of similar addresses—choose X.121 Prefix or AEF Prefix—or to all calls unless otherwise specified—choose X.121 Default or AEF Default. In the example, calls are being routed to three different remote networks. Each remote network address starts with a unique 4 digit sequence, so X.121 Prefix

is the appropriate Route Type to choose in all three cases. (AEF addresses are used on OSI networks. Use AEF addresses instead of X.121 addresses if your network uses the OSI protocol stack instead of the TCP/IP protocol stack.)

**3. Enter the X.121 address prefix.**

You need to enter enough digits here to distinguish the remote network clearly, without adding so many that you limit which destinations on the remote network can be reached. The 4 digits shown in the example clearly identify each network without restricting calls to part of the network.

---

**Note** – When making international calls, some PSDNs require you to precede the X.121 address with a code indicating that this is an international call. For example to make an international call from Germany, you must add a 0 to the front of the X.121 address. If you are configuring international calls and this applies to your PSDN, make sure you include this as part of the X.121 address prefix.

---

**4. Enter the number of the link that reaches this destination.**

This is the number you assigned to the link when you created it.

**5. Optionally, enter a comment.**

It might be useful to identify the destination that this link reaches, for example.

**6. Save your changes.**

Pull down the File menu and choose the Save Routes option. Save them to the working configuration, as in this example, or apply them to the active configuration.

Once you have finished adding routes, you are ready to start the SunLink X.25 software. Start X.25 by pulling down the Control menu and choosing Start X.25 Network.

You can check that your configuration is working correctly by trying to make a PAD call to a machine on one of the remote networks.

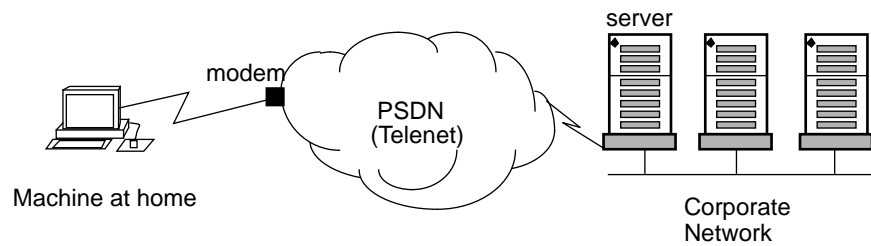


## A Dial-up Configuration

11 ≡

<i>Configuring the WAN Link to the PSDN</i>	<i>page 84</i>
<i>Configuring Parameters</i>	<i>page 85</i>
<i>Configuring X.32 Authentication Procedures.</i>	<i>page 90</i>
<i>Configuring the X.25 Routing Table</i>	<i>page 91</i>

In this example, the workstation is running SunLink X.25 so that it can dial into the PSDN. A modem provides the connection to the PSDN.



As there is a server on the corporate network that is attached to the same PSDN, the workstation can access the server - for example by making a PAD call. From there, it can `rlogin` to other machines on the corporate network. Alternatively, the server could be configured to act as an IP router, giving direct access to the whole network. To configure a machine to use a dial-up connection:

- Create a link to the PSDN.
- Configure the logical channel ranges.
- Specify that V25 calling procedures are to be used.
- Set the idle disconnect to a reasonable value.
- Configure X.32 authentication procedures.
- Add the telephone number of the point of connection to the network, in this case a modem, to the X.25 Routing table.

---

**Note** – Before configuring SunLink X.25 9.0, you must configure your modem to operate in V.25 mode—refer to your modem manufacturer’s documentation for instructions that apply to your particular modem.

---

## *Configuring the WAN Link to the PSDN*

First configure the link between the server and the PSDN. In the example this is the onboard serial port connected to the modem.

- 1. Log in as root or become superuser and start `x25tool`:**

```
hostname% su
Password: xxxx
# /opt/SUNWconn/bin/x25tool
```

- 2. Bring up the Interface Configuration window.**  
Click SELECT on the Link button in the `x25tool` main window.
- 3. Edit Link 0, the default WAN link.**  
Click SELECT on the entry for Link 0 in the scrolling list to display the default WAN link values.
- 4. Change the other values as shown in the snapshot below.**

Refer to “x25tool Overview” on page 29 for help if you do not know how to change values:

**Interface Configuration**

Link	Device	Description
0	ZSH-0	dialup connection to network
1	LE-0	Ethernet interface

Link Number: 0    
 Device:  ZSH   
 Local Address: 311087253111  
 Description:  connection to network   
 Local SAP: 7E Loopback SAP: 7D Max. Conn: 20    
 LAP Mode:  LAPB   
 Interface:    
 Full Address: \_\_\_\_\_  
 Extended Address  None  Extension: \_\_\_\_\_

Annotations:

- Keep Link Number as 0
- Keep device as zsh
- X.121 address assigned by PSDN
- Optional description
- Keep LAP mode as LAPB
- Click SELECT on Apply when done
- Choose year of X.25 Recommendation
- Keep port number 0
- Optional alias
- Interface **must** be DTE

5. Click SELECT on Apply to update the configuration.

## Configuring Parameters

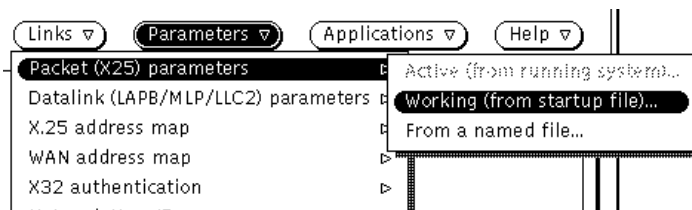
Once you have created the link, you need to:

- Configure the logical channel ranges.
- Specify that V25 calling procedures are to be used, and set the idle disconnect to a reasonable value.

## Configuring the Logical Channel Ranges

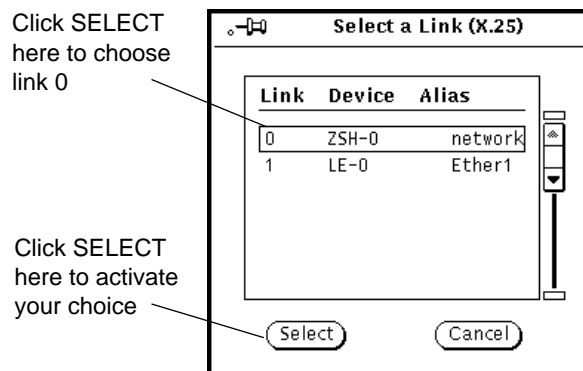
To change the logical channel ranges:

1. Pull down the Parameters menu and select the Packet (X25) Parameters item. In the submenu, click SELECT on the Working(from startup file) option:



Using the Working option means that the parameters set in the file that will be used the next time X.25 is restarted on the link is used.

2. The Select a Link window appears:



Choose link 0.



**3. The X25 Parameters screen appears:**

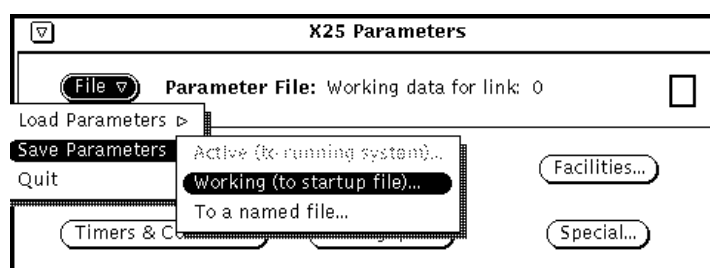
Due to the large number of X25 Parameters, there are 6 subscreens.

**4. Click SELECT on the Network Profile button to display the Logical Channel ranges:**

Enter the values assigned by your PSDN. In the example, there are 40 two way SVCs, numbered 1 to 40.

**5. Click SELECT on Apply.**

6. In the X25 Parameters screen, press MENU on the File menu button and then press MENU on the Save parameters option. In the submenu, click SELECT on Working(to startup file)



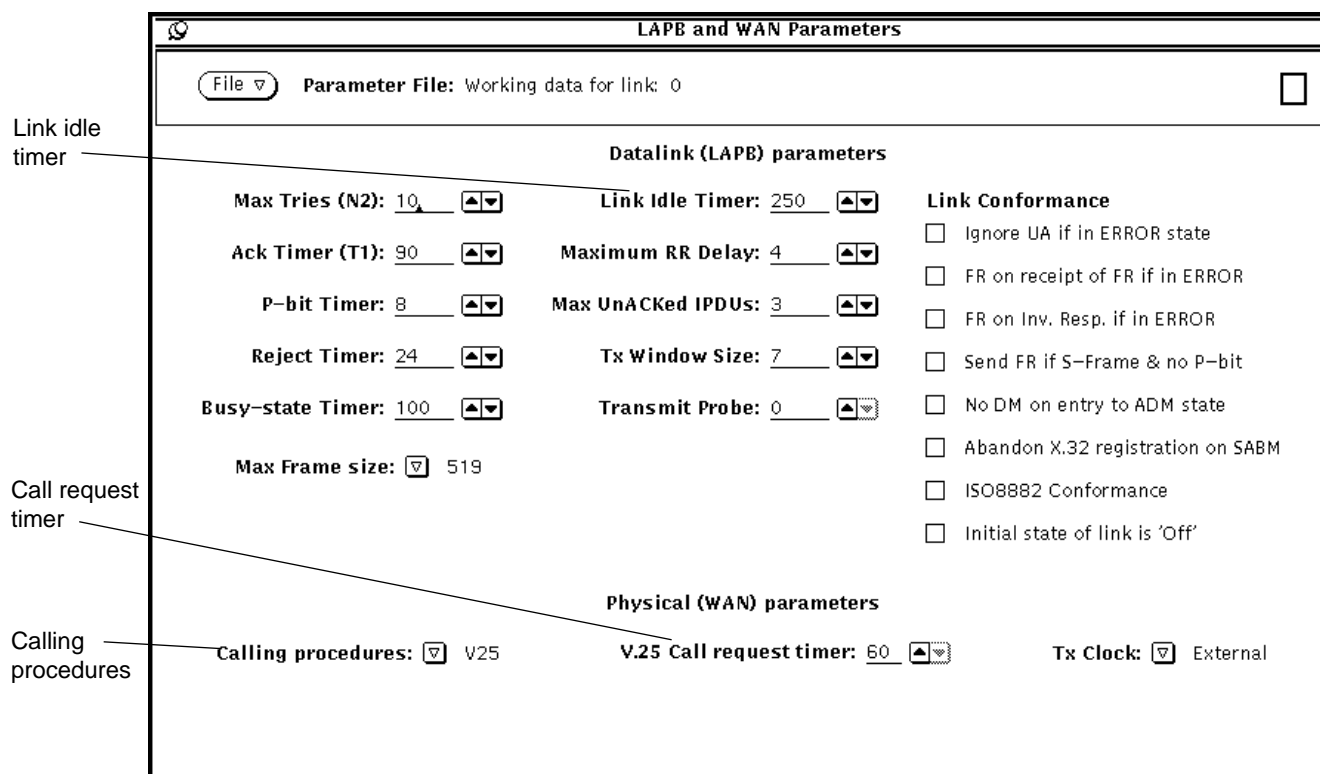
This makes sure your changes will be used when you start X.25.

## Configuring V25 Calling Procedures

For a dial-up link, you *must* specify that V25 calling procedures are to be used. These are used to control the modem. The parameters you need are located in the LAPB and WAN Parameters window. To configure the parameters:

### 1. Display the LAPB and WAN Parameters window.

Pull down the Parameters menu and choose Datalink (LAPB/MLP/LLC2) parameters. Choose LAPB (single interface) and then choose the Working option. In this case, as there is only one WAN link there is no need for a Select a Link window. The LAPB and WAN Parameters window appears:



### 2. Choose V25 Calling procedures.

Pull down the Calling procedures menu and choose V25.

**3. Set the V25 Call request timer.**

This is the timer that determines the length of time that your machine will go on trying to connect to the remote network without timing out. You only need to set this if your modem does not support call fail indications. Check with your service supplier to find out if this is the case. If your modem does support call fail indications, set this to 0.

**4. Set the Link Idle Timer.**

This is period in tenths of a second for which the link can remain idle without being closed down. Set a value high enough to allow for lost traffic and retries, but low enough that you are not constantly paying for an idle link.

**5. Save your changes to the Working configuration.**

Pull down the File menu and choose Save Parameters. Then choose Working (startup file). These changes will be used the next time you start X.25.

## *Configuring X.32 Authentication Procedures.*

Next you need to configure the X.32 authentication procedures. These are used on dial-up links by most PSDNs, to prevent people without permission from dialing in. To configure X.32 authentication:

**1. Display the X.32 Map window.**

Pull down the Parameters menu and choose X.32 authentication. Choose Working (from X.32 map file). The X.32 Map appears. Click SELECT on Create to display a template entry.

## 2. Fill in the X.32 Map values as shown below:

The screenshot shows the 'X.32 Map' window. At the top is a 'File' menu. Below it is a table with one row: '0' in the first column, 'Lnk smithathome' in the second, and '&&&djfe1\*\*' in the third. To the right of the table is a vertical scrollbar. Below the table are 'Create' and 'Delete' buttons. Further down is a 'Register at' section with a dropdown menu set to 'Link level, single link'. Below that is a 'Link:' label followed by a text box containing '0' and a small icon. At the bottom are two text boxes: 'Identity: smithathome' and 'Signature: &&&djfe1\*\*^@'. Annotations with arrows point to various parts: 'Click SELECT here to start.' points to the '0' in the table; 'Choose between link level and packet level.' points to the 'Register at' dropdown; 'Specify the link number.' points to the '0' in the 'Link:' text box; 'Any string of ASCII characters, up to 32 digits long.' points to the 'Identity' and 'Signature' text boxes; and 'Click here to update display.' points to the '&&&djfe1\*\*' in the table.

You can choose to carry out X.32 authentication at link level or a packet level. When connecting to a PSDN, use link level as this means the authentication is carried out by the network. Packet level is appropriate when connecting with another machine (back to back, for example) when you want the machine and not the network to do the authentication. Both the Identity and the Signature can be any ASCII string, up to 32 characters long, not containing whitespace.

## 3. Save your changes to the Working configuration.

Pull down the File menu and choose the Save X.32 map option. Choose the Working option.

## Configuring the X.25 Routing Table

The final step in configuring a dial-up machine is to add the telephone number of the point of connection to the network to the X.25 routing table, mapped to the X.121 address of the machine you want to be able to access. In the example, this is a host on the remote network that is configured to act as an IP router, providing access to the remainder of the network.

To display the X.25 Routing table, click SELECT on Routing and choose to configure from Working. When you choose Working, the Routing Entries window appears immediately. There is no Select a Link window, as the X.25 Routing table applies across all links. When the window first appears, the parameters are all grayed out. Click SELECT on Create to create a new template entry.

The completed Routing Entries window for this example looks like this:

To begin, click SELECT here

Type	Link	Address
XH	0	311087253112

Create Edit

Route Type: X.121 Host Link: 0

X.121 Address: 311087253112

Address Extension

MAC Address: PID:

Telephone Number: 8175551234

Comment:

To fill it in:

1. **Click SELECT on Create to bring up a new template entry.**  
By default, this is placed at the top of the list.
2. **Configure the Route Type.**  
The example uses a route to an individual host. Choose X.121 Host here.
3. **Enter the X.121 address.**  
Enter the address of the server on the corporate network that also has a connection to the X.25 PSDN. In the example, this is 31108753112.

**4. Enter the number of the link that reaches this destination.**

This is the number you assigned to the link when you created it. In the example this is link 0.

**5. Enter the Telephone Number used to reach this destination.**

In a dial-up configuration, this is the address of your point of attachment to the X.25 PSDN, in most cases a modem.

**6. Optionally, enter a comment.**

It might be useful to identify the destination that this link reaches, for example.

**7. Save your changes.**

Pull down the File menu and choose the Save Routes option. Save them to the working configuration, as in this example, or apply them to the active configuration.

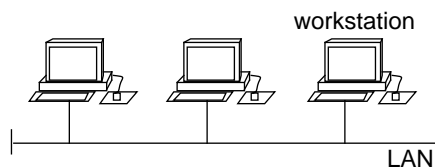
This configuration creates a mapping between the telephone number and the X.121 address of the remote host. When the machine has traffic for the remote host, it knows to dial into the X.25 PSDN. The traffic will then be routed to the remote machine.





## *A Workstation attached to a LAN*

12 ≡



In this example, a new workstation is being added to the Local Area Network (LAN). When installed on a machine attached to a LAN, X.25 is configured over LLC2 instead of over LAPB.

This kind of configuration is straightforward. You only need to configure the link to the LAN. The default parameters used at both the Packet layer and the LLC2 layer should work in almost all LAN configurations.

To configure a LAN link:

1. Start `x25tool` and click **SELECT** on **Links** to bring up the **Interface Configuration** window.

## 2. Using link 1 as a template, configure the values for your LAN link, as shown below:

Click SELECT here to start

Keep Link Number as 1

Keep device as LE

Enter your MAC address here

Optionally, enter a description

Keep local SAP and Loopback SAP as 7e and 70

Click SELECT on Apply to finish

Keep Link Type as LAN

**Interface Configuration**

Link	Device	Description
0	ZSH-0	Internal serial port
1	LE-0	Ethernet interface

Create Edit PVC Options...

Link Number: 1 Link Type: LAN

Device: LE Port Number: 0

Local Address: 08002074C0E9

Description: Ethernet interface Alias: Ether1

Local SAP: 7E Loopback SAP: 70 Max. Conns: 20

LAP Mode: LAPB Interface: CTE DCE

Full Address:

Extended Address Extension:

None

Apply Reset Cancel

You can keep almost all of the default values. The Local Address is the MAC address of your machine. You can find it out by entering the following command:

```
hostname% arp machinename
```

Make sure that you do not change or delete the Local SAP or the Loopback SAP, unless you are certain that your network uses different values.

Once you have added the LAN link like this, you can start the X.25 software. You should now be able to run your applications over the LAN.

---

For example, you can make PAD calls to machines on the same LAN by specifying the link number and the MAC address, followed by the SAP, as shown below:

```
hostname% pad 1.0800207111117e
```

where 1 is the link number, 080020711111 is the MAC address, and 7e is the SAP.

See “Configuring the PAD” on page 47 for information on adding entries to the PAD Hosts Database.

---


**Note** – Even if the LAN link is the only link on your machine, you need to specify the link number when using applications such as the PAD. This is because SunLink X.25 defaults to use the lowest numbered WAN link. If there is no WAN link, there is no default link.

Another way to deal with this situation is by using the X.25 Routing table. Map the MAC address plus link number to an X.121 address, then make calls to the X.121 address rather than the MAC address. See “Configure X.25 Routing” on page 78 for an example of configuring the X.25 Routing table.

---

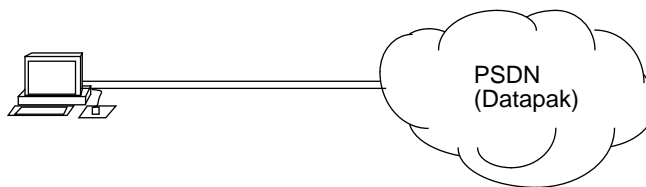


## An MLP Configuration

13 

<i>Configuring the MLP Link</i>	<i>page 100</i>
<i>Configuring the Logical Channel Ranges</i>	<i>page 101</i>
<i>Configuring MLP Parameters</i>	<i>page 102</i>

In this example configuration, the workstation uses two lines to connect to the PSDN in a multilink configuration. This allows for greater throughput than would be allowed by a single link. Each of the two lines is attached to a high speed interface using the SunLink HSI card, and each runs at 64Kbps.



**Note** – The multilink protocol (MLP) software is a standard part of the SunLink X.25 product. However, you can only make use of it if you are connecting to a PSDN that supports MLP. Check with your network supplier to find out if this is the case.

To set up a configuration like this, you need to:

- Create a two-line MLP link to the PSDN.
- Configure the logical channel ranges used by the PSDN.
- Configure the MLP Priority, MLP Window and MLP Guard values to be used on the link.

## Configuring the MLP Link

The first step in creating this configuration is to create the MLP link. Start `x25tool` and click SELECT on Links to bring up the Interface Configuration window. Create the MLP link, as shown below:

The screenshot shows the 'Interface Configuration' window. It contains a table with columns 'Link', 'Device', and 'Description'. The first row shows '0', '<MLP>', and 'MLP link'. Below the table are buttons for 'Create', 'Edit', and 'PVC Options...'. The 'Link Number' is set to '0'. The 'Link Type' is set to 'MLP 2-line'. The 'Device' is set to 'HSI' for both lines. The 'Port Number' is set to '0' for the first line and '1' for the second line. The 'Local Address' is '2402111111'. The 'Description' is 'MLP link'. The 'Alias' is 'MLP'. The 'Local SAP' is '7E', 'Loopback SAP' is '70', and 'Max. Conn.' is '2'. The 'LAP Mode' is 'LAPD'. The 'Interface' is set to 'DTE'. The 'Full Address' and 'Extended Address' are empty. The 'Extension' is 'None'. The 'Apply', 'Reset', and 'Cancel' buttons are at the bottom.

Click SELECT on Create to bring up a new template

Each link must have a unique link number

Choose the correct device type here

Enter the X.121 address here

The description is optional

Click on Apply when done

Clicking here updates the list item

Set the year of the X.25 revision here

Device plus port number must be unique for each line

Alias is optional

Interface is DTE for connecting to a PSDN

---

**Note** – The example uses two HSI interfaces. You can mix links that use the onboard serial port (zsh) and links that use high speed interfaces, however, you cannot run SunLink X.25 on more than two onboard serial ports on the same machine.

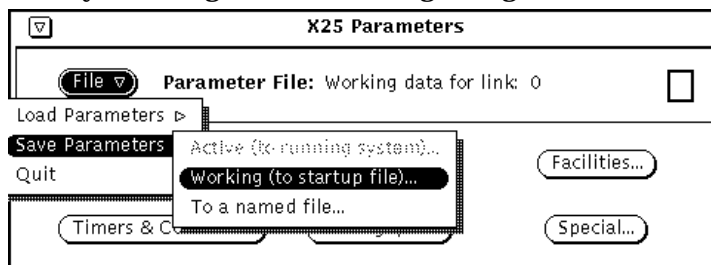
---

## Configuring the Logical Channel Ranges

Once you have created the MLP link, you need to configure the packet layer parameters. You almost certainly need to configure the logical channel ranges. You may also need to configure other packet layer and LAPB layer parameters.

To change the logical channel ranges:

- 1. Pull down the Parameters menu and choose Packet (X25) Parameters. Choose the Working (from startup file) option.**  
The X25 Parameters screen appears. In the example, there is only one link, so no Select a Link window is needed.
- 2. Click SELECT on Network Profile, to display the Logical Channel Ranges.**  
Type in the values used by the PSDN that link 0 attaches to and click SELECT on Apply.
- 3. Change any other X25 Parameters for this link.**  
Different PSDNs may require you to change different packet layer parameters.
- 4. Save your changes to the working configuration:**



### *Configuring MLP Parameters*

You need to configure the MLP Priority, MLP Window size, and MLP Guard values to be used on the link. The values of these parameters are interdependent.

Set the MLP priority separately for each line in the MLP link. The MLP Priority defines how many unacknowledged frames can be sent on one line before the next line is used. Setting this correctly has the effect of forcing traffic to be distributed between the lines in an MLP link. The values you set depend on the absolute speed of each line and on the relative speeds of your lines. In general, don't set an MLP Priority of less than 3. If your lines operate at 64kbps, or more, you should increase the MLP Priority.

The MLP Window size, which applies to the link as a whole, not to the individual lines, should be larger than the total of the MLP Priority values.

The MLP Guard should be the same as the MLP Window.

---

**Note** – All of the machines connected to the same network must use the same MLP Window size. If you are connecting to a PSDN, check with your service provider to find out the appropriate MLP Window size to use. This may restrict the MLP Priority values that you can set, as the total of the MLP Priority values must not be greater than the MLP Window size.

---

The following combinations of values have been observed to provide efficient (90%) line use in two line MLP configurations:

For two 64Kbps lines, setting the MLP Priority for each line to 10 and the MLP Window and MLP Guard to 25.

For one 512Kbps line and one 128Kbps line, setting the MLP Priorities to 30 and 5, respectively, and the MLP Window and Guard to 40.

To set these values:

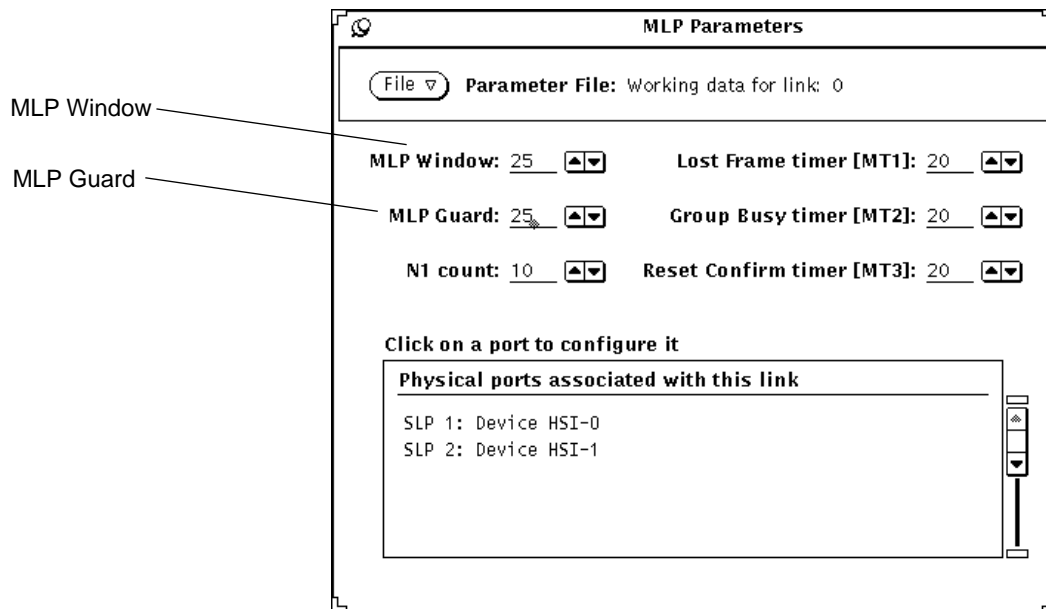
#### **1. Display the MLP Parameters window.**

Pull down the Parameters menu and choose Datalink (LAPB/MLP/LLC2) parameters. Choose to configure from Working. In the example configuration, there is only one MLP link, so there is no Select a Link window. The MLP Parameters window appears.



**2. Configure the MLP Window and MLP Guard values.**

In the example, 25 is an appropriate value:

**3. Click SELECT on the entry for SLP 1 in the scrolling list.**

This displays the LAPB and WAN Parameters window for the first MLP line.

## 4. Configure the MLP Priority, and any other parameters required by your PSDN.

In the example, 10 is an appropriate value:

**LAPB and WAN Parameters**

File ▾ Parameter File: Working data from SLP 1 of MLP link 0

**Datalink (LAPB) parameters**

Max Tries (N2): 10 ▲▼ Link Idle Timer: 250 ▲▼

Ack Timer (T1): 90 ▲▼ Maximum RR Delay: 4 ▲▼

P-bit Timer: 7 ▲▼ Max UnACKed IPDUs: 3 ▲▼

Reject Timer: 25 ▲▼ Tx Window Size: 7 ▲▼

Busy-state Timer: 100 ▲▼ Transmit Probe: 0 ▲▼

Max Frame size: ▾ 519 MLP priority: 10 ▲▼

**Link Conformance**

☐ Ignore UA if in ERROR state

☐ FR on receipt of FR if in ERROR

☐ FR on Inv. Resp. if in ERROR

☐ Send FR if S-Frame & no P-bit

☐ No DM on entry to ADM state

☐ Abandon X.32 registration on SABM

☐ ISO8882 Conformance

☐ Initial state of link is 'Off'

**Physical (WAN) parameters**

Calling procedures: ▾ None V.25 Call request timer: 60 ▲▼ Tx Clock: ▾ External

## 5. Save the change to the Working configuration.

Pull down the File menu and choose Save To. A Select an SLP window appears. Choose SLP 1, then choose Working.


## 6. Repeat steps 3 to 5 for the remaining SLP(s).

## 7. In the MLP Parameters window, save the parameters to the Working configuration.

Pull down the File menu in the MLP parameters window and choose Save To. Then choose Working.

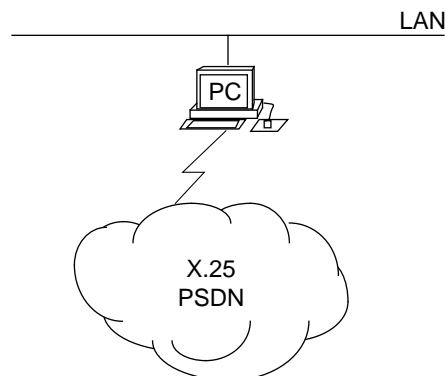
Once you have carried out the configuration described in this section, you are ready to start X.25 on your machine. Pull down the Control menu and choose Start X.25.

## *A PC running X.25 on the LAN and on the WAN*

14 

<i>Installing the SCii-ExpressX Card</i>	<i>page 106</i>
<i>Creating the LAN and WAN links.</i>	<i>page 108</i>
<i>Configuring Parameters</i>	<i>page 111</i>

This chapter describes how to configure a WAN and a LAN link on a PC running SunLink X.25. The configuration described in this chapter uses the default values provided with the product.



The configuration process is identical to that used for the SPARC version of the product, but the device names change.

To configure SunLink X.25 to be used over the WAN, you need to:

- install the SCii-ExpressX card
- configure some information about the link
- change the logical channel ranges used by the SunLink X.25 software to match those used by your PSDN

Before you start, make sure you know the following information:

- the version of the X.25 Recommendation used on the PSDN
- the X.121 address of the port you intend to use
- the logical channel ranges used by the PSDN

To configure the LAN link, you only need to configure the link to the LAN. The default parameters used at both the Packet layer and the LLC2 layer should work in almost all LAN configurations.

## Installing the SCii-ExpressX Card

In order to run SunLink X.25 9.0 over the WAN, the PC must have the SCiiExpress-X card installed. Install this as described in *Installing the SCiiExpress-X Card*. You must use a different interrupt setting for each card that you install—consult your PC manufacturer's documentation for instructions on finding out which interrupts and i/o addresses are available.

Once you have changed the interrupts or addresses, you *must* also change the `inter` and `ioaddr` parameters in the `/usr/kernel/drv/expx.conf` file to match. If you forget to do this, a message appears in the console to remind you. The example below shows how this file looks for a system that has a single card installed on interrupt 5, with address 500:

```
#
#       The following declares an ExpX card at io address 0x500
#       and interrupt vector 5 :
#
name="expx" class="sysbus" reg=0x500,0,0 ioaddr=0x500 intr=7,5 ;
```

Change the `reg` and `ioaddr` parameters to match the i/o address. Change the *second* digit of the `intr` parameter to match the value of the interrupt used.

---

**Note** – Do not change the *first* digit of the `intr` parameter value as this invalidates your configuration.

---

In the example, the card is connected to a modem using a straight-through cable, using the pin out described for Port A in the V.24 diagram in *Installing the SCiiExpress-X Card*. The pin out matches the conventional assignment for a 25 pin V.24 serial port. When you subscribe to a PSDN, your supplier almost always provides a modem. If this is not the case, contact the supplier to find out what kind of modem you need.

## Creating the LAN and WAN links.

In the `x25tool` base window, pull down the Links menu and select the Create/Modify item. The Interface Configuration window appears. The snapshot below shows the default Interface Configuration window for an x86 system:

The screenshot shows the 'Interface Configuration' window. It contains a table with two links, a list of buttons (Create, Edit, PVC Options...), and several configuration fields for the selected link (Link 0).

Link	Device	Description
0	EXPX-0	ISA X.25 card
1	ELX-0	3Com 3C509 Etherlink III card

Buttons: Create ▾, Edit ▾, PVC Options...

Link Number: 0 ▴ ▾      Link Type: ▾ WAN (1988)

Device: ▾ EXPX      Port Number: 0 ▴ ▾

Local Address: 0000

Description: ISA X.25 card      Alias: sp

Local SAP: 7E      Loopback SAP: 7D      Max. CDUs: 20 ▴ ▾

LAP Mode: ▾ LAPB      Interface: DTE DCE

Full Address: 0000

Extended Address      Extension: \_\_\_\_\_

☒ None

Buttons: Apply, Reset, Cancel

By default, there are two template links already configured, one WAN link and one LAN link.

Configure a single WAN link by editing the WAN template:

1. **Make sure the entry for Link 0 in the scrolling list is highlighted.**  
This ensures that the information displayed applies to link 0.

## 2. Set the Link Type.

Pull down the Link Type menu and choose the version of the X.25 recommendation used by your PSDN.

## 3. Set the Device type and Port Number.

The example uses the default `expx` device, which is the device type for the SCiiExpress-X card. Currently, this is the only available device for WAN links:

Choose the relevant device type

Type in the port number

Device:  Port Number:

Local Address:  Alias:

Description:  Local SAP:  Loopback SAP:  Max. Conns:

LAP Mode:  Interface:

Full Address:  Extension:

Extended: ☒ None

## 4. Set the Local Address.

Type in the address of port 0 in this field. This is the X.121 address assigned to you by your supplier. This address is often referred to as an X.25 address. Your service supplier should tell you this address.

**Note** – The Full Address and Extended Address parameters are not used when the product is in normal operation. You only need to enter these if you are using an application that expects to read them. If this is the case with your PSDN, your service provider will tell you what you need to enter here.

## 5. Set the LAP Mode to LAPB, unless you are sure your PSDN uses a different LAP Mode.

LAP and LAPBE are used very rarely.

## 6. Make sure the Interface is set as DTE.

You only need to set the Interface as DCE if you are running two machines back-to-back, for example for testing.

## 7. Click on Apply to confirm your changes.

Next create the LAN link.

Using link 1 as a template, configure the values for your LAN link, as shown below:

Click SELECT here to start

Keep Link Number as 1

Set device type

Enter your MAC address here

Keep local SAP and Loopback SAP as 7e and 70

Click SELECT on Apply to finish

Keep Link Type as LAN

Link	Device	Description
0	EXPX-0	ISA X.25 card
1	ELX-0	3Com 3C509 Etherlink III card

Create Edit PVC Options...

Link Number: 1 Link Type: LAN

Device: ELX Port Number: 0

Local Address: 08002074C0E5

Description: Etherlink III card Alias: Ether1

Local SAP: 7E Loopback SAP: 70 Max. Conns: 20

LAP Mode: LAPB Interface: CTE DCE

Full Address:

Extended Address: None Extension:

Apply Reset Cancel

You can keep almost all of the default values. The device type depends on the type of Ethernet card used by your PC. The default ELX-0 applies to the 3Com® Etherlink® III card. If you are not sure of the device type used by your PC, enter the following command:

```
hostname% ifconfig -a
```

Included in the information returned by this command is the name of the device that IP is running over. Use this same device type for X.25.



The Local Address is the MAC address of your machine. You can find it out by entering the following command:

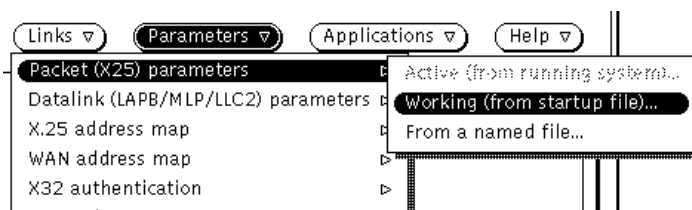
```
hostname% arp machinename
```

Make sure that you do not change or delete the Local SAP or the Loopback SAP, unless you are certain that your network uses different values.

## Configuring Parameters

Once you have created the WAN and LAN links, you need to configure the parameters used by traffic over the WAN link. The default parameters are adequate for most situations, however, you usually need to change the logical channel ranges to match those used on your PSDN. To do this

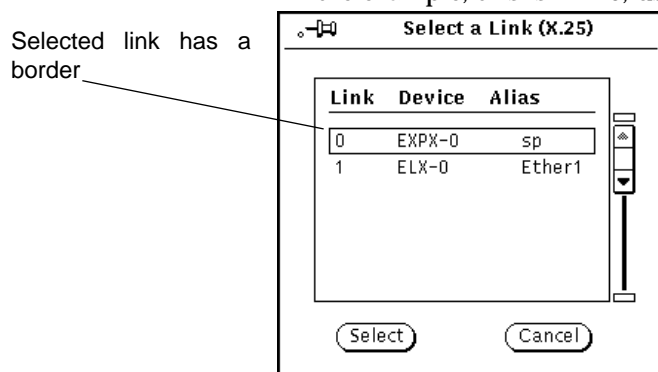
1. Pull down the Parameters menu and select the Packet (X25) Parameters item. In the submenu, click SELECT on the Working (from startup file) option:



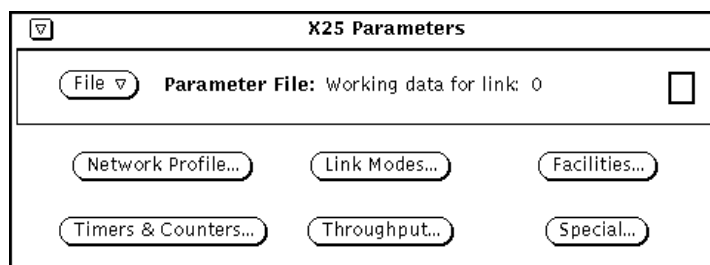
Using the Working option means that the parameters set in the file that will be used the next time X.25 is restarted on the link is used.

## 2. Choose the link you are working with from the list in the Select a Link window.

In the example, this is link 0, using device EXPX-0:



### 3. The X25 Parameters screen appears.



Due to the large number of X25 Parameters, there are 6 subscreens. They have the following content:

*Table 14-1 X.25 Parameters subscreens*

Window	Description
Network Profile	Set the logical channel ranges, the X.25 Recommendation year, Modulo 8 or 128 and DTE or DCE.
Link Modes	Parameters affecting packet format and size.
Facilities	Parameters affecting closed user group operation and use of optional X.25 facilities.
Timers and Counters	Transmission, retransmission and delay timers.
Throughput	Throughput class and packet and window sizes.
Special	D-bit control and throughput class packet/window mapping.

In general, you do not need to change to majority of these parameters, the default values are appropriate for almost all situations. However, you almost certainly need to edit the logical channel ranges, as each public network uses different settings.

4. Click **SELECT** on the **Network Profile** button to display the **Logical Channel ranges**:

The screenshot shows a dialog box titled "Network Profile". Inside, there is a section titled "Logical Channel ranges". It contains four rows of input fields for minimum and maximum values, each with up and down arrow buttons. The first row is "PVC - Minimum: 0" and "Maximum: 0". The second row is "Incoming - Minimum: 0" and "Maximum: 0". The third row is "Two Way - Minimum: 1" and "Maximum: 40". The fourth row is "Outgoing - Minimum: 0" and "Maximum: 0". Below these are two more fields: "Version: 1988" and "Modulo: 8 128". At the bottom, there is a checkbox labeled "DTE/DCE operation: Matches Link" which is checked. At the very bottom are "Apply" and "Cancel" buttons.

Your PSDN will tell you which values to use here. Contact them if you require this information. If you are configuring a private network, all machines on the network must use the same logical channel ranges. In this case, you can choose any values you like as long as they comply with the X.25 Recommendations.

5. Click **SELECT** on **Apply**.
6. In the **X25 Parameters** screen, press **MENU** on the **File** menu button and then press **MENU** on the **Save parameters** option. In the submenu, click **SELECT** on **Working(to startup file)**

The screenshot shows a dialog box titled "X25 Parameters". At the top, there is a "File" button with a dropdown arrow. Below it, the text "Parameter File: Working data for link: 0" is displayed. A menu is open under the "File" button, showing options: "Load Parameters", "Save Parameters", and "Quit". The "Save Parameters" option is highlighted, and a submenu is open below it, showing "Active (k-running system)...", "Working (to startup file)...", and "To a named file...". The "Working (to startup file)..." option is highlighted. To the right of the menu are buttons for "Facilities..." and "Special...". At the bottom left, there is a button labeled "Timers & Control".

This makes sure your changes will be used next time you start X.25.

---

**Note** – For a default configuration, you do not need to configure the Datalink layer parameters, the defaults should be adequate.

---

**7. Start X.25 by pulling down the Control menu and clicking SELECT on Start X.25 Network.**

To check that the configuration is valid, make a PAD call to yourself. To do this, enter the `pad` command at a command line, followed by your own X.121 address:

```
hostname% pad X.121 address
```

Once you have created a link that works, you can go on and fine-tune it, or configure the application(s) you want to run over it. The procedure for doing so is the same as for the SPARC version of the product.



<i>Setting Up a Loopback Configuration</i>	<i>page 117</i>
<i>Setting up a Back-to-Back Test Configuration</i>	<i>page 121</i>

This chapter describes two configurations that can be useful for test purposes, a loopback configuration and a back to back configuration.

### *Setting Up a Loopback Configuration*

A loopback configuration is useful for testing and troubleshooting your local configuration down to, and including, the link layer. Completing a call over a loopback interface is a useful check of your local X.25 and link layer configuration. If you have problems bringing up the X.25 network, a loopback test should be one of the first tests you perform. To set up a loopback test, follow the instructions in this section.

Follow the instructions in “Loopback over a WAN (LAPB)” on page 118 to configure a loopback over LAPB and in “Loopback over LLC2 (LAN Links)” on page 121), to configure a loopback over LLC2.

## Loopback over a WAN (LAPB)

For each loopback configuration over LAPB, you must have two links. Configure these as follows:

1. **Display the Interface Configuration window.**  
In the `x25tool` base window, click SELECT on Links.
2. **Click SELECT on the Create button to create the first loopback link.**  
In this example, this is called WLOOP-0.
3. **Assign the values shown below:**

The screenshot shows the 'Interface Configuration' window. It contains a table with three links: 0 (ZSH-0, Internal serial port), 1 (LE-0, Ethernet interface), and 2 (WLOOP-0, loopback1). Below the table are buttons for 'Create', 'Edit', and 'PVC Options...'. The 'Create' button is highlighted with an annotation 'Click SELECT here to create link'. The 'Link Number' is set to 2, with an annotation 'Link number must be unique'. The 'Device' is set to WLOOP, with an annotation 'Device type is WLOOP'. The 'Link Type' is set to WAN (1988), with an annotation 'Default Link Type is WAN (1988)'. The 'Port Number' is set to 0, with an annotation 'Keep port number as 0'. The 'Local Address' is set to 1234, with an annotation 'Local Address can be any string of digits'. The 'Description' is set to loopback1, with an annotation 'Optionally, enter a description'. The 'Alias' is set to loop1, with an annotation 'Optionally, enter an alias'. The 'LAP Mode' is set to LAPB, with an annotation 'LAP mode is LAPB'. The 'Interface' is set to DTE, with an annotation 'Interface is DTE'. The 'Full Address' and 'Extended Address' fields are empty. The 'Extension' is set to None, with an annotation 'Click SELECT here to update'. The 'Max. Conns.' is set to 16.

Click SELECT here to create link

Link number must be unique

Device type is WLOOP

Local Address can be any string of digits

Optionally, enter a description

LAP mode is LAPB

Click SELECT here to update

Default Link Type is WAN (1988)

Keep port number as 0

Optionally, enter an alias

Interface is DTE

Link	Device	Description
0	ZSH-0	Internal serial port
1	LE-0	Ethernet interface
2	WLOOP-0	loopback1

Create Edit PVC Options...

Link Number: 2 Link Type: WAN (1988)

Device: WLOOP Port Number: 0

Local Address: 1234 Alias: loop1

Description: loopback1

Local SAP: 7E Loopback SAP: 7D Max. Conns: 16

LAP Mode: LAPB Interface: DTE DCE

Full Address: Extended Address: Extension: None

Apply Reset Cancel



#### 4. Create another link.

Still in the Interface Configuration window, click SELECT on the Create button to create another link. Configure the values shown below:

Link Number is 3

Device type is WLOOP

Local Address can be any string of digits

Optionally, enter a description

LAP mode is LAPB

Click SELECT here to update

Default Link Type is WAN (1988)

Set port number to 1

Optionally, enter an alias

Interface **must be** DCE

Link	Device	Description
0	ZSH-0	Internal serial port
1	LE-0	Ethernet interface
2	WLOOP-0	loopback1
3	WLOOP-1	loopback2

Create Edit PVC Options...

Link Number: 3 Link Type: WAN (1988)

Device: WLOOP Port Number: 1

Local Address: 1111 Alias: loop2

Description: loopback2

Local SAP: 7E Loopback SAP: 7D Max. Coins: 15

LAP Mode: LAPB Interface: DTE DCE

Full Address: Extension:

Extended Address: None

Apply Reset Cancel

#### 5. Click SELECT on Apply.

#### 6. Dismiss the Interface Configuration window.

#### 7. Stop then restart your X.25 network.

Use the Stop X.25 Network and Start X.25 Network items under the Network Control menu button.

At this point, you have a usable loopback interface for LAPB. You can test it with a command such as the one below. In this example, you have a loopback interface on link 2 with a Remote Address of 1111:

```
% pad 2.1111
Break-in sequence is '^Pa'

Connecting...
Connected
SunLink X.29 Terminal Service
login:
```

You can connect to the other member of the link pair by specifying its link number and its Local Address. For example:

```
% pad 3.7777
Break-in sequence is '^Pa'

Connecting...
Connected
SunLink X.29 Terminal Service
login:
```

It is convenient to set up entries for your loopback interfaces in your PAD hosts database. See “Configuring the PAD Hosts Database” on page 48 for instructions. In the PAD Hosts Database window, you need enter values only for the Host Name, Remote Address, and Link Number parameters.

You can run `x25trace` in another window and observe LAPB and X.25 Packet Layer activity over the loopback interface. For example:

```
# /opt/SUNWconn/bin/x25trace -i /dev/lapb
```

See “Obtaining Packet and Link-Level Traces” on page 190 for instructions on the use of `x25trace`.

## *Loopback over LLC2 (LAN Links)*

The LLC2 layer supports loopback by default, using the loopback SAP of 70. To create a loopback connection over LLC2, simply specify your LLC2 link number, MAC address, and SAP address of 70 as arguments to the `pad` program. For example, if your LLC2 link number is 1 and your Ethernet address is `8:0:20:ab:21:6`, enter:

```
% pad 1.080020ab210670
Break-in sequence is ``^Pa'

Connecting...
Connected
SunLink X.29 Terminal Service
login:
```

You can also set up entries for your LLC2 loopback interface in your PAD hosts database. See “Configuring the PAD Hosts Database” on page 48 for instructions. In the PAD Hosts Database window, you need enter values only for the Host Name, Remote Address (your MAC address plus 70), and Link Number parameters.

To observe LLC2 protocol activity over the loopback interface, as root, you can enter an `x25trace` command such as:

```
# /opt/SUNWconn/bin/x25trace -i /dev/l1c2
```

See “Obtaining Packet and Link-Level Traces” on page 190 for instructions on the use of `x25trace`.

## *Setting up a Back-to-Back Test Configuration*

If you are using SunLink X.25 to connect to a PSDN you need to make a call over that PSDN in order to check that your configuration works with the PSDN. However, you can test user-developed applications, and certain aspects of your X.25, LAPB, and WAN configuration, by using a null modem cable or modem eliminator to set up a “back-to-back” connection to another machine.

---

**Note** – See Chapter 17, “Cabling,” for instructions on building a null modem cable.

---

Follow the instructions in “Back-to-Back WAN Links” on page 122 to set up a back-to-back WAN connection, and in “Back to Back LAN Links” on page 124 to set up a LAN connection.

## *Back-to-Back WAN Links*

### **1. Connect your communications equipment.**

If you are using a modem eliminator, connect the cables from the modem eliminator to the two machines. If you are using a null modem cable, connect the cable to the two machines.

### **2. Create a link on the local machine.**

Follow the instructions in “Configuring a Single WAN Link” on page 33.

In the `x25tool` windows use the following values:

- In the Interface Configuration window, accept ZSH (the default), or specify HSI for the Device item.
- In the Interface Configuration window, accept the default, DTE, or specify DCE for the Interface parameter. You must be the opposite of the DTE/DCE role of the machine at the remote end. If the remote machine is a 7.0 SunNet X.25 machine, on that machine enter a command such as:

```
remote_host% x25config -d /etc/sunlink/x25/x25params0 | grep 198
x25 1984 normal dte
```

In the example output above, the remote machine is a DTE. In such a case, specify DCE for the local machine.

- Still in the Interface Configuration window, specify a Local Address. Make a note of this address.
- Choose an X.25 configuration file that is appropriate for your DTE/DCE role and for the X.25 recommendation year supported by the remote machine. For example, if the remote machine is a DTE that supports 1984 X.25, select `def.dce84.x25`.

- In the X.25 Configuration window, click SELECT on Network Profile. Under Logical Channel ranges, specify a two-way range that corresponds to the range used by the remote machine. If the remote machine is a 7.0 SunNet X.25 machine, on that machine enter a command such as:

```
remote_host% x25config -d /etc/sunlink/x25/x25params0 | grep way
lcn_two_way 512-575
```

In the example output above, the remote machine has a logical channel range of 512-575, the default for 7.0 SunNet X.25. In such a case, specify the same range for the local machine.

- Choose a speed that is supported by the remote machine for the Tx Clock parameter. If the remote machine is a 7.0 SunNet X.25 machine, on that machine enter a command such as:

```
remote_host% grep syncinit /etc/sunlink/x25/rc
/usr/sunlink/sync/syncinit zss0 speed=19200 txc=baud rxc=rx
> /dev/console 2>&1
```

In the example output above, the remote machine is running at 19200 bps. In such a case, specify 19200 for Tx Clock for the local machine.

### 3. Display the PAD Hosts Database widow.

In the `x25tool` base window, click SELECT on the Application Configuration menu button.

In the PAD Hosts Database window, click SELECT on Insert and enter the name of the remote machine in the Host Name item and the DTE or DCE (X.121) address of the remote machine in the Remote Address item. If the remote machine is a 7.0 SunNet X.25 machine, on that machine enter a command such as:

```
remote_host% x25config -d /etc/sunlink/x25/x25params0 | grep ^add
address 1000-5555-22
```

In the example output above, the remote machine has an address of 1000555522. Enter this value (without the hyphens) in the Remote Address item.

After entering the name and address of the remote machine, click SELECT on Apply in the PAD Hosts Database Window. Click SELECT on the pushpin to dismiss the window.

**4. Start the X.25 network.**

**5. Repeat Steps 2, 3 and 4 of this procedure on the remote machine to bring up the X.25 software on that machine.**

If this machine is running the current release of SunLink X.25, perform the steps exactly as described above. If the remote machine is running 7.0 SunNet X.25 or another vendor's X.25, create an equivalent configuration.

**6. In an OpenWindows window, enter a command such as:**

```
local_host% /opt/SUNWconn/bin/pad remote host
```

where *<remote host>* is the name you entered for the remote host. You should receive a message indicating that your call is connected. If you do not, it indicates a configuration problem on the local or remote end.

### *Back to Back LAN Links*

**1. Ensure that both machines are connected to the same Ethernet segment or FDDI dual ring or concentrator (or back-to-back with FDDI/S).**

**2. Create a link on the local machine.**

Follow the procedure specified in Chapter 12, "A Workstation attached to a LAN."

In the `x25tool` windows use the following values:

- In the Interface Configuration window, specify LE (Ethernet), FDDI/S, or FDDI/DX for the Device item.
- In the X25 Configuration window, click SELECT on Network Profile. Under Logical Channel ranges, specify a two-way range that corresponds to the range used by the remote machine. If the remote machine is a 7.0 SunNet X.25 machine, on that machine enter a command such as:

```
remote_host% x25config -d /etc/sunlink/x25/x25params link number11c2 | grep way
lcn_two_way 512-575
```

In the example output above, the remote machine has a logical channel range of 512-575, the default for 7.0 SunNet X.25. Specify the same range for the local machine.

**3. Display the PAD Hosts Database window.**

In the x25tool base window, click SELECT on the Application Configuration menu button.

**4. Enter information about the remote machine.**

In the PAD Hosts Database window, click SELECT on Insert and enter the name of the remote machine in the Host Name item and the MAC address of the remote machine in the Remote Address item. Append the value 7e (the LSAP address that designates LLC2) to the MAC address.

If the remote machine is on the same Ethernet segment or FDDI ring, you can obtain its MAC address by entering the commands shown below on the local machine:

```
local_host% ping remote hostname ; arp remote hostname
remote hostname is alive
remote hostname (129.144.41.29) at 8:0:20:10:b5:a2
```

In the example output above, the last field on the second output line, 8:0:20:10:b5:a2, is the MAC address. You can copy-and-paste arp output into the Remote Address field and append :7e to form a full LSAP address.

After entering the name and address of the remote machine, click SELECT on Apply in the PAD Hosts Database Window. Click SELECT on the pushpin to dismiss the window.

**5. Start the X.25 network.**

You do not need to do this if your X.25 network is already up, and you made no changes in the Interface Configuration window.

**6. Repeat Steps 2, 3 and 4 of this procedure on the remote machine to bring up the X.25 software on that machine.**

If this machine is running the current release of SunLink X.25, perform the steps exactly as described above. If the remote machine is running 7.0 SunNet X.25 or another vendor's X.25, create an equivalent configuration.

**7. In an OpenWindows window, enter a command such as:**

```
hostname% /opt/SUNWconn/bin/pad remote host
```

where *remote host* is the name of the remote host.

You should receive a message indicating that your call is connected. If you do not, there is a configuration problem on the local or remote end.



<i>Interface Configuration</i>	<i>page 128</i>
<i>X.25 Parameters</i>	<i>page 132</i>
<i>LAPB and WAN Parameters</i>	<i>page 144</i>
<i>MLP Parameters</i>	<i>page 147</i>
<i>LLC2 Parameters</i>	<i>page 148</i>
<i>Routing</i>	<i>page 151</i>
<i>X.32 Map</i>	<i>page 153</i>
<i>Network User Identifier Map</i>	<i>page 153</i>
<i>PAD Hosts Database</i>	<i>page 154</i>
<i>PAD Daemon Listen Database</i>	<i>page 157</i>
<i>X.3 Parameters</i>	<i>page 160</i>
<i>IP over X.25</i>	<i>page 164</i>

This chapter contains reference information for all available SunLink X.25 parameters. All of the parameters described here can be set either by using `x25tool`, or by editing the configuration files.

The parameters are grouped together functionally, following the pattern used by `x25tool`. The name used to identify the parameter by `x25tool` is given as a header, with the keyword used by the configuration file in brackets.

---

**Note** – For a list of configuration file parameter values, refer to Appendix A, “Configuration File Format and Values”. In a few cases a numerical mapping has been used to distinguish between the available values. Where this has been done, this chapter gives the configuration file value as well as the `x25tool` value.

---

## Interface Configuration

The parameters described in this section configure a physical link.

### **Link Number**

A number that identifies a connection over a specific network interface a PSDN or LAN. Each link must have a unique number.

### **Link Type (type)**

The available values are:

*Table 16-1* Link type values

value	meaning
WAN (1988)	A connection to a WAN conforming to the 1988 version of the X.25 Recommendations.
WAN (1984)	A connection to a WAN conforming to the 1984 version of the X.25 Recommendations.
WAN (1980)	A connection to a WAN conforming to the 1980 version of the X.25 Recommendations.
LAN	A connection to a LAN.
MLP <i>n</i> - links	A multi-link protocol connection using <i>n</i> physical links.

**Device (device)**

The name of the link level device. The available types are:

*Table 16-2* Device types

value	meaning
ZSH	One of the onboard serial ports.
HSI	High Speed Interface. A serial port on the SunLink HSI/S SBus card.
EXPX	A serial port on the SCiiExpress-X card.
WLOOP	The loopback driver.
LE	An Ethernet interface on a SPARC station.
IE	An Ethernet interface on a SPARC station.
BE	A fast Ethernet interface.
QE	The SBus Quad Ethernet card.
SMC	A PC Ethernet interface.
EL	A PC Ethernet interface.
ELX	An Ethernet interface on the 3Com Etherlink III card. The default Ethernet interface type for a PC.
SMCE	A PC Ethernet interface.
SMCEU	A PC Ethernet interface.
IEE	A PC Ethernet interface.
HEE	A PC Ethernet interface.
IEEF	A PC Ethernet interface.
EEPRO	A PC Ethernet interface.
NEI	A PC Ethernet interface.
RI	A PC Ethernet interface.
XP	A PC Ethernet interface.
PCN	A PC Ethernet interface.
FDDI	An FDDI interface.
TR	A Token Ring interface.

For the x86 version of the product, the device type depends on the type of Ethernet card used by your PC. The default `ELX-0` applies to the 3Com Etherlink III card. If you are not sure of the device type used by your PC, enter the following command:

```
hostname% ifconfig -a
```

Included in the information returned by this command is the name of the device that IP is running over. Use this same device type for X.25.

---

**Note** – The list of device types available for the x86 version of the product is constantly being updated. Therefore, your PC may use a device that is not shown in Table 16-2 on page 129. If this is the case, the device type you need should automatically be added to the list of available device types.

---

### **Port Number** (device)

The port number of the LAN or WAN device used beneath X.25. The Device Type plus Port Number must form a unique identifier for each link.

### **Local Address** (local\_address)

For WAN interfaces this is your DTE or DCE address, normally an X.121 address, consisting of a DNIC, NTN, and, optionally, a subaddress. Your service provider should notify you of what this address is. A small number of public 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 (full\_address)” on page 132. If this is the case, your service provider will inform you.

For LAN interfaces, this is a six-byte (12 hexadecimal) digit address. The default of twelve zeroes tells SunLink X.25 to use your machine’s default MAC address. To use the MAC address stored on an interface controller card (such as the address on the FDDI/S SBus card) 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** (description)

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

**Alias** (alias)

An 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**

This applies to LAN connections only. It is a one-byte (two-hexadecimal-digit) address. The default of 7e is the standard SAP for LLC2 under X.25.

**Loopback SAP**

This applies to LAN connections only. It is a one-byte (two-hexadecimal-digit) address. The default of 70 is the standard loopback SAP for LLC2.

**Max. Conns.** (max\_lan\_conns)

This applies to LAN connections only. It is the maximum number of simultaneous connections to be made over this link.

**LAP Mode** (protocol)

This applies to WAN connections only. Choose between LAP, LAPB and LAPBE. Almost all PSDNs use LAPB.

**Interface** (mode)

This applies to WAN connections only. Choose between DTE and DCE. If you are connecting to a PSDN via a modem, the machine running the SunLink X.25 software is the DTE and the modem acts as the DCE. If you are connecting two machines back-to-back, make one DTE and the other DCE.

### ***Full Address*** (`full_address`)

This applies to WAN connections only. This is the complete X.121 address, including DNIC, NTN, and subaddress, if any. 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 (`src_addr_control`)” on page 136).

### ***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.

### ***PVC Options***

These are only available for LAPB links. You *only* need to use them if you plan to use one or more permanent virtual circuits (PVCs) to connect to your X.25 network *and* you require different packet and window sizes for the PVCs than you use for switched virtual circuits on the same link. You can set different local and remote packet and window sizes for each PVC.

## ***X25 Parameters***

The X25 parameters configure layer 3, the packet layer of the SunLink X.25 software. `x25tool` divides the X25 parameters in to 6 groups on 6 screens, due to the large number of parameters. This section describes them in these groupings.

## Network Profile

### **Logical Channel Ranges**(pvc\_range, inc\_range, out\_range, two\_range)

Consult your service provider to find out the correct logical channel ranges to use. 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 inability to establish connections. A common symptom of an LCR mismatch is that connections operate in one direction only.

### **Version** (network)

The version of the X.25 Recommendation that your PSDN conforms to—1980, 1984, or 1988.

### **Modulo** (modulo)

Specify modulo 8 or modulo 128, according to whether your network uses packet sequence numbers ranging from 1 to 7 or 1 to 127.

### **DTE/DCE Operation**

For a WAN connection, set the Matches Link value. For a LAN connection, use Automatic.

## Link Mode Parameters

These parameters deal with options and requirements of the PSDN to which you are connecting.

### **Allow omission of diagnostic packets** (acc\_nodiag)

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

### **Use diagnostic packets** (use\_diag)

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

***Restrict Clear Lengths*** (`ccitt_clear_len`)

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

***Disallow diagnostic packets*** (`bar_diag`)

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

***Discard diagnostics on non-Zero LCN*** (`disc_nz_diag`)

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

***Allow hex digits in DTE addresses*** (`acc_hex_add`)

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

***Bar nonprivileged listeners*** (`bar_nonpriv_listen`)

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

***Prioritize International Calls*** (`intl_prioritised`)

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

***Process Priority According to the DATAPAC (1976) rules***  
(`datapac_priority`)

Apply the rules used by the 1976 Datapac recommendations to calls.

***Strict ISO8882 Conformance*** (`iso_8882_mode`)

This parameter is for test purposes only.

***Keep X.121 address in Call Request to LAN*** (`send_x121_to_lan`)

Includes X.121 address in X.25 packet.



***Insert X.121 address in Call Indications from LAN***  
(insert\_x121\_from\_lan)

Inserts the X.121 address into Call Indications.

***Outgoing International calls*** (intl\_addr\_recogn)

The choices are:

*Table 16-3* Outgoing international call parameters

x25tool value	file value	meaning
Not distinguished:	0	No special action taken for international calls.
Check National DNIC:	1	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	2	The software assumes a called address with a prefix of 1 indicates an international call
Prefix digit of 0	3	The software assumes a called address with a prefix of 0 indicates an international call

***National DNIC*** (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** (`src_addr_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. The choices are:

*Table 16-4* Source address control parameters

<code>x25tool</code> value	file value	meaning
No special action	0	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	1	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	2	The software uses the local address as the calling address if an application supplies no calling address.
Force use of local address	3	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.

### **Priority Encoding** (`prty_encode_control`)

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

The choices are:

*Table 16-5* Priority encoding

<code>x25tool</code> value	file value	meaning
No special action	0	SunLink X.25 performs no special encoding.
DATAPAC Priority Bit	1	The software encodes the priority request using the DATAPAC Priority Bit (1976 version).
DATAPAC Traffic Class	2	Priority request encoded using the DATAPAC Traffic Class (1980 version using the Calling Network facility marker).

**Forced Packet Size** (prty\_pkt\_forced\_value)

Sets the packet size for all priority call requests and incoming calls. Possible values are: Default, 16, 32, 64, 128, 256, 512, 1024, 2048 and 4096.

**Note** – In the configuration file, packet sizes are expressed as powers of 2. For example, to specify 128, enter 7.

## *Closed User Groups and Facilities*

**Closed User Groups** (sub\_cug, sub\_pref\_cug, sub\_cugoa, sun\_cugia, bar\_cug\_in)

Choose any of the 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** (cug\_format)

Choose either Basic or Extended.

**Facilities** (accept\_revchg, prev\_chg, bar\_incall, bar\_outcall, sub\_toa\_npi\_fmt, bar\_toa\_npi\_fmt, sub\_nui\_override, bar\_call\_x32\_reg)

Choose any of the 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
- Bar Outgoing during X.32 registration

### ***Fast Select*** (`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*** (`use_negotiation`)

Choose either 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.

## ***Timers and Counters***

These parameters set CCITT-defined timers. The values, in numerical order, are:

### ***Restart Response [T20]*** (`t20_value`)

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]*** (`t21_value`)

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 200.

***Reset Response [T22] (t22\_value)***

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 180.

***Clear Req Response [T23] (t23\_value)***

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 180.

***DTE Window Status [T24] (t24\_value)***

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] (t25\_value)***

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 within the allowed time, the DTE retransmits all data packets in the window, and restarts this timer. The default value is 2000.

***Interrupt Response [T26] (t26\_value)***

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

***Registration Request [T28] (t28\_value)***

The ISO Registration Request timer.

## ***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*** (connect\_value)

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*** (idlevalue)

The period over which SunLink X.25 maintains an idle link-level connection. For WANs, leave it at 0.

## ***DTE Restart Request[R20]*** (r20\_value)

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

## ***DTE Reset Request[R23]*** (r23\_value)

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

## ***DTE Clear Request[R22]*** (r22\_value)

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

**DTE Registration Request[R28] (r28\_value)**

The number of Registration Requests that can be sent without acknowledgment.

**Internal Delay (local\_delay)**

The period in milliseconds by which transmission is delayed due to internal processing. The allowable range is 0-32000 milliseconds.

**Line Delay (access\_delay)**

The period by which transmission is delayed due to the effects of line transmission rate. The allowable range is 0-32000 milliseconds.

## *Throughput Class and Packet Sizes*

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.

**Throughput Class (thclass\_type)**

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 142) 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 (thclass\_neg\_to\_def)**

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 (locmaxpktsize, remmaxpktsize, locdefpktsize, remdefpktsize)**

You need to specify the Default and Maximum packet sizes for the local and remote networks. The default must be less than or equal to the maximum.

---

**Note** – In the configuration file, packet sizes are expressed as powers of 2. For example, to specify 128, enter 7. The valid range of values for the configuration file is 7 to 12.

---

***Max NSDU Length*** (maxnsdulength)

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*** (locmaxwinsize, remmaxwinsize, locdefwinsize, remdefwinsize)

Window sizes can be in the range 1 to 7 for modulo 8 networks or 1 to 127 for modulo 128 networks. The default must be less than or equal to the maximum.

## *Special Parameters*

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 available:

***Call Accept In*** (dbit\_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 options are:

- Leave D-bit set
- Clear call
- Zero D-bit

***Call Accept Out*** (dbit\_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:

- Leave D-bit set



- Clear call
- Zero D-bit

**Data In** (dbit\_data\_in)

Determines SunLink X.25's response when it receives a Data packet with the D-bit set. The options are:

- Leave D-bit set
- Reset call
- Zero D-bit

**Data Out** (dbit\_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:

- Leave D-bit set
- Reset call
- Zero D-bit

**Throughput Class Type** (thclass\_type)

The values are:

- Normal Negotiation
- Use Low Nibble of Map
- Use High Nibble of Map
- Use Both Nibbles of Map

**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 a value between 1 and 15.

**Window Map** (thclass\_wmap)

A number in the range from 1 to 127.

**Packet Map** (`thclass_pmap`)

The range for valid packet sizes is 16 to 4096.

---

**Note** – In the configuration file, packet sizes are expressed as powers of 2. For example, to specify 128, enter 7.

---

## *LAPB and WAN Parameters*

The LAPB and WAN Parameters screen configures the datalink and physical layer parameters used by a LAPB link.

### *Datalink (LAPB) Parameters*

The datalink layer parameters are:

**Max Tries (N2)** (`n2_count`)

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)** (`t1_timer`)

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** (`pf_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** (`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** (`busy_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** (`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** (`rr_ack_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** (`unack_max`)

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** (`local_win`)

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** (`local_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.

***MLP Priority (mlp\_priority)***

Defines how many unacknowledged frames can be sent on one line before the next line is used. Setting this correctly has the effect of forcing traffic to be distributed between the lines in an MLP link. The values you set depend on the absolute speed of each line and on the relative speeds of your lines. In general, don't set an MLP Priority of less than 3. If your lines operate at 64kbps, or more, you should increase the MLP Priority.

The following combinations of values provide efficient (90%) line use in two line MLP configurations:

- For two 64Kbps lines, setting the MLP Priority for each line to 10 and the MLP Window and MLP Guard to 25.
- For one 512Kbps line and one 128Kbps line, setting the MLP Priorities to 30 and 5, respectively, and the MLP Window and Guard to 40.

***Ignore UA if in ERROR state I (ign\_ua\_error)***

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

***FR on receipt of FR if in ERROR (frmr\_frmr\_error)***

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

***FR on Inv. Resp. if in ERROR (frmr\_invrsp\_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 (sframe\_pbit)***

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

***No DM on entry to ADM state (no\_dm\_adm)***

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

***Abandon X.32 registration on SABM (sabm\_in\_x32)***

Abandon X.32 registration if a SABM is received.

**ISO8882 Conformance** (iso8882)

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

**Initial state of link is “Off”** (initial\_down)

When the SunLink X.25 software comes up, the link is off. To switch it on subsequently, use the `linkstart` command.

**Physical (WAN) Parameters**

The physical layer parameters for a single LAPB link are:

**Calling Procedures** (connect\_proc)

The type of calling procedure to use, None, X21 or V35.

**Address Translation** (translate)

Set this to On or Off.

**V.25 Call Request Timer**

Only used if you are using V25 Calling Procedures. This timeout is only needed if the network does not support call fail indications.

**TxClock**

If the local machine supplies the clocking, set the bit transmission rate of your link, in bits per second.

**MLP Parameters**

The parameters described in this section configure the additional datalink parameters for an MLP link.

**MLP Window** (mlp\_window)

The maximum number of outstanding unacknowledged frames allowable. This should be larger than the total of the MLP Priority values.

---

**Note** – All of the machines connected to the same network must use the same MLP Window size. If you are connecting to a PSDN, check with your service provider to find out the appropriate MLP Window size to use. This may restrict the MLP Priority values that you can set, as the total of the MLP Priority values must not be greater than the MLP Window size.

---

***MLP Guard*** (mlp\_guard)

A range of MLP frame sequence numbers that lets the receiving MLP work out when frames have been lost. Set this to the same value as MLP Window.

***N1 Count*** (mn1\_val)

The maximum number of times that MLP attempts to send a frame to an SLP without receiving an acknowledgment.

***Lost Frame Timer [MT1]*** (mt1\_val)

The time during which MLP expects to receive an acknowledgment to an outstanding frame.

***Group Busy Timer [MT2]*** (mt2\_val)

The time during which MLP waits for system resources, for example buffer space, to become available before declaring a frame as blocked and dropping it.

***Reset Confirm Timer [MT3]*** (mt3\_val)

The length of the timer that determines how long the DTE waits for confirmation from the DCE that it has reset.

***Physical Ports Associated with this Link***

Clicking a port here brings up the LAPB and WAN parameters window described in “LAPB and WAN Parameters” on page 144.

## *LLC2 Parameters*

The parameters described in this section configure the datalink and physical layers of a LAN link.

**Max Transmissions (N2) (n2\_count)**

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) (t1\_timer)**

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 (pf\_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 (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 (busy\_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 3000.

**Link Idle Timer (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** (rr\_ack\_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** (unack\_max)

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** (local\_win)

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

**Transmit Probe** (local\_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** (xid\_window)

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** (xid\_ndup)

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** (xid\_tdup)

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** (max\_iframe\_len)

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

## Routing

If you have multiple links, SunLink X.25 automatically selects a link for outgoing calls based on address information in a Call Request packet. The parameters for configuring this are:

**Route Type**

The available route types are:

Table 16-6 Route types

type	meaning
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.

## ***Telephone Number***

Used for dial-up configurations, this is the telephone number of the point of attachment to the PSDN. In most cases, this is a modem.

**Comment**

You can add an optional comment.

## *X.32 Map*

Allows an X.32 identity and signature to be configured on a subnetwork basis. This is a client only implementation of X.32.

**Register at**

Choose between the Packet Level, Link Level for a single link and Link Level for a multiple link. When connecting to a PSDN, use link level as this means the authentication is carried out by the network. Packet level is appropriate when connecting with another machine (back to back, for example) when you want the machine and not the network to do the authentication.

**Link**

The link number.

**Identity**

An X.32 identity of up to 32 alphanumeric characters. Do not use whitespace.

**Signature**

An X.32 signature of up to 32 alphanumeric characters. Do not use whitespace.

## *Network User Identifier Map*

Creates a mapping between Network User Identifiers and facilities. When a call is made using NUI override, the facilities set here override any other facilities that might otherwise apply to the call.

**NUI**

The Network User Identifier, a string of up to 64 alphanumeric characters.

**Packet Format**

Choose between Normal and Extended.

***Packet Size***

The sizes to use for incoming and outgoing packets. These can be different.

***Window Size***

The window size to use for incoming and outgoing calls. These can be different.

***TP Class***

The throughput class to use for incoming about outgoing calls. These can be different.

***CUG***

Whether Closed User Groups are in use. Choose between None, Normal and Outgoing.

***CUG Type***

Choose between Basic and Extended.

## ***PAD Hosts Database***

The PAD Hosts Database contains information about remote hosts that makes it easier for users to make PAD calls to them. The parameters are:

***Host Name***

An alphanumeric string that is the name of the remote host. This name can be used in place of the address for making calls to the remote host.

***Link Selection***

Choose either Automatic or Specified. Automatic uses the SunLink X.25 routing (link selection) feature. If you choose Specified you must specify the link number yourself.

***Alias(es)***

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 link over which PAD makes calls to the specified remote host. This parameter only applies if you have multiple links.

***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 DTE address is of 15 or fewer decimal digits. An LSAP is 14 hexadecimal digits in length. In most cases, the last two digits of an LSAP (the SAP) 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 can make reverse charge calls.

### ***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.

### ***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.

***PAD Daemon Listen Database***

The PAD daemon handles incoming PAD calls. Some parameters are available on a per-host basis as well as globally. The per-host parameters override any global settings.

***Accept PAD calls***

Setting this to No prevents this system from accepting incoming PAD calls. It can still make outgoing calls.

***Log PAD calls***

Log information about each PAD call made to the file `/var/opt/SUNWconn/x25/x29serverlog`. Over the course of time, this file may become very large. If you have problems with disk space, check its size and, if necessary, delete it.

***Welcome banner***

A string that the PAD daemon 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`. The new Welcome Banner comes into effect the next time you restart the PAD Daemon.

***Initial command***

The command that the PAD daemon 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 default parameter settings are:

*Table 16-7*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. If you click SELECT on Customize, the X.3 parameters screen appears. The parameters available from this screen are described in “X.3 Parameters” on page 160.

### **Non-native**

In non-native mode the parameter setting are:

*Table 16-8*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. If you click SELECT on Customize, the X.3 parameters screen appears. The parameters available from this screen are described in “X.3 Parameters” on page 160.



### ***Called Address***

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

*Table 16-9* Called and Calling Address parameters

<b>parameter</b>	<b>meaning</b>
Starts with	The PAD daemon 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 daemon accepts calls from PAD callers that have called addresses that exactly match the string of digits you enter here.
Don't care	The PAD daemon 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 daemon 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 daemon uses to match the Call User Data on incoming PAD calls. By convention this is 01. Do not delete the 01 that appears in this field unless you are sure that your network uses a different value to distinguish incoming PAD calls. If this field is blank, or if the value entered is invalid, your machine will not be able to receive PAD calls.

## 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. The parameter numbering is in accordance with the X.3 Parameter standard.

### **1:Recall Character**

Setting this parameter lets you configure a character to use to switch from the data transfer state to recall the PAD. Possible values are:

*Table 16-10* 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.

---

### **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. Possible values are:

- A-Z, a-z, 0-9
- CR
- ESC, BEL, ENQ, ACK
- DEL, CAN, DC2
- ETX, EOT

- HT, LF, VT, FF
- Control characters not listed above

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 16-11*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 occurrence 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 occurrence 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 appropriate echo mask. Possible values are:

- All
- Not CR
- Not LF
- Not VT, HF, FF
- Not BEL, BS
- Not ESC, ENQ
- Not ACK, NAK, STX, SOH, EOT, ETB, ETX
- Not chars from P16, P17, P18
- Not <DEL> or other Ctrl chars

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.

### *IP over X.25*

SunLink X.25 can route IP. To allow for this, you must set up a mapping between IP and X.25 (X.121) addresses. The parameters for IP over X.25 configuration are:

#### ***Local IP address***

Enter an IP address in either name or numeric form).

#### ***Link Selection***

Choose either Automatic or Specified. Automatic uses the SunLink X.25 routing (link selection) feature. If you choose Specified you must specify the link number yourself.

#### ***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.

#### ***Link Number***

Enter a link number specifying the link over which you reach the IP network specified in the preceding parameter.

#### ***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.

#### ***Point to***

Choose between point-to-multipoint and point-to-point.

**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**

The X.25 version supported by the remote network.

**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.

**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.

**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.

### ***Reset Action***

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.

### ***Accept Unknown Hosts***

To restrict access, adding a measure of security, you can choose not to accept calls from unknown hosts, that is hosts whose addresses are not in the Remote Host to X.25 Address Map.

### ***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.

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:***

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

### ***Remote IP Address***

The IP address of the remote IP host, in either hostname or numeric form.

### ***Link***

A link number specifying the link over which you reach the specified host.

### ***Remote X25 Address***

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.

### ***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***

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 host requesting reverse-charging.

### ***CUG Type***

Possible values are none, multi-user and bilateral CUG.

### ***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. If you have multiple RPOA numbers, enter them together in the same sequence of digits, with no spaces between.

### ***CUG Number***

If your host is a member of a multi-user or bilateral CUG, enter the CUG number.

<i>Null Modem Requirements</i>	<i>page 170</i>
<i>Configuring Internal or External Clocking</i>	<i>page 170</i>
<i>Building the Null Modem Cable</i>	<i>page 171</i>
<i>IPC/IPX X.25 Adapter Cable</i>	<i>page 177</i>

This appendix explains how to build:

- a synchronous null modem cable, for both RS-232-C and RS-449 interfaces;
- an X.21-to-RS-449 converter;
- an X.25 adapter cable that allows you to run SunLink X.25 over a serial interface on a SPARCstation IPC or IPX.
- a cable that lets you use the X.25 port on the SCiiExpress-X card as if it were an HSI port.

---

**Note** – The CPU serial port on a SPARCstation IPC or IPX can be jumpered for RS-423. References here to RS-232-C apply to IPC/IPX RS-423 ports as well.

---

## *Null Modem Requirements*

A synchronous null modem is a specially configured cable that simulates two back-to-back modems. When the distance between two hosts is not great, you might be able to use a null modem cable instead of more expensive synchronous modems or synchronous modem eliminators. The use of the null modem cable described here allows you to connect your Sun machine to another machine, Sun or non-Sun, for synchronous communication over a short distance.

The maximum distance at which a null modem cable can work is determined by the specification for your serial port interface and depends greatly on the quality of the cable you use.

You must perform the following steps to use a null modem cable for machine-supplied clocking:

- Build the null modem cable, according to the pin-outs provided here.
- Set the Define/Modify Interfaces►X.25 Links...►Interface parameter in `x25tool` so that one side is DTE and the other side is DCE.
- Set the Tx Clock parameter to the bit rate you want in the Create/Modify configuration file►WAN Parameters window in `x25tool`.

You can use a null modem cable with any of Sun's RS-232-C or RS-449 serial port options, except the EXPX device, which cannot supply a clock.

## *Configuring Internal or External Clocking*

SunLink X.25 supports the following clocking alternatives:

- Transmit clock and receive clock are both external. This is the situation in which clocking is provided by a synchronous modem or modem eliminator.
- Transmit clock is internal; receive clock is external. On the machine that is to supply clocking, set the Tx Clock parameter to the bit rate you want in the Create/Modify configuration file►WAN Parameters window in `x25tool`.

---

**Note** – You can only use an IPC/IPX only in situations where clocking is external, that is, where the remote (non-IPC/IPX side) supplies both the transmit and receive clocks.

---

## *Building the Null Modem Cable*

The following subsections provide four null-modem-cable schematic diagrams. The first pair of diagrams are RS-232-C null modems; the second pair are RS-449 null modems. Within each pair, one diagram illustrates a null modem cable to connect two Sun workstations in which both Suns supply clocking. The other diagram illustrates a null modem cable to connect a Sun to another machine (Sun or non-Sun), in which one (or, the only) Sun supplies clocking for both sides.

To build a null modem cable, you can configure your own cable or use a standard cable with an adapter box. If you decide to use an adapter box, be sure to obtain an adapter that allows you to change pin configurations. Pre-configured adapters generally do not work with synchronous protocols because they do not handle clock signals correctly.

For an RS-232-C cable, use a good quality, shielded wire. For an RS-449 cable, it is best to use shielded, twisted pair wire.

### *RS-232-C Null Modem Cables*

The following diagram illustrates a synchronous null modem that allows you to connect two Sun machines that each supply clocking, using the RS-232-C interface. Each Sun supplies clocking on pin 24. The null modem routes this clocking to pin 17 on the opposite side to provide receive clocking.

In `x25tool`, on both machines, set the Tx Clock parameter to the bit rate you want (not External) in the Create/Modify configuration file ► WAN Parameters window.

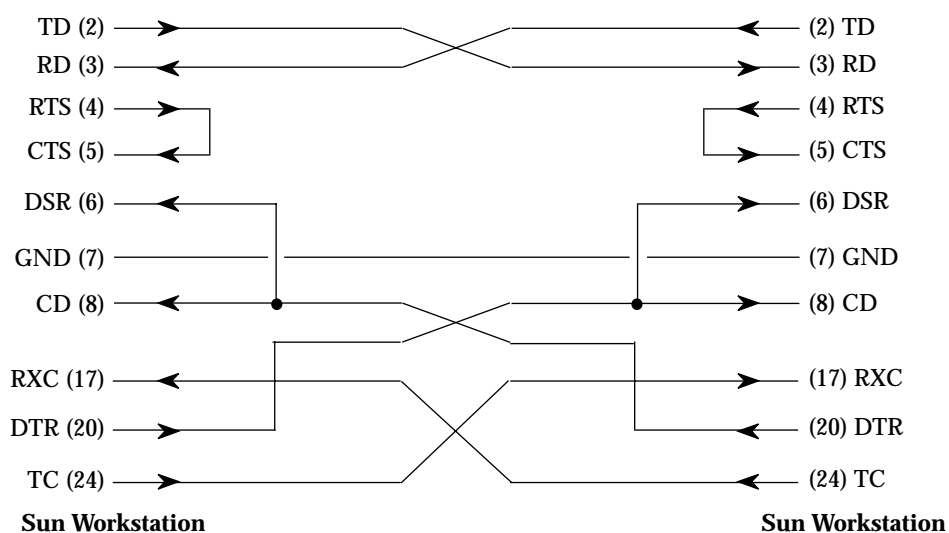


Figure 17-1 RS-232-C Null Modem: Both Suns Supply Clocking

The following diagram illustrates a synchronous null modem that allows you to connect a Sun machine to another machine, Sun or non-Sun, using the RS-232-C interface. The Sun supplies both the transmit and receive clocks for the other machine. Note that this null modem is not symmetrical.

In `x25tool`, on the Sun that is to supply clocking, set the Tx Clock parameter to the bit rate you want (not External) in the Create/Modify configuration file ► WAN Parameters window.

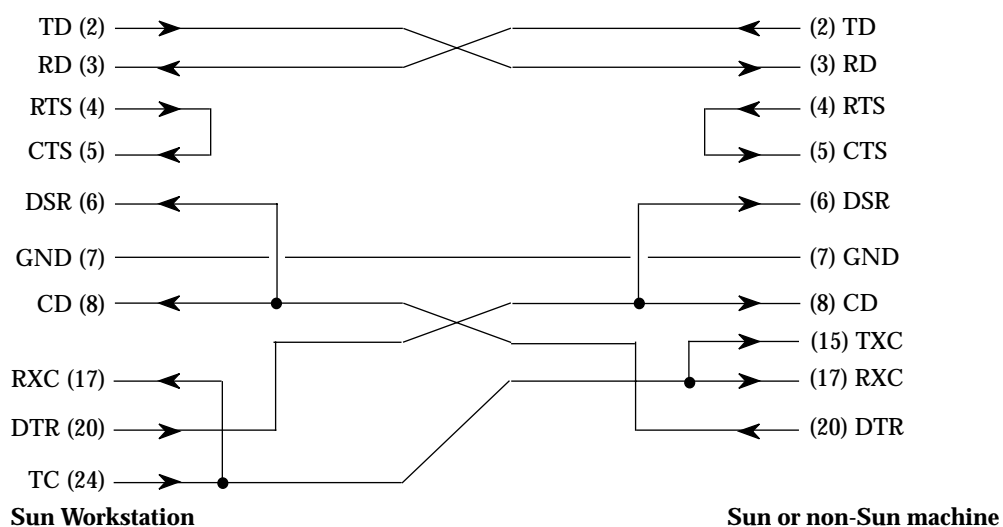


Figure 17-2 RS-232-C Null Modem: Sun Supplies Clocking for Both Sides

## RS-449 Null Modem Cables

The following diagram illustrates a synchronous null modem cable that allows you to connect two Sun machines that each supply clocking, using the RS-449 interface. Each Sun supplies clocking on pins 17 and 35. The null modem cable routes this clocking to pins 8 and 26 on the opposite side to provide receive clocking.

Because the RS-449 interface is balanced, there are two pins for each signal. For example, in the diagram below, Send Data (SD), pins 4 and 22, is connected to Receive Data (RD), pins 6 and 24. This means that pin 4 is connected to pin 6 and pin 22 is connected to pin 24.

In `x25tool`, on both machines, set the Tx Clock parameter to the bit rate you want (not External) in the Create/Modify configuration file ► WAN Parameters window.

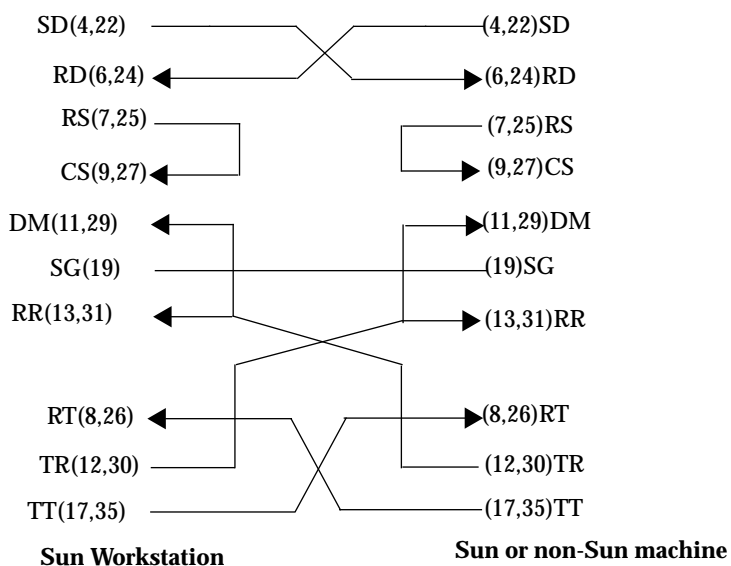


Figure 17-3 RS-449 Null Modem Cable: Both Machines Supply Clocking

The following diagram illustrates a synchronous null modem cable that allows you to connect a Sun machine to another machine, Sun or non-Sun, using the RS-449 interface. The Sun supplies both the transmit and receive clocks for the other machine. Note that this null modem cable is not symmetrical.

Because the RS-449 interface is balanced, there are two pins for each signal. For example, in the diagram below, Send Data (SD), pins 4 and 22, is connected to Receive Data (RD), pins 6 and 24. This means that pin 4 is connected to pin 6 and pin 22 is connected to pin 24.



In `x25tool`, on the Sun that is to supply clocking, set the Tx Clock parameter to the bit rate you want (not External) in the Create/Modify configuration file ► WAN Parameters window.

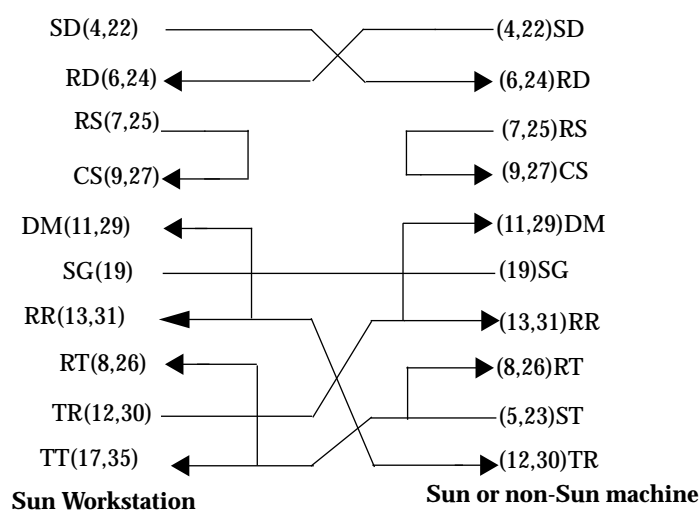


Figure 17-4 RS-449 Null Modem Cable: Sun Supplies Clocking Both Sides

## X.21-to-RS-449 Converter

Tables A-1 and A-2 list the signals and names for RS-449 and X.21 circuits.

Table 17-1 RS-449 Signals

Circuit	Name	Direction
SD	Send Data	To DCE
RD	Receive Data	From DCE
TT	Terminal Timing	To DCE
ST	Send Timing	From DCE
RT	Receive Timing	From DCE
RS	Request to Send	To DCE

Table 17-1 RS-449 Signals

Circuit	Name	Direction
CS	Clear to Send	From DCE
RR	Receiver Ready	From DCE
TR	Terminal Ready	To DCE
DM	Data Mode	From DCE
SG	Signal Ground	

Table 17-2 X.21 Signals

Circuit	Name	Direction
G	Signal Ground	
T	Transmit	To DCE
R	Receive	From DCE
C	Control	To DCE
I	Indication	From DCE
S	Signal Element Timing	From DCE
B	Byte Timing	From DCE

The diagram below illustrates the pin connections required for an X.21-to-RS-449 converter.

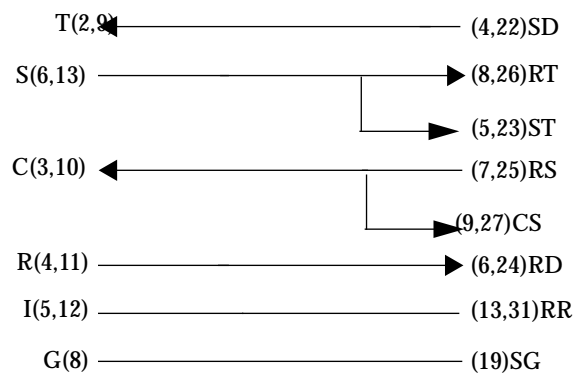
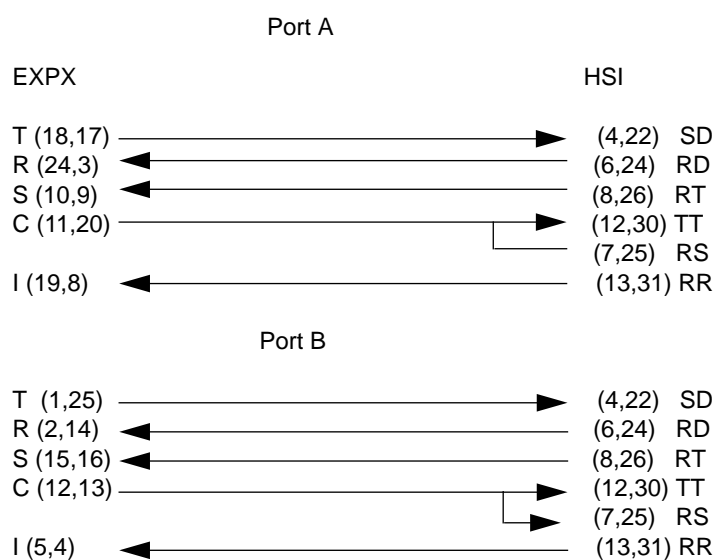


Figure 17-5 X.21-to-RS-449 converter

## Using the X.21 interface as an HSI

**Note** – The information in this section applies only to the x86 version of the product.

If you want to use the X.21 interface provided by the SCiiExpress-X card in the same way as an HSI interface, make up a cable as below:



## IPC/IPX X.25 Adapter Cable

Sun sells an X.25 Adapter Cable, part number X989A, that allows you to run SunLink X.25 over the 8-pin serial port on a SPARCstation IPC or IPX. Contact your local Sun sales representative for ordering information for the cable.

The following table lists the pin-outs in the X.25 Adapter Cable.

*Table 17-3 Pin-outs for IPC/IPX Adapter Cable*


<b>Signal Name</b>	<b>Female DB-25 Pin Number</b>	<b>DIN-8 Pin Number</b>
TD	2	3
RD	3	5
RTS	4	6
TC	15	2
GND	7	4
DCD	8	7
RC	17	8
DTR	20	1

---

**Note** – Pin-15-to-pin-2 is the only difference from the asynchronous DIN-8-to-DB-25 cable, which has DB-25 pin 5 pinned to DIN-8 pin 2.

---

## SunLink X.25 Command Line Utilities

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This table summarizes the command line utilities that are delivered with SunLink X.25.

*Table 18-1* SunLink X.25 command line utilities

Name	Description
ixemap	Sets up X.25 address/Internet address mapping. Options are: -a specify IP address. Must be used with -D and -G options. -d specify a device. The default is /dev/ixe. -f specify a file to read mapping from. The default is /etc/opt/SUNWconn/x25/ixemapconf. -D delete mapping for specified IP address. -G fetch mapping for a specified IP address. -M fetch all existing mappings and echo to standard output. -P load all mapping in specified file to IXE internal table. -Z zero the IXE internal table.
ixetune	Configure IXE driver. Options are: -d specify a device. The default is /dev/ixe. -f specify a file to read mapping from. The default is /etc/opt/SUNWconn/x25/ixemapconf.
linkreset	Resets the state machine for a LAPB link. This has the effect of cycling the link into disconnected state, and back to running.
linkstart	Puts a LAPB link into running state.
linkstate	Displays state of a LAPB link.
linkstop	Puts a LABP link into non-running state.

*Table 18-1 SunLink X.25 command line utilities*

Name	Description
lltune	Sends and receives LAPB and LLC2 tuning parameters to and from driver. Options are: -l specify link id. -p specify protocol. -G gets parameters from driver and writes to standard output. -P sends parameters to the driver. -d specifies the device to use. Defaults are /dev/lapb and /dev/llc2.
mlptune	Sends and receives MLP tuning parameters to and from the driver. Options are: -L specify the link id. -s specify subnet id. -G gets parameters from driver and writes to standard output. -P sends parameters to the driver. -d specifies the device to use. Default is /dev/mlp.
nuimap	Sets up NUI/facilities mapping. Options are: -n specify NUI. -d specify device. Default is /dev/x25. -f specify file to read mappings from. Default is /etc/opt/SUNWconn/x25/nuimapconfig. -D delete mapping from specified device from mapping table. -G get mapping for specified NUI and echo to standard output. -M get all existing mappings and echo to standard output.
pvcmap	Set up packet and window sizes for PVCs. Options are: -d specify a device. -f specify a file to read the mappings from. Default file is /etc/opt/SUNWconn/x25/pvcmapconf. -G retrieve all existing packet and window sizes and echo to standard output. -P load the packet and window sizes in the specified file to the internal X.25 vc table. -M specify the WAN module.

Table 18-1 SunLink X.25 command line utilities

Name	Description
vcstat	Check virtual circuit status. Options are: -L display per-link statistics. -n display cumulative statistics. -l specify an interface. -i specify sampling interval. -p specify sampling period. -v specify range of vcs.
wantune	Sends and receives WAN tuning parameters to and from the WAN. Options are: -l specifies the link to be referenced. -G gets parameters from the WAN module and writes them to standard output. -P sends parameters to the WAN module. -d specifies the WAN device. Default is /dev/wans0.
x25info	generates a complete configuration report for an X.25 link. Options are: -h display help information -i interactive mode -ln specify the link number
x25netd	Configure a STREAMS network from a specification in the file /etc/opt/SUNWconn/x25/netconf.
x25route	Add routes to the X.25 routing configuration file. Options are: -s display all routes <i>interval</i> The interval in seconds for updating the display when using the -s option -f flush all routes <i>routing file</i> Path and name of X.25 routing file.
x25stat	Displays per protocol statistics. Options are: -l specify link number -p specify protocol -w display WAN statistics -z reset statistics for protocol specified with -p

Table 18-1 SunLink X.25 command line utilities

Name	Description
x25trace	Run a trace at X.25 packet level. Options are: -a displays total bytes of user data instead of data itself -u buffers output line by line -x decodes packet and displays in hexadecimal -i specify interface to trace: /dev/l1c2, /dev/lapb or /dev/x25 -l specify single link to trace -t use absolute not relative time stamps betweenmac trace packets between these dstmac trace only packets with this destination MAC address mac trace packets to or from this MAC address multicast trace only LLC2 packets with a multicast address pdu_in trace only incoming PDUs pdu_out trace only outgoing PDUs srcmac trace only packets or frames with this source address x25lcn + trace only packets on the next logical channel set up x25lcn n trace only packets on logical channel n
x25tune	Sends and receives tuning parameters to and from X.25. Options are: -l specifies link id to be used -G get parameters from the link and write to standard output -P send parameters to the X.25 module -d specify the device. Default is /dev/x25 -a specify address
x32map	Configures X.32 registration procedures. Options are: -f specify a file containing identities and signatures -G fetch all existing identities and signatures -P load X.32 identities and signatures to internal X.25 table -s specify subnet -L specify the link id.



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<i>Checking the Physical Layer</i>	<i>page 188</i>
<i>Checking the Datalink Layer.</i>	<i>page 190</i>
<i>Checking the Network Layer</i>	<i>page 199</i>
<i>Licensing Problems</i>	<i>page 203</i>

This chapter contains information for troubleshooting possible problems with SunLink X.25. Problems are generally related to one of the following areas:

- Cabling
- Modem problems
- Logical Channel Ranges
- Other Configuration problems

“Resolving Common Problems” on page 184 suggestions for dealing with these 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)

## *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 the remainder of this chapter.

### *Cabling Problems*

The following may be symptoms of cabling problems:

- Network does not come up
- X.25 link layer does not come up, or does not stay up
- The message `xmit hung` appears in the console
- No data is being sent and/or received

Check the following:

1. Make sure you are using the correct type of cable. Refer to Chapter 17, “Cabling” for cabling diagrams.
2. Make sure all cables are properly seated.

3. 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.

## *Modem Problems*

The following may be symptoms of modem problems:

- Network does not come up
- X.25 link layer does not come up, or does not stay up
- The message `xmit hung` appears in the console
- No data is being sent and/or received

Check the following:

1. Make sure your modem is correctly configured. Check your modem's documentation.
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 using a null modem connection, one side should be a DTE, the other a DCE and one or both sides must supply clocking. See "Building the Null Modem Cable" on page 171 for instructions on setting up a null modem connection.

## *Logical Channel Ranges*

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 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. The following symptoms may mean that the logical channel ranges are incorrectly configured:

- Inability to establish a packet level connection—for example PAD calls fail
- Traffic can be sent in one direction only
- PAD calls are cleared with the error `Call Cleared - Out of Order (0900)`
- Calls are cleared with an error code of `0x00 24`

Check that the logical channel ranges you configured match those used on the X.25 network. If this is a PSDN, contact your service provider to find out what these should be. Refer to “Configuring a Single WAN Link” on page 33 for how to configure these using `x25tool`.

### *Other Configuration Problems*

The following symptoms may indicate that you have made a mistake in your configuration:

- Network does not come up
- X.25 link layer does not come up, or does not stay up
- Inability to establish a packet level connection—for example PAD calls fail
- Link is up but not responding correctly
- Repeated Resets are being received

Check the following:

1. Make sure you specified the wrong serial port when you ran `x25tool` or edited the configuration file. Refer to “Configuring a Single WAN Link” on page 33 for how to configure this using `x25tool`.
2. For LAPB links, check that the link is configured as a DTE if communicating over a PSDN.

3. Facilities and other parameter mismatches, between your machine and the PSDN, can prevent the establishment of virtual circuits. Check that the Negotiate Toward Defaults item in the Parameters►Packet (X25) parameters►Throughput window. For the majority of PSDNs this should be set to No.
4. Check where calls are being cleared from. 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.
5. If you receive an error code of 0x00 43, check that your X.121 address is specified correctly. 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. Modify your LAPB parameters as necessary.
7. If you receive error code 0x00 70, check your console to see if you have a licensing problem
8. If you can find out about the remote host, check that it is still up.
9. 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 “Checking the Protocol Status” on page 199. 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.
10. 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 “Obtaining Packet and Link-Level Traces” on page 190.

11. 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`. This message may also indicate that there are too many simultaneous PAD calls for the software to cope with. Wait a moment, then try again.
12. 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.
13. If you receive repeated RESETS with error code `0x0092`, there may be a window size mismatch.
14. Perform a loopback test, to check your local configuration down to the link layer.
15. Perform a back-to-back test, to test your configuration against that of another machine.

### *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 of a SPARC station, or the SCiiExpress-X card attached to a PC, the most thorough hardware test you can do is to use `syncloop`. If you are using a high speed interface, the most thorough hardware test you can do is to use `hsi_loop`.

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

### *Checking a Serial Port*

If you are using the onboard serial port, or a port of the SCiiExpress-X card, use the `syncloop` command to perform a loopback test. The command operates slightly differently on SPARC stations and on PCs—refer to your system's man pages for details on how to use it.

If you see errors in the output, contact your local technical support for help in interpreting them.

### *Checking a High Speed Interface*

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

If you see errors in the output, contact your local technical support for help in interpreting them.

### *Checking the Serial Port Line Status*

The `syncstat` command monitors traffic that uses the onboard serial port or the serial port on the SCiiExpress-X card.

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.

### *Checking High Speed Interface Line Status*

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

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.

## *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 check 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 to your support provider.

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.

## *Obtaining Packet and Link-Level Traces*

Use `/opt/SUNWconn/bin/x25trace` command to capture 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.

`x25trace` supports the following devices:

*Table 19-1* 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

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 (\*\*).

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*.

### *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/l1c2:***

```
hostname# x25trace -i /dev/l1c2 llc
```

## ***Tracing X.25 packets to/from specific MAC addresses on /dev/l1c2:***

```
hostname# x25trace -i /dev/l1c2 srcmac 8:20:0:1:2:3 x25  
hostname# x25trace -i /dev/l1c2 dstmac 8:20:0:1:2:3 x25  
hostname# x25trace -i /dev/l1c2 betweenmac 8:20:0:1:2:3 9:0:2b:18:21:5 x25
```

## ***Trace outgoing LLC2 frames that are not multicast:***

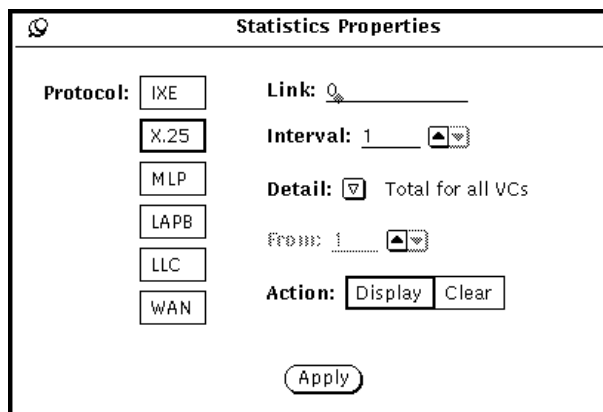
```
hostname# x25trace -i /dev/l1c2 pdu_out not multicast
```

## ***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
```

## Displaying Protocol Statistics

Displaying protocol statistics lets you track what is going on a link or links. You can display statistics on a per-protocol basis, or display statistics for all protocols. To display statistics, start `x25tool`, then pull down the Control menu. Choose the Network Statistics menu item. The Network Statistics window appears. Click SELECT on the Properties button. The Statistics Properties window appears:

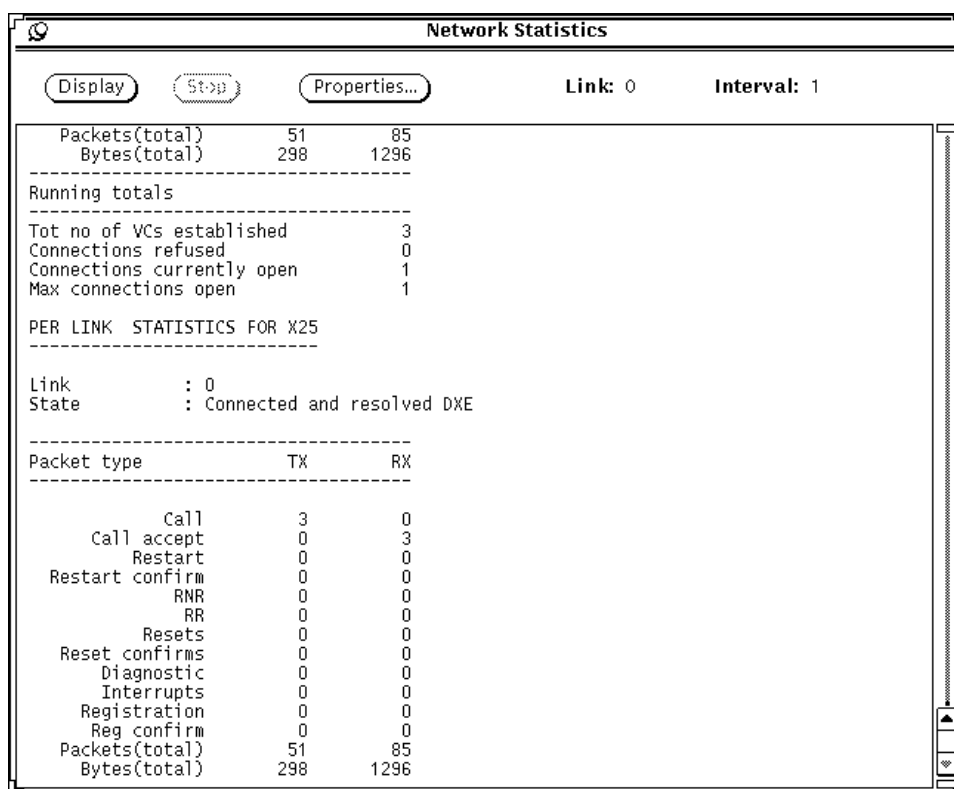


The **Statistics Properties** dialog box contains the following controls:

- Protocol:** A vertical stack of buttons: `IXE`, `X.25` (highlighted with a red box), `MLP`, `LAPB`, `LLC`, and `WAN`.
- Link:** A text field containing the value `0`.
- Interval:** A text field containing the value `1`, followed by an up/down arrow button.
- Detail:** A dropdown menu showing `Total for all VCs`.
- From:** A text field containing the value `1`, followed by an up/down arrow button.
- Action:** Two buttons: `Display` and `Clear`.
- Apply:** A button at the bottom center of the dialog.

Click on some or all of the protocol buttons to select them. Specify a Link Number or All as in the example. Specify the Interval (in seconds) that Statistics should be collected for, and the level of detail you require. For example, you may want to isolate the statistics for a particular VC, if you suspect that is where the problem is. Click SELECT on Display to display the statistics—Clear resets them to zero. Once you are happy with your settings, click SELECT on Apply.

To collect and display statistics, click SELECT on the Display button in the Network Statistics window. Statistics appear in the window and are updated every time the Interval elapses:



If you do not have `x25tool` running on your system, you can access the same information by running the command `x25stat`.

## Logging Trace Information

The SunOS 5.x streams `strace (1M)` command lets you log trace information. See the `strace` man page for detail on the command's use.

The `strace` command must be followed by three arguments:

*module id*

Possible values are:

Value	Meaning
200	PLP driver
201	LAPB driver
202	LLC2 driver

*link number*

The number of the link over which the driver you are tracing is running, or all to specify all links.

*level*

The tracing level that allows you to receive more or fewer packets or frames. Table 19-2 shows available `strace` tracing levels for the X.25, LAPB, and LLC2 drivers.

Table 19-2 `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

Specify all to trace all available levels. For example:

```
# /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.

## *Capturing Streams Error Messages*

In SunLink X.25, the X.25, LAPB, and LLC2 drivers can generate streams error messages. The SunOS 5.x streams `strerr (1M)` daemon captures streams error messages. This daemon receives error messages and appends them to log files in `/var/adm/streams`. Log file names take 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`. If you receive a streams error message, contact your local Sun customer service representative.

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.

## 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

## 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 ixc
ixc: 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.

---

## *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.

## *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.

## *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
dresden pc	route1	UG	0	0	ie1
loopback	localhost	U	2	113436	lo0
beta-bb	alpha	U	4063	146044	ie0
dallas2	route7	UG	0	0	ie0
training pc	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
```

### *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.

### *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.

### *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.

## *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.



## Configuration File Format and Values



This appendix summarizes the format and parameters used by the X.25 configuration files. The configuration files are contained in the `/etc/opt/SUNWconn/x25/config` directory. The contents of this directory when you install the software are:

```
hostname% ls /etc/opt/SUNWconn/x25/config
Samples/          link_config_0000.cfg
link_config_0001.cfg
```

File `link_config_0000.cfg` configures link 0. In the default configuration, this is a WAN link. File `link_config_0001.cfg` configures link 1. In the default configuration, this is a LAN link.

There is a separate configuration file for each link. The filename is of the format `link_config_n.cfg`, where *n* is the link number. These are the files that will be read when the SunLink X.25 is next started. Editing them is equivalent to editing the *working* configuration using `x25tool`. Use a different naming convention if you want to save changes without using them on the next restart.

To create a new non-MLP WAN link use file `link_config_0000.cfg` as a template. Copy it and giving the new file the correct name for the link you want it to apply to. For example, to configure port 3 as a WAN link, call the file `link_config_0003.cfg`.

To create a new MLP WAN link, use the sample file `/etc/opt/SUNWconn/x25/Samples/def_mlp_config.cfg` as a template.

To create a new LAN link, copy and rename the file `link_config_0001.cfg`. Then edit the new file to use the values you want.

Each configuration file is composed of a series of sections, one for each part of the configuration. In the case of an MLP configuration file, the LAPB and WAN sections become sub-sections of the MLP section. Refer to the `/etc/opt/SUNWconn/x25/Samples/def_mlp_config.cfg` file to see how this works.

Table A-1 summarizes the available sections, keywords and parameters. Refer to Chapter 16, “Parameter Reference” for a discussion of the meaning and use of the available parameters.

**Note** – All timer values are given in seconds.

*Table A-1 Configuration file format*

Section/Subsection	Keyword	Valid Parameter values
IDENTIFICATION	PRODUCT_NAME	SunLink X.25
	PRODUCT_VERSION	9.0
	FILE_TYPE	x25link
	MODIFIED_BY	<i>user_id</i>
	FILE_DATE	<i>date</i>
LINK	device	<i>/dev/devicenamen</i>
	local_address	A valid X.121 or MAC address
	full_address	<i>linkno.address</i>
	type	WAN, LAN
	version	1980, 1984, 1988
	mode	DTE, DCE
	protocol	LAP, LAPB, LLC2, MLAPB
	alias	32 character string
	description	32 character string
MLP	mlp_window	Numerical value between 1 and 4095. Default is 10.



*Table A-1* Configuration file format

Section/Subsection	Keyword	Valid Parameter values
LAPB	mlp_guard	Numerical value between 1 and 4095. Default is 10.
	mt1_val	Timer value in seconds, between 1.0 and 300.0. Default is 2.0.
	mt2_val	Timer value in seconds, between 1.0 and 300.0. Default is 2.0.
	mt3_val	Timer value in seconds, between 1.0 and 300.0. Default is 2.0.
	mn1_val	Numerical value between 1 and 255. Default is 10.
	n2_count	Numerical value between 1 and 255. Default is 10.
	t1_timer	Numerical value between 1 and 3000. Default is 9.0.
	pf_timer	Numerical value between 1.0 and 300.0. Default is 0.7.
	reject_timer	Numerical value between 1.0 and 1000.0. Default is 2.5.
	busy_timer	Numerical value between 1.0 and 3000.0. Default is 10.0.
	idle_timer	Numerical value between 0 and 3200.0. Default is 25.0.
	rr_ack_delay	Numerical value between 0 and 300.0. Default is 0.4.
	unack_max	Numerical value between 0 and 127. Default is 3.
	local_win	For modulo 8 networks, a numerical value between 1 and 7. For modulo 128 networks, a numerical value between 1 and 127.

*Table A-1* Configuration file format

Section/Subsection	Keyword	Valid Parameter values
	local_probe	For modulo 8 networks, a numerical value between 1 and 7. For modulo 128 networks, a numerical value between 1 and 127.
	max_iframe_len	261, 262, 263, 517, 518, 519, 1029, 1030, 1031, 2053, 2054, 2055, 4101, 4102 or 4103. Default is 517.
	ign_ua_error	Y(es) or N(o)
	frmr_frmr_error	Y(es) or N(o)
	frmr_inversp_error	Y(es) or N(o)
	sframe_pbit	Y(es) or N(o)
	no_dm_adm	Y(es) or N(o)
	iso8882	Y(es) or N(o)
	sabm_in_x32	Y(es) or N(o)
	initial_down	Y(es) or N(o)
	mlp_priority	Numerical value between 1 and 127. Default is 1.
	line_speed	EXTERNAL, 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 48000, 56000, 64000, 128000, 256000, 512000, 1.024M, 1.536M, 2.048M
	max_frame	max_iframe_len plus 1.
WAN	connect_proc	NONE or V25
	V25_callreq	Numerical value between 6.0 and 30.0.
	n2_count	Timer value between 1 and 255. Default is 10
	t1_timer	Timer value between 1.0 and 300.0. Default is 9.0

Table A-1 Configuration file format

Section/Subsection	Keyword	Valid Parameter values
	pf_timer	Timer value between 1 and 300.0. Default is 0.7
	reject_timer	Timer value between 1 and 1000.0. Default is 2.5
	busy_timer	Timer value between 1 and 3000.0. Default is 10.0
	idle_timer	Timer value between 0 and 3200.0. Default is 25.0
	rr_ack_delay	Timer value between 0 and 300.0. Default is 0.4
	unack_max	Numerical value between 0 and 127. Default is 3
	local_win	Numerical value between 1 and 3000. Default is 9.0
	local_probe	Numerical value between 1 and 3000. Default is 0
	max_iframe_len	Numerical value between 1 and 3000. Default is 517
	xid_window	Numerical value between 1 and 127. Default is 7.
	xid_ndup	Numerical value between 0 and 255. Default is 2.
	xid_tdup	Numerical value between 0 and 300.0. Default is 5.
	network	X25_80, X25_84, X25_88, X25_LLC
	plpmode	Normal or Auto
X25	pvc_range	Pair of numerical values. Default is 0-0.
	inc_range	Pair of numerical values. Default is 0-0.
	out_range	Pair of numerical values. Default is 0-0.

*Table A-1* Configuration file format

Section/Subsection	Keyword	Valid Parameter values
	two_range	Pair of numerical values. Default is 512-575.
	modulo	8 or 128. Default is 8.
	use_negotiation	Y(es) or N(o)
	bar_negotiation	Y(es) or N(o)
	src_addr_control	Default is 0.
	accept_revchg	Y(es) or N(o)
	prev_chg	Y(es) or N(o)
	fast_select	Y(es) or N(o)
	fs_r_response	Y(es) or N(o)
	bar_nonpriv_listen	Y(es) or N(o)
	locmaxpktsize	7,8,9,10,11,12.
	remmaxpktsize	7,8,9,10,11,12.
	locdefpktsize	7,8,9,10,11,12.
	remdefpktsize	7,8,9,10,11,12.
	locmaxwinsize	Numerical value between 1 and 127. Default is 7.
	remmaxwinsize	Numerical value between 1 and 127. Default is 7.
	locdefwinsize	Numerical value between 1 and 127. Default is 2.
	remdefwinsize	Numerical value between 1 and 127. Default is 2.
	maxnsdulength	Numerical value between 1 and 32000. Default is 256.
	ackdelay	Numerical value between 1 and 3200.0. Default is 5.
	t20value	Timer value between 0 and 3200.0. Default is 180.0.

*Table A-1* Configuration file format

Section/Subsection	Keyword	Valid Parameter values
	t21value	Timer value between 0 and 3200.0. Default is 200.0.
	t22value	Timer value between 0 and 3200.0. Default is 180.0.
	t23value	Timer value between 0 and 3200.0. Default is 180.0.
	t24value	Timer value between 0 and 3200.0. Default is 75.0.
	t25value	Timer value between 0 and 3200.0. Default is 180.0.
	t26value	Timer value between 0 and 3200.0. Default is 180.0.
	t28value	Timer value between 0 and 3200.0. Default is 0.0
	idlevalue	Timer value between 0 and 3200.0. Default is 0.0.
	connectvalue	Numerical value between 0 and 3200.0. Default is 200.0.
	r20value	Numerical value between 1 and 255. Default is 1
	r22value	Numerical value between 1 and 255 Default is 1.
	r23value	Numerical value between 1 and 255 Default is 1.
	r28value	Numerical value between 1 and 255 Default is 1.
	localdelay	Numerical value between 0 and 32000 Default is 0.005
	access_delay	Numerical value between 0 and 32000 Default is 0.005
	locmaxthclass	Numerical value between 0 and 15 Default is 12.

*Table A-1* Configuration file format

Section/Subsection	Keyword	Valid Parameter values
	remmaxthclass	Numerical value between 0 and 15 Default is 12.
	locdefthclass	Numerical value between 0 and 15 Default is 12.
	remdefthclass	Numerical value between 0 and 15 Default is 12.
	locminthclass	Numerical value between 0 and 15 Default is 4.
	remminthclass	Numerical value between 0 and 15 Default is 4.
	sub_cug	Y(es) or N(o)
	sub_pref_cug	Y(es) or N(o)
	sub_cugia	Y(es) or N(o)
	cug_format	Basic or Extended
	bar_cug_in	Y(es) or N(o)
	bar_incall	Y(es) or N(o)
	bar_outcall	Y(es) or N(o)
	sub_toa_npi_fmt	Y(es) or N(o)
	bar_toa_npi_fmt	Y(es) or N(o)
	sub_nui_override	Y(es) or N(o)
	bar_call_x32_reg	Y(es) or N(o)
	acc_nodiag	Y(es) or N(o)
	use_diag	Y(es) or N(o)
	ccitt_clear_len	Y(es) or N(o)
	bar_diag	Y(es) or N(o)
	disc_nz_diag	Y(es) or N(o)
	acc_hex_add	Y(es) or N(o)
	intl_prioritised	Y(es) or N(o)
	iso_8882_mode	Y(es) or N(o)

*Table A-1* Configuration file format

Section/Subsection	Keyword	Valid Parameter values
	send_xl2l_to_lan	Y(es) or N(o)
	insert_xl2l_from_lan	Y(es) or N(o)
	datapac_priority	Y(es) or N(o)
	dnic	Any legal DNIC. Default is 0000.
	intl_addr_recogn	0, 1, 2, 3
	prty_encode_control	0, 1, 2
	prty_pkt_forced_val	0, 4, 5, 6, 7, 8, 9, 10, 11, 12.
	dbit_accept_in	clear, leave or zero
	dbit_accept_out	clear, leave or zero
	dbit_data_in	clear, leave or zero
	dbit_data_out	clear, leave or zero
	thclass_neg_to_def	Y(es) or N(o)
	thclass_type	Array of 16 integers.
	thclass_wmap	Array of 16 integers.
	thclass_pmap	4, 5, 6, 7, 8, 9, 10, 11, 12

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## *Error Messages and Error Codes*

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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.

### *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 cannot 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 means 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.

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 organization 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 16-10 on page 160 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 9.x software. If your scripts expect to find this file, amend them.

## *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-provider.

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.

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## *SunNet Manager Agent*

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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. Perform all steps as root.

- 1. On the machine running SunLink X.25 9.0, create the directory**  
`/var/adm/snm`.
- 2. Copy** `/opt/SUNWconn/x25/snm/na.x25` **into** `/usr/snm/agents` **on the machine running SunLink X.25.**
- 3. On the machine running SunNet Manager, create a software link between the** `/etc/snm.conf` **file and the** `/etc/opt/SUNWconn/snm/snm.conf` **file.**
- 4. Copy** `/opt/SUNWconn/x25/snm/schema.x25` **to** `/usr/snm/agents` **on the SunNet Manager console machine.**

5. 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.

6. 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
```

7. 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

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`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 Solaris 2.4/x86* for details on using the SNM Console for extracting data from agents.



## *Compatibility with version 7.0*

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SunLink X.25 9.0 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 9.0 Programming 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.

## 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 “Checking the Datalink Layer.” on page 190.

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).

**-v *virtual circuit***

Specify a virtual circuit or range of virtual circuits.

**-s *symbolic address***

Specify a symbolic address.

## 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

To display a name or partial name from the `xhosts` table, use the `-s` option.

MAC Address

An LSAP address is present for virtual circuits running over LLC2.

## 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.

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**Note** – For LLC2, `vcstat` collects statistics on a per-physical-link basis, not per dynamic LLC2 link.

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**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.

## *High-Level Data Link Control*

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**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. In other situations, use LAPB plus DLPI. This implementation of HDLC does not support `hdlcconf`.

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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
```

## *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 */

```

## 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.

### *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.

### *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_sentsabms` 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.

## 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 `HDLC_LINK_DOWN` state. Calls to read and write will fail, and `errno` is set to `ENETDOWN`. This is the same call that `hdlcstop` uses.

## 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.

### 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.

### *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*

---

**Bits per second (bps)**

The number of bits passed per second.

**Call**

Communication between two DTEs using a virtual circuit.

**CCITT**

Consultative Committee for International Telephony and Telegraphy. Previous name of the ITU-T.

**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.

**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.

---

**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.

**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.

**Defense Data Network (DDN)**

A network administered by the US Department of Defense, that uses a form of X.121 to IP address mapping defined in RFC 1236.

**Duplex**

Circuits that allow for simultaneous two way communication.

**Facility**

An optional service offered by a public network's administration. Usually requested by the user when subscribing.

**Flag**

A sequence of bits that signifies the beginning and end of a frame.

**Frame**

The unit of information used at layer 2 of the X.25 Recommendations.

**I-Frame**

A frame containing data—an Information Frame.

**International Telecommunication Union—Telecommunication Standardization Sector (ITU-T)**

An international organization of communication carriers, most of which are government telephone and telegraph agencies. The ITU-T develops telecommunication standards through the use of their recommendations. The X.25, X.3, and X.29 standards are ITU-T Recommendations.

**LAPB**

The datalink layer protocol specified by the X.25 Recommendations.

**Logical Channel**

An association between two DTEs through which they exchange data.

**Octet**

The ITU-T's term for an 8-bit byte.

---

**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.

**Permanent virtual circuit (PVC)**

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.

**Public Data Network (PDN)**

A data communications network whose services are available to any user willing to pay for them. Tymnet and Telnex 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.

**Recognized Private Operating Agency (RPOA)**

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.

---

**Subaddress**

An optional component of an X.121 address that identifies a specific application on a DTE.

**Switched virtual circuit (SVC)**

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.

**Throughput**

The rate at which data is passed through a particular system.

**V25**

The recommendation that defines dial-up X.25.

**X.21bis**

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.

**X.32**

The recommendation that defines the security procedures used for dial-up access to public PSDNs.

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