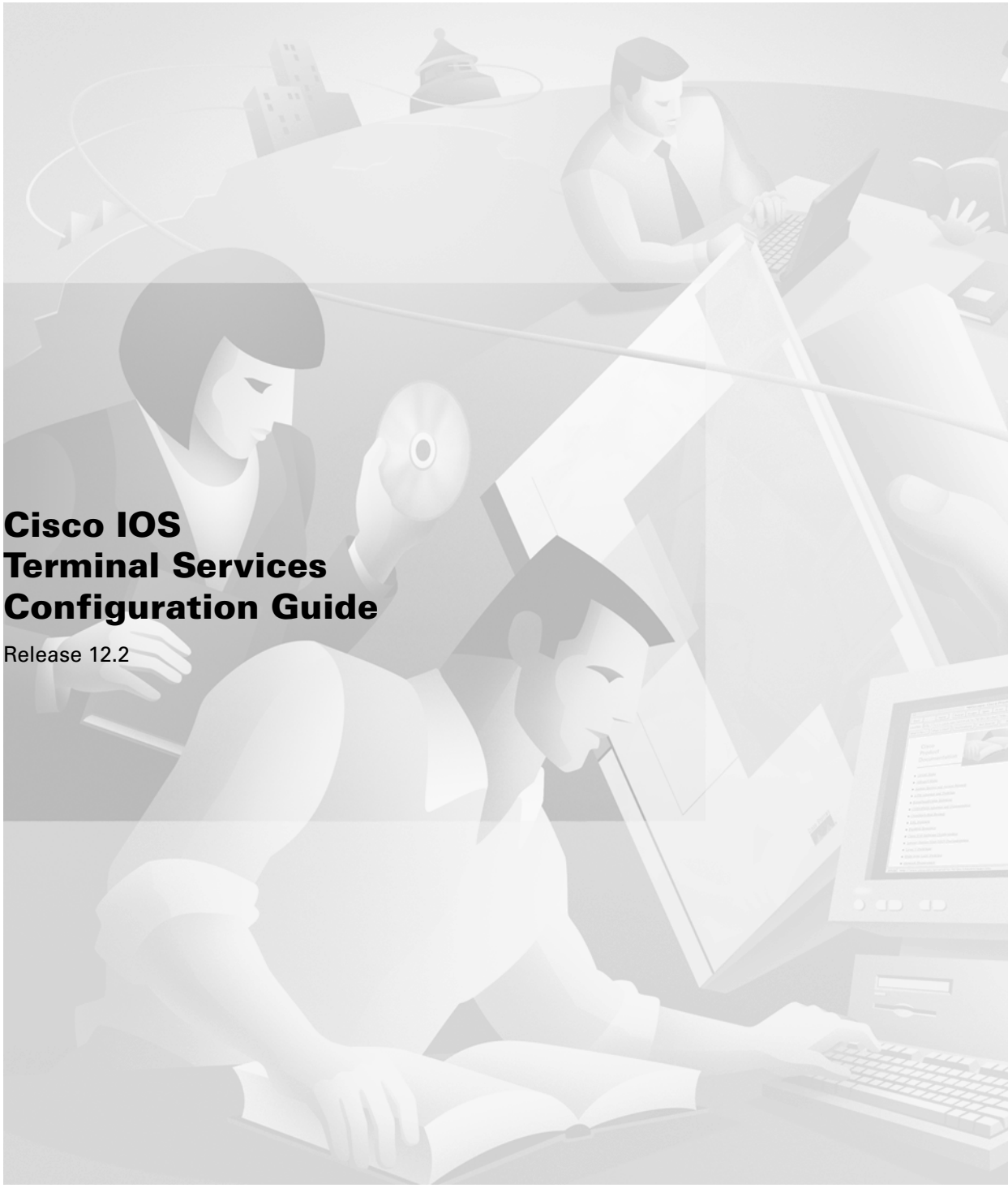

Cisco IOS Terminal Services Configuration Guide

Release 12.2

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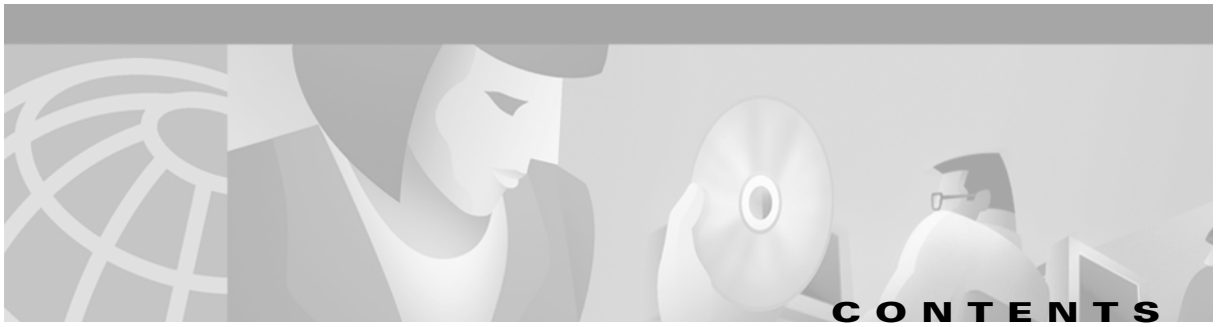

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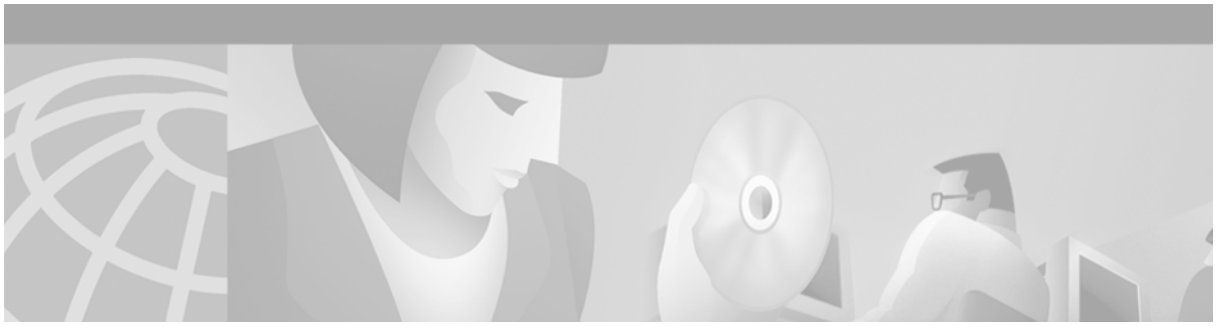


About Cisco IOS Software Documentation

This chapter discusses the objectives, audience, organization, and conventions of Cisco IOS software documentation. It also provides sources for obtaining documentation from Cisco Systems.

Documentation Objectives

Cisco IOS software documentation describes the tasks and commands necessary to configure and maintain Cisco networking devices.

Audience

The Cisco IOS software documentation set is intended primarily for users who configure and maintain Cisco networking devices (such as routers and switches) but who may not be familiar with the tasks, the relationship between tasks, or the Cisco IOS software commands necessary to perform particular tasks. The Cisco IOS software documentation set is also intended for those users experienced with Cisco IOS software who need to know about new features, new configuration options, and new software characteristics in the current Cisco IOS software release.

Documentation Organization

The Cisco IOS software documentation set consists of documentation modules and master indexes. In addition to the main documentation set, there are supporting documents and resources.

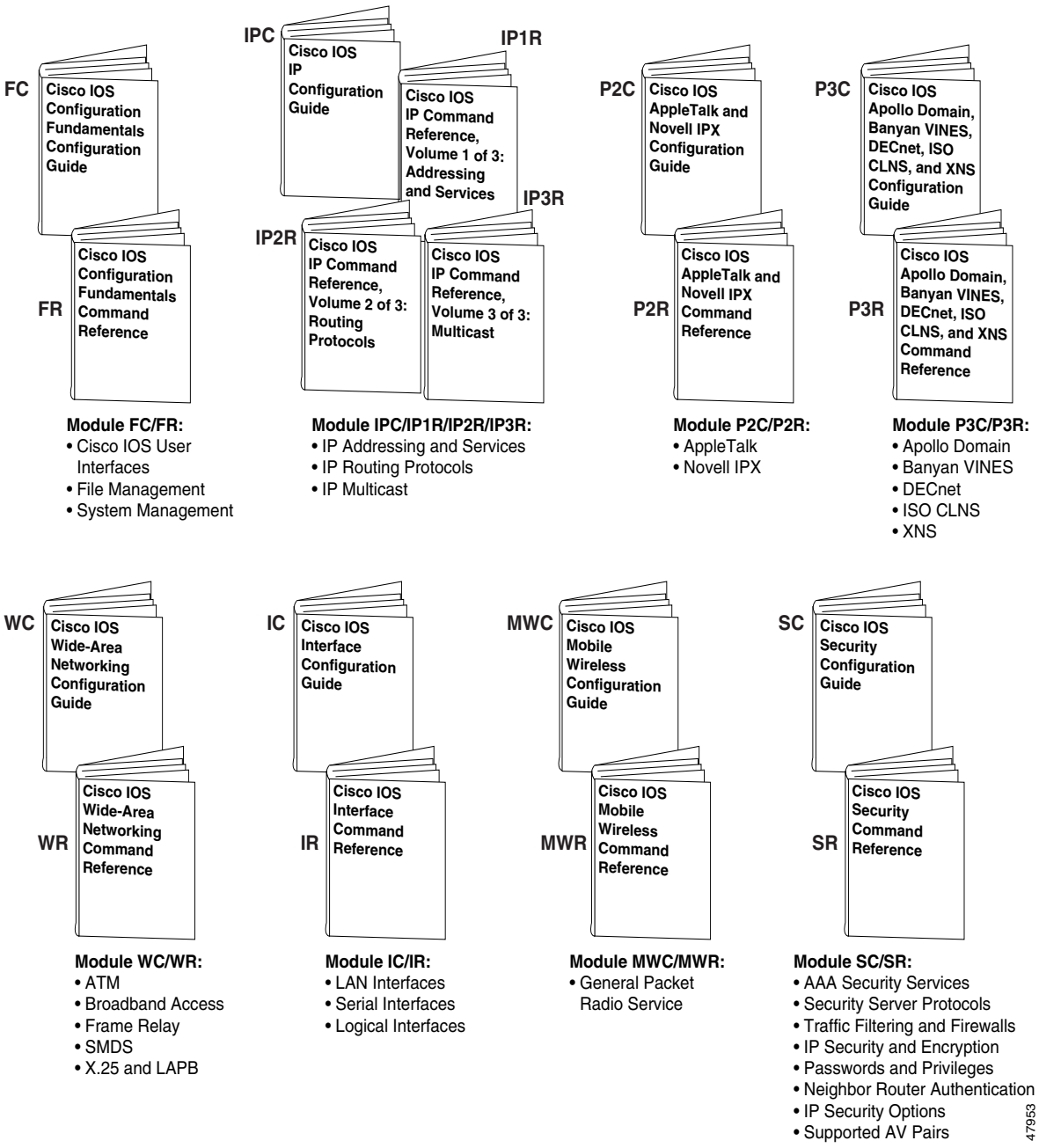
Documentation Modules

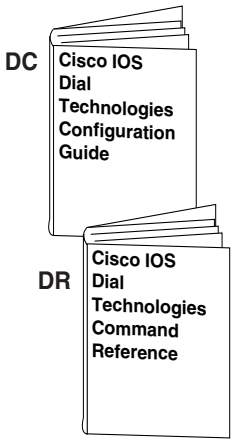
The Cisco IOS documentation modules consist of configuration guides and corresponding command reference publications. Chapters in a configuration guide describe protocols, configuration tasks, and Cisco IOS software functionality and contain comprehensive configuration examples. Chapters in a command reference publication provide complete Cisco IOS command syntax information. Use each configuration guide in conjunction with its corresponding command reference publication.

Figure 1 shows the Cisco IOS software documentation modules.

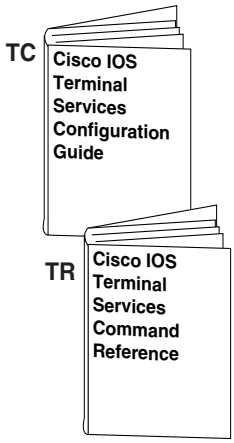
Note The abbreviations (for example, FC and FR) next to the book icons are page designators, which are defined in a key in the index of each document to help you with navigation. The bullets under each module list the major technology areas discussed in the corresponding books.

Figure 1 Cisco IOS Software Documentation Modules

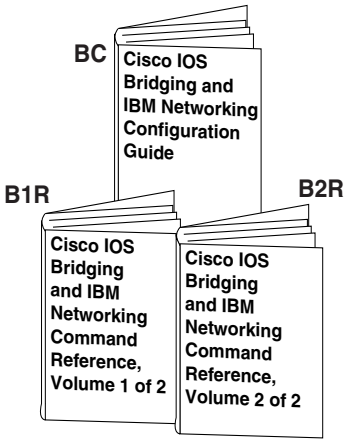




Module DC/DR:
- Preparing for Dial Access
- Modem and Dial Shelf Configuration and Management
- ISDN Configuration
- Signalling Configuration
- Dial-on-Demand Routing Configuration
- Dial-Backup Configuration
- Dial-Related Addressing Services
- Virtual Templates, Profiles, and Networks
- PPP Configuration
- Callback and Bandwidth Allocation Configuration
- Dial Access Specialized Features
- Dial Access Scenarios

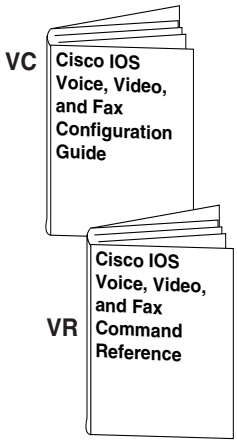


Module TC/TR:
- ARA
- LAT
- NASI
- Telnet
- TN3270
- XRemote
- X.28 PAD
- Protocol Translation

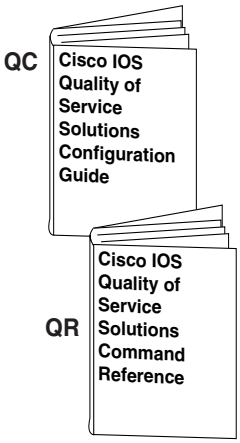


Module BC/B1R:
- Transparent Bridging
- SRB
- Token Ring Inter-Switch Link
- Token Ring Route Switch Module
- RSRB
- DLSw+
- Serial Tunnel and Block Serial Tunnel
- LLC2 and SDLC
- IBM Network Media Translation
- SNA Frame Relay Access
- NCIA Client/Server
- Airline Product Set

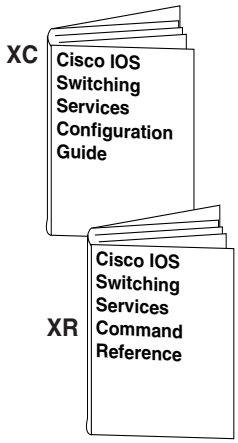
Module BC/B2R:
- DSPU and SNA Service Point
- SNA Switching Services
- Cisco Transaction Connection
- Cisco Mainframe Channel Connection
- CLAW and TCP/IP Offload
- CSNA, CMPC, and CMPC+
- TN3270 Server



Module VC/VR:
- Voice over IP
- Call Control Signalling
- Voice over Frame Relay
- Voice over ATM
- Telephony Applications
- Trunk Management
- Fax, Video, and Modem Support



Module QC/QR:
- Packet Classification
- Congestion Management
- Congestion Avoidance
- Policing and Shaping
- Signalling
- Link Efficiency Mechanisms



Module XC/XR:
- Cisco IOS Switching Paths
- NetFlow Switching
- Multiprotocol Label Switching
- Multilayer Switching
- Multicast Distributed Switching
- Virtual LANs
- LAN Emulation

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Master Indexes

Two master indexes provide indexing information for the Cisco IOS software documentation set: an index for the configuration guides and an index for the command references. Individual books also contain a book-specific index.

The master indexes provide a quick way for you to find a command when you know the command name but not which module contains the command. When you use the online master indexes, you can click the page number for an index entry and go to that page in the online document.

Supporting Documents and Resources

The following documents and resources support the Cisco IOS software documentation set:

- *Cisco IOS Command Summary* (two volumes)—This publication explains the function and syntax of the Cisco IOS software commands. For more information about defaults and usage guidelines, refer to the Cisco IOS command reference publications.
- *Cisco IOS System Error Messages*—This publication lists and describes Cisco IOS system error messages. Not all system error messages indicate problems with your system. Some are purely informational, and others may help diagnose problems with communications lines, internal hardware, or the system software.
- *Cisco IOS Debug Command Reference*—This publication contains an alphabetical listing of the **debug** commands and their descriptions. Documentation for each command includes a brief description of its use, command syntax, usage guidelines, and sample output.
- *Dictionary of Internetworking Terms and Acronyms*—This Cisco publication compiles and defines the terms and acronyms used in the internetworking industry.
- New feature documentation—The Cisco IOS software documentation set documents the mainline release of Cisco IOS software (for example, Cisco IOS Release 12.2). New software features are introduced in early deployment releases (for example, the Cisco IOS "T" release train for 12.2, 12.2(x)T). Documentation for these new features can be found in standalone documents called "feature modules." Feature module documentation describes new Cisco IOS software and hardware networking functionality and is available on Cisco.com and the Documentation CD-ROM.
- Release notes—This documentation describes system requirements, provides information about new and changed features, and includes other useful information about specific software releases. See the section "Using Software Release Notes" in the chapter "Using Cisco IOS Software" for more information.
- Caveats documentation—This documentation provides information about Cisco IOS software defects in specific software releases.
- RFCs—RFCs are standards documents maintained by the Internet Engineering Task Force (IETF). Cisco IOS software documentation references supported RFCs when applicable. The full text of referenced RFCs may be obtained on the World Wide Web at http://www.rfc-editor.org/.
- MIBs—MIBs are used for network monitoring. For lists of supported MIBs by platform and release, and to download MIB files, see the Cisco MIB website on Cisco.com at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

New and Changed Information

The Release 12.2 *Cisco IOS Terminal Services Configuration Guide* and *Cisco IOS Terminal Services Command Reference* were extracted from Release 12.1 of the *Cisco IOS Dial Services Configuration Guide: Terminal Services* and *Cisco IOS Dial Services Command Reference.*

Document Conventions

Within Cisco IOS software documentation, the term *router* is generally used to refer to a variety of Cisco products (for example, routers, access servers, and switches). Routers, access servers, and other networking devices that support Cisco IOS software are shown interchangeably within examples. These products are used only for illustrative purposes; that is, an example that shows one product does not necessarily indicate that other products are not supported.

The Cisco IOS documentation set uses the following conventions:

Convention	Description
^ or Ctrl	The ^ and Ctrl symbols represent the Control key. For example, the key combination ^D or Ctrl-D means hold down the Control key while you press the D key. Keys are indicated in capital letters but are not case sensitive.
string	A string is a nonquoted set of characters shown in italics. For example, when setting an SNMP community string to public, do not use quotation marks around the string or the string will include the quotation marks.

Command syntax descriptions use the following conventions:

Convention	Description
boldface	Boldface text indicates commands and keywords that you enter literally as shown.
italics	Italic text indicates arguments for which you supply values.
[x]	Square brackets enclose an optional element (keyword or argument).
|	A vertical line indicates a choice within an optional or required set of keywords or arguments.
[x | y]	Square brackets enclosing keywords or arguments separated by a vertical line indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments separated by a vertical line indicate a required choice.

Nested sets of square brackets or braces indicate optional or required choices within optional or required elements. For example:

Convention	Description
[x {y | z}]	Braces and a vertical line within square brackets indicate a required choice within an optional element.

Examples use the following conventions:

Convention	Description
`screen`	Examples of information displayed on the screen are set in Courier font.
`boldface screen`	Examples of text that you must enter are set in Courier bold font.
< >	Angle brackets enclose text that is not printed to the screen, such as passwords.
!	An exclamation point at the beginning of a line indicates a comment line. (Exclamation points are also displayed by the Cisco IOS software for certain processes.)
[ ]	Square brackets enclose default responses to system prompts.

The following conventions are used to attract the attention of the reader:

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Timesaver Means the *described action saves time*. You can save time by performing the action described in the paragraph.

Obtaining Documentation

The following sections provide sources for obtaining documentation from Cisco Systems.

World Wide Web

The most current Cisco documentation is available on the World Wide Web at the following website:

http://www.cisco.com

Translated documentation is available at the following website:

http://www.cisco.com/public/countries_languages.html

Documentation CD-ROM

Cisco documentation and additional literature are available in a CD-ROM package, which ships with your product. The Documentation CD-ROM is updated monthly and may be more current than printed documentation. The CD-ROM package is available as a single unit or through an annual subscription.

Ordering Documentation

Cisco documentation can be ordered in the following ways:

- Registered Cisco Direct Customers can order Cisco product documentation from the Networking Products MarketPlace:

  http://www.cisco.com/cgi-bin/order/order_root.pl

- Registered Cisco.com users can order the Documentation CD-ROM through the online Subscription Store:

  http://www.cisco.com/go/subscription

- Nonregistered Cisco.com users can order documentation through a local account representative by calling Cisco corporate headquarters (California, USA) at 408 526-7208 or, in North America, by calling 800 553-NETS(6387).

Documentation Feedback

If you are reading Cisco product documentation on the World Wide Web, you can submit technical comments electronically. Click **Feedback** in the toolbar and select **Documentation**. After you complete the form, click **Submit** to send it to Cisco.

You can e-mail your comments to bug-doc@cisco.com.

To submit your comments by mail, use the response card behind the front cover of your document, or write to the following address:

Cisco Systems, Inc.
Document Resource Connection
170 West Tasman Drive
San Jose, CA 95134-9883

We appreciate your comments.

Obtaining Technical Assistance

Cisco provides Cisco.com as a starting point for all technical assistance. Customers and partners can obtain documentation, troubleshooting tips, and sample configurations from online tools. For Cisco.com registered users, additional troubleshooting tools are available from the TAC website.

Cisco.com

Cisco.com is the foundation of a suite of interactive, networked services that provides immediate, open access to Cisco information and resources at anytime, from anywhere in the world. This highly integrated Internet application is a powerful, easy-to-use tool for doing business with Cisco.

Cisco.com provides a broad range of features and services to help customers and partners streamline business processes and improve productivity. Through Cisco.com, you can find information about Cisco and our networking solutions, services, and programs. In addition, you can resolve technical issues with online technical support, download and test software packages, and order Cisco learning materials and merchandise. Valuable online skill assessment, training, and certification programs are also available.

Customers and partners can self-register on Cisco.com to obtain additional personalized information and services. Registered users can order products, check on the status of an order, access technical support, and view benefits specific to their relationships with Cisco.

To access Cisco.com, go to the following website:

http://www.cisco.com

Technical Assistance Center

The Cisco TAC website is available to all customers who need technical assistance with a Cisco product or technology that is under warranty or covered by a maintenance contract.

Contacting TAC by Using the Cisco TAC Website

If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

http://www.cisco.com/register/

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

http://www.cisco.com/tac/caseopen

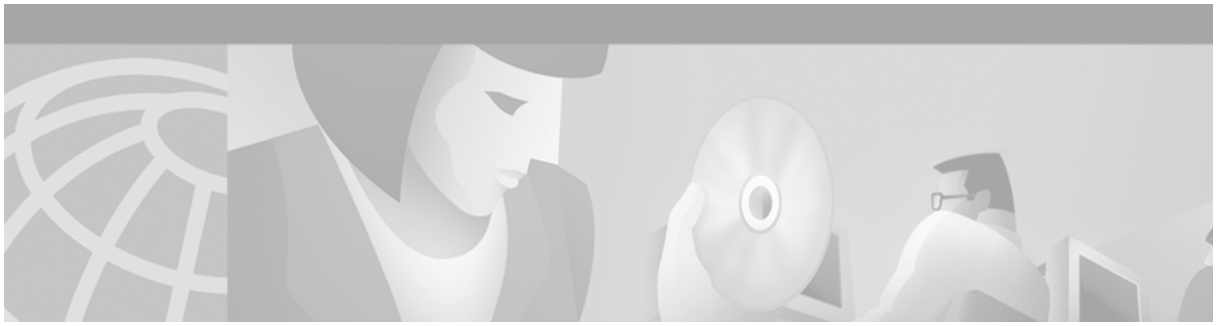
Contacting TAC by Telephone

If you have a priority level 1 (P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.



Using Cisco IOS Software

This chapter provides helpful tips for understanding and configuring Cisco IOS software using the command-line interface (CLI). It contains the following sections:

- Understanding Command Modes
- Getting Help
- Using the no and default Forms of Commands
- Saving Configuration Changes
- Filtering Output from the show and more Commands
- Identifying Supported Platforms

For an overview of Cisco IOS software configuration, refer to the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2.

For information on the conventions used in the Cisco IOS software documentation set, see the chapter "About Cisco IOS Software Documentation" located at the beginning of this book.

Understanding Command Modes

You use the CLI to access Cisco IOS software. Because the CLI is divided into many different modes, the commands available to you at any given time depend on the mode you are currently in. Entering a question mark (**?**) at the CLI prompt allows you to obtain a list of commands available for each command mode.

When you log in to the CLI, you are in user EXEC mode. User EXEC mode contains only a limited subset of commands. To have access to all commands, you must enter privileged EXEC mode, normally by using a password. From privileged EXEC mode you can issue any EXEC command—user or privileged mode—or you can enter global configuration mode. Most EXEC commands are one-time commands. For example, **show** commands show important status information, and **clear** commands clear counters or interfaces. The EXEC commands are not saved when the software reboots.

Configuration modes allow you to make changes to the running configuration. If you later save the running configuration to the startup configuration, these changed commands are stored when the software is rebooted. To enter specific configuration modes, you must start at global configuration mode. From global configuration mode, you can enter interface configuration mode and a variety of other modes, such as protocol-specific modes.

ROM monitor mode is a separate mode used when the Cisco IOS software cannot load properly. If a valid software image is not found when the software boots or if the configuration file is corrupted at startup, the software might enter ROM monitor mode.

Table 1 describes how to access and exit various common command modes of the Cisco IOS software. It also shows examples of the prompts displayed for each mode.

Table 1 Accessing and Exiting Command Modes

Command Mode	Access Method	Prompt	Exit Method
User EXEC	Log in.	`Router>`	Use the **logout** command.
Privileged EXEC	From user EXEC mode, use the **enable** EXEC command.	`Router#`	To return to user EXEC mode, use the **disable** command.
Global configuration	From privileged EXEC mode, use the **configure terminal** privileged EXEC command.	`Router(config)#`	To return to privileged EXEC mode from global configuration mode, use the **exit** or **end** command, or press **Ctrl-Z**.
Interface configuration	From global configuration mode, specify an interface using an **interface** command.	`Router(config-if)#`	To return to global configuration mode, use the **exit** command. To return to privileged EXEC mode, use the **end** command, or press **Ctrl-Z**.
ROM monitor	From privileged EXEC mode, use the **reload** EXEC command. Press the **Break** key during the first 60 seconds while the system is booting.	`>`	To exit ROM monitor mode, use the **continue** command.

For more information on command modes, refer to the "Using the Command-Line Interface" chapter in the *Cisco IOS Configuration Fundamentals Configuration Guide*.

Getting Help

Entering a question mark (**?**) at the CLI prompt displays a list of commands available for each command mode. You can also get a list of keywords and arguments associated with any command by using the context-sensitive help feature.

To get help specific to a command mode, a command, a keyword, or an argument, use one of the following commands:

Command	Purpose
help	Provides a brief description of the help system in any command mode.
*abbreviated-command-entry***?**	Provides a list of commands that begin with a particular character string. (No space between command and question mark.)
abbreviated-command-entry<**Tab**>	Completes a partial command name.
?	Lists all commands available for a particular command mode.
command **?**	Lists the keywords or arguments that you must enter next on the command line. (Space between command and question mark.)

Example: How to Find Command Options

This section provides an example of how to display syntax for a command. The syntax can consist of optional or required keywords and arguments. To display keywords and arguments for a command, enter a question mark (**?**) at the configuration prompt or after entering part of a command followed by a space. The Cisco IOS software displays a list and brief description of available keywords and arguments. For example, if you were in global configuration mode and wanted to see all the keywords or arguments for the **arap** command, you would type **arap ?**.

The <cr> symbol in command help output stands for "carriage return." On older keyboards, the carriage return key is the Return key. On most modern keyboards, the carriage return key is the Enter key. The <cr> symbol at the end of command help output indicates that you have the option to press **Enter** to complete the command and that the arguments and keywords in the list preceding the <cr> symbol are optional. The <cr> symbol by itself indicates that no more arguments or keywords are available and that you must press **Enter** to complete the command.

Table 2 shows examples of how you can use the question mark (**?**) to assist you in entering commands. The table steps you through configuring an IP address on a serial interface on a Cisco 7206 router that is running Cisco IOS Release 12.0(3).

Table 2 How to Find Command Options

Command	Comment

`Router> enable`
`Password: <password>`
`Router#`
	Enter the **enable** command and password to access privileged EXEC commands. You are in privileged EXEC mode when the prompt changes to `Router#`.

`Router# configure terminal`
`Enter configuration commands, one per line. End with CNTL/Z.`
`Router(config)#`
	Enter the **configure terminal** privileged EXEC command to enter global configuration mode. You are in global configuration mode when the prompt changes to `Router(config)#`.

`Router(config)# interface serial ?`
`  <0-6>  Serial interface number`
`Router(config)# interface serial 4 ?`
`  /`
`Router(config)# interface serial 4/ ?`
`  <0-3>  Serial interface number`
`Router(config)# interface serial 4/0`
`Router(config-if)#`
	Enter interface configuration mode by specifying the serial interface that you want to configure using the **interface serial** global configuration command.
	Enter **?** to display what you must enter next on the command line. In this example, you must enter the serial interface slot number and port number, separated by a forward slash.
	You are in interface configuration mode when the prompt changes to `Router(config-if)#`.

Table 2 How to Find Command Options (continued)

Command	Comment

`Router(config-if)# ?`
`Interface configuration commands:`
`  .`
`  .`
`  .`
`  ip  Interface Internet Protocol config commands`
`  keepalive  Enable keepalive`
`  lan-name  LAN Name command`
`  llc2  LLC2 Interface Subcommands`
`  load-interval  Specify interval for load calculation for an interface`
`  locaddr-priority  Assign a priority group`
`  logging  Configure logging for interface`
`  loopback  Configure internal loopback on an interface`
`  mac-address  Manually set interface MAC address`
`  mls  mls router sub/interface commands`
`  mpoa  MPOA interface configuration commands`
`  mtu  Set the interface Maximum Transmission Unit (MTU)`
`  netbios  Use a defined NETBIOS access list or enable name-caching`
`  no  Negate a command or set its defaults`
`  nrzi-encoding  Enable use of NRZI encoding`
`  ntp  Configure NTP`
`  .`
`  .`
`  .`
`Router(config-if)#`
	Enter **?** to display a list of all the interface configuration commands available for the serial interface. This example shows only some of the available interface configuration commands.

`Router(config-if)# ip ?`
`Interface IP configuration subcommands:`
`  access-group  Specify access control for packets`
`  accounting  Enable IP accounting on this interface`
`  address  Set the IP address of an interface`
`  authentication  authentication subcommands`
`  bandwidth-percent  Set EIGRP bandwidth limit`
`  broadcast-address  Set the broadcast address of an interface`
`  cgmp  Enable/disable CGMP`
`  directed-broadcast  Enable forwarding of directed broadcasts`
`  dvmrp  DVMRP interface commands`
`  hello-interval  Configures IP-EIGRP hello interval`
`  helper-address  Specify a destination address for UDP broadcasts`
`  hold-time  Configures IP-EIGRP hold time`
`  .`
`  .`
`  .`
`Router(config-if)# ip`
	Enter the command that you want to configure for the interface. This example uses the **ip** command.
	Enter **?** to display what you must enter next on the command line. This example shows only some of the available interface IP configuration commands.

Table 2 How to Find Command Options (continued)

Command	Comment

`Router(config-if)# ip address ?`
`  A.B.C.D  IP address`
`  negotiated  IP Address negotiated over PPP`
`Router(config-if)# ip address`
	Enter the command that you want to configure for the interface. This example uses the **ip address** command.
	Enter **?** to display what you must enter next on the command line. In this example, you must enter an IP address or the **negotiated** keyword.
	A carriage return (<cr>) is not displayed; therefore, you must enter additional keywords or arguments to complete the command.

`Router(config-if)# ip address 172.16.0.1 ?`
`  A.B.C.D  IP subnet mask`
`Router(config-if)# ip address 172.16.0.1`
	Enter the keyword or argument you want to use. This example uses the 172.16.0.1 IP address.
	Enter **?** to display what you must enter next on the command line. In this example, you must enter an IP subnet mask.
	A <cr> is not displayed; therefore, you must enter additional keywords or arguments to complete the command.

`Router(config-if)# ip address 172.16.0.1 255.255.255.0 ?`
`  secondary  Make this IP address a secondary address`
`  <cr>`
`Router(config-if)# ip address 172.16.0.1 255.255.255.0`
	Enter the IP subnet mask. This example uses the 255.255.255.0 IP subnet mask.
	Enter **?** to display what you must enter next on the command line. In this example, you can enter the **secondary** keyword, or you can press **Enter**.
	A <cr> is displayed; you can press **Enter** to complete the command, or you can enter another keyword.

`Router(config-if)# ip address 172.16.0.1 255.255.255.0` `Router(config-if)#`	In this example, Enter is pressed to complete the command.

Using the no and default Forms of Commands

Almost every configuration command has a **no** form. In general, use the **no** form to disable a function. Use the command without the **no** keyword to reenable a disabled function or to enable a function that is disabled by default. For example, IP routing is enabled by default. To disable IP routing, use the **no ip routing** command; to reenable IP routing, use the **ip routing** command. The Cisco IOS software command reference publications provide the complete syntax for the configuration commands and describe what the **no** form of a command does.

Configuration commands also can have a **default** form, which returns the command settings to the default values. Most commands are disabled by default, so in such cases using the **default** form has the same result as using the **no** form of the command. However, some commands are enabled by default and

have variables set to certain default values. In these cases, the **default** form of the command enables the command and sets the variables to their default values. The Cisco IOS software command reference publications describe the effect of the **default** form of a command if the command functions differently than the **no** form.

Saving Configuration Changes

Use the **copy system:running-config nvram:startup-config** command to save your configuration changes to the startup configuration so that the changes will not be lost if the software reloads or a power outage occurs. For example:

```
Router# copy system:running-config nvram:startup-config
Building configuration...
```

It might take a minute or two to save the configuration. After the configuration has been saved, the following output appears:

```
[OK]
Router#
```

On most platforms, this task saves the configuration to NVRAM. On the Class A Flash file system platforms, this task saves the configuration to the location specified by the CONFIG_FILE environment variable. The CONFIG_FILE variable defaults to NVRAM.

Filtering Output from the show and more Commands

In Cisco IOS Release 12.0(1)T and later releases, you can search and filter the output of **show** and **more** commands. This functionality is useful if you need to sort through large amounts of output or if you want to exclude output that you need not see.

To use this functionality, enter a **show** or **more** command followed by the "pipe" character (|); one of the keywords **begin**, **include**, or **exclude**; and a regular expression on which you want to search or filter (the expression is case-sensitive):

command | {**begin** | **include** | **exclude**} *regular-expression*

The output matches certain lines of information in the configuration file. The following example illustrates how to use output modifiers with the **show interface** command when you want the output to include only lines in which the expression "protocol" appears:

```
Router# show interface | include protocol

FastEthernet0/0 is up, line protocol is up
Serial4/0 is up, line protocol is up
Serial4/1 is up, line protocol is up
Serial4/2 is administratively down, line protocol is down
Serial4/3 is administratively down, line protocol is down
```

For more information on the search and filter functionality, refer to the "Using the Command-Line Interface" chapter in the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2.

Identifying Supported Platforms

Cisco IOS software is packaged in feature sets consisting of software images that support specific platforms. The feature sets available for a specific platform depend on which Cisco IOS software images are included in a release. To identify the set of software images available in a specific release or to find out if a feature is available in a given Cisco IOS software image, see the following sections:

- Using Feature Navigator
- Using Software Release Notes

Using Feature Navigator

Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a particular set of features and which features are supported in a particular Cisco IOS image.

Feature Navigator is available 24 hours a day, 7 days a week. To access Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, e-mail the Contact Database Administration group at cdbadmin@cisco.com. If you do not have an account on Cisco.com, go to http://www.cisco.com/register and follow the directions to establish an account.

To use Feature Navigator, you must have a JavaScript-enabled web browser such as Netscape 3.0 or later, or Internet Explorer 4.0 or later. Internet Explorer 4.0 always has JavaScript enabled. To enable JavaScript for Netscape 3.x or Netscape 4.x, follow the instructions provided with the web browser. For JavaScript support and enabling instructions for other browsers, check with the browser vendor.

Feature Navigator is updated when major Cisco IOS software releases and technology releases occur. You can access Feature Navigator at the following URL:

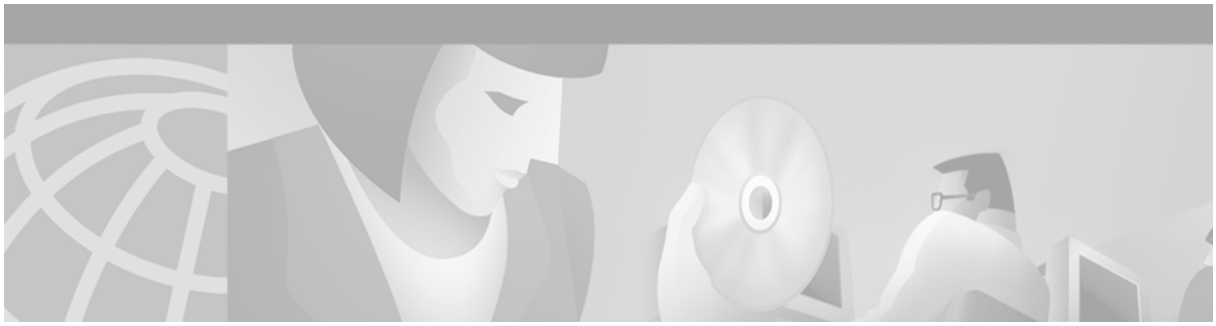
http://www.cisco.com/go/fn

Using Software Release Notes

Cisco IOS software releases include release notes that provide the following information:

- Platform support information
- Memory recommendations
- Microcode support information
- Feature set tables
- Feature descriptions
- Open and resolved severity 1 and 2 caveats for all platforms

Release notes are intended to be release-specific for the most current release, and the information provided in these documents may not be cumulative in providing information about features that first appeared in previous releases.



Terminal Services Overview

This chapter provides an overview of Cisco IOS terminal services and includes the following main sections:

Cisco IOS Network Access Devices

Network devices that support access services enable single users to access network resources from remote sites. Remote users include corporate telecommuters, mobile users, and individuals in remote offices who access the central site. Access services connect remote users over serial lines to modems, networks, terminals, printers, workstations, and other network resources on LANs and WANs. In contrast, routers that do not support access services connect LANs or WANs.

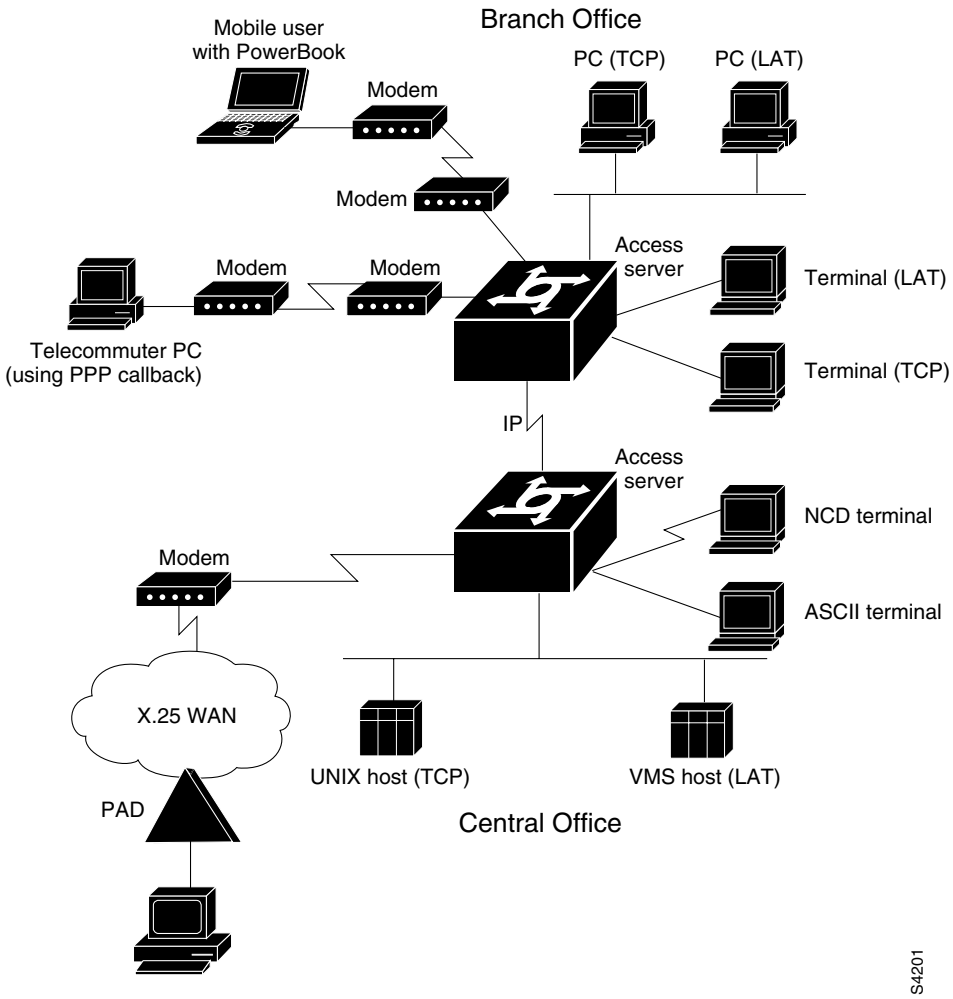
Note Access services are supported on the Cisco 2500, Cisco 2600, and Cisco 3600 series routers. See the *Cisco Products Quick Reference Guide*, available at Cisco.com, for more information about Cisco devices for terminal and modem access services.

Figure 2 illustrates the following access services available in the Cisco IOS software:

- Terminal services are shown between the terminals and hosts running the same protocol (LAT to LAT or TCP to TCP).
- Protocol translation is supported between the terminals and hosts running unlike protocols (such as LAT to TCP or TCP to LAT).

Asynchronous IP routing is shown by the PC running Serial Line Internet Protocol (SLIP) or Point-to-Point Protocol (PPP), and between the two access servers. Asynchronous routing configuration is described in the *Cisco IOS Terminal Services Configuration Guide*, Release 12.2.

Figure 2 Access Service Functions



Line Characteristics and Modems

The Cisco IOS software permits you to connect to asynchronous serial devices such as terminals and modems and to configure custom device operation. You can configure a single physical or virtual line or a range of lines. For example, you can configure one line for a laser printer and then configure a set of lines to switch incoming modem connections to the next available line. You also can customize your configurations. For example, you can define line-specific transport protocols, control character, and packet transmissions, set line speed, flow control, and establish time limits for user access.

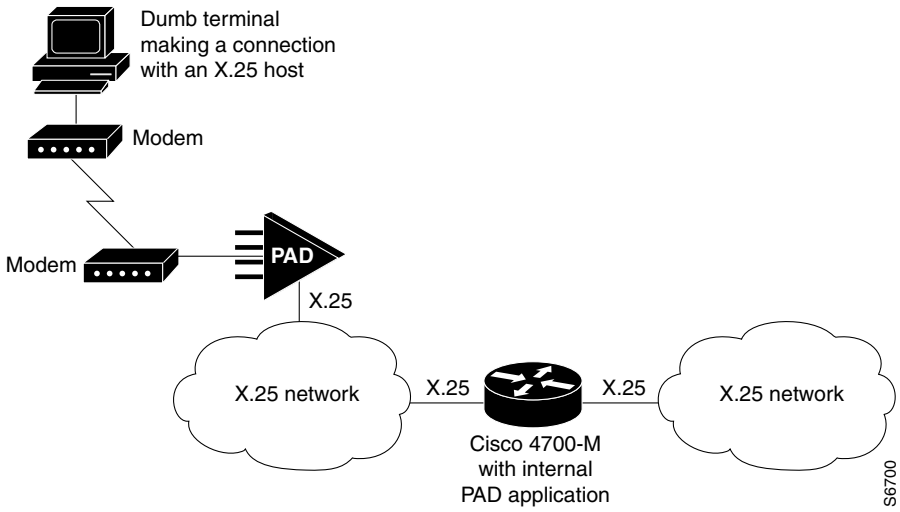
The chapters in this publication describe how to configure the lines for a specific device application. See the chapter "Configuring Protocol Translation and Virtual Asynchronous Devices" in this publication, and the chapters "Interfaces, Controllers, and Lines Used for Dial Access Overview" and "Preparing Modem and Asynchronous Interfaces" in the *Cisco IOS Dial Technologies Configuration Guide* for additional information about configuring Cisco asynchronous serial interfaces.

Asynchronous Character Stream Calls

Asynchronous character stream calls enter the router or access server through virtual terminal (vty) lines and virtual asynchronous interfaces (vty-async). These virtual lines and interfaces terminate incoming character streams that have no physical connection to the access server or router (such as a physical serial interface). For example, if you begin a PPP session over an asynchronous character stream, a vty-async interface is created to support the call. The following types of calls are terminated on a virtual asynchronous interface: Telnet, local-area transport (LAT), V.120, TN3270, and Link Access Procedure, Balanced-terminal adapter (LAPB-TA) and packet assembler/disassembler (PAD) calls.

Figure 3 shows a dumb terminal using a modem and packet assembler/disassembler (PAD) to place a call in to an X.25 switched network. The Cisco 4700-M router is configured to support vty lines and vty-async interfaces.

Figure 3 Standard X.25 Dial-Up Connection



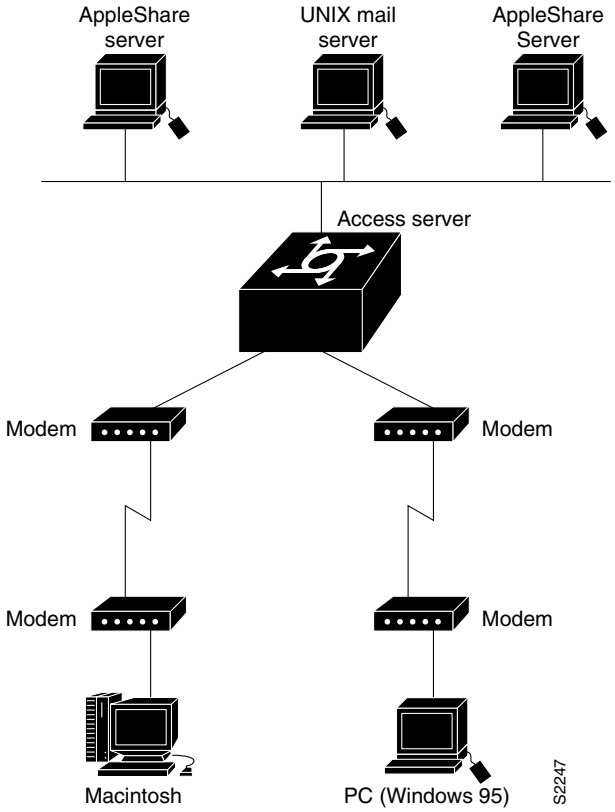
Remote Node Services

Remote node services permit remote users to connect devices over a telephone network using the following protocols:

- AppleTalk Remote Access (ARA), which is described in the chapter "Configuring AppleTalk Remote Access" in this publication.

  Using ARA, Macintosh users can connect across telephone lines into an AppleTalk network to access network resources, such as printers, file servers, and e-mail. Remote users running ARA have the same access to network resources as a Macintosh connected directly to the LAN. They can also run other applications on top of ARA to access UNIX file servers for such tasks as reading e-mail and copying or transferring files between UNIX hosts. Note that Macintosh users can run Macintosh-based SLIP or PPP applications to access non-AppleTalk-based resources (see Figure 4).

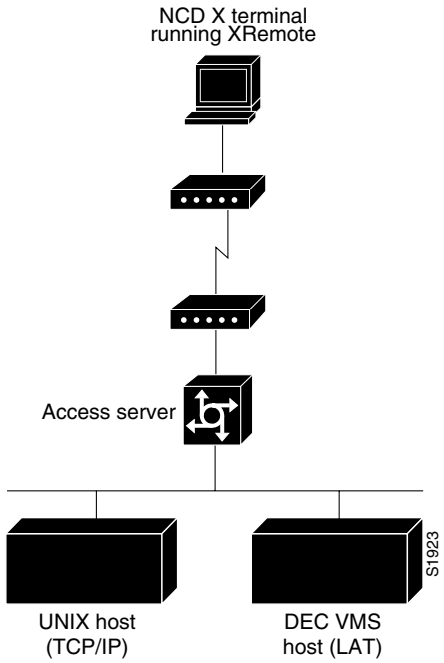
Figure 4 Remote Node Connection—Macintosh and PC Users Dialing In



- XRemote, the Network Control Device, Inc. (NCD) X Window Systems terminal protocol, which is described in the section "Configuring XRemote" in the "Configuring Dial-In Terminal Services" chapter in this publication.

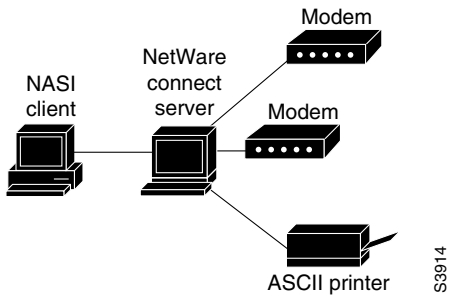
  Remote users with X terminals, such as NCD terminals, use the XRemote protocol over asynchronous lines. The router provides network functionality to remote X terminals. Figure 5 illustrates an XRemote connection.

Figure 5 XRemote Connection



- NetWare Access Server Interface (NASI) server, which is described in the chapter "Configuring Support for NASI Clients to Access Network Resources" in this publication. Configuring a NASI server enables NASI clients to connect to asynchronous resources attached to a router. NASI clients are connected to the Ethernet interface 0 on the router. When the user on the NASI client uses the Windows or DOS application to connect to the router, a list of available terminal and virtual terminal lines appears. The user selects the desired outgoing terminal and virtual terminal port. (See Figure 6.)

Figure 6 NASI Setup in a NetWare Environment



Terminal Services

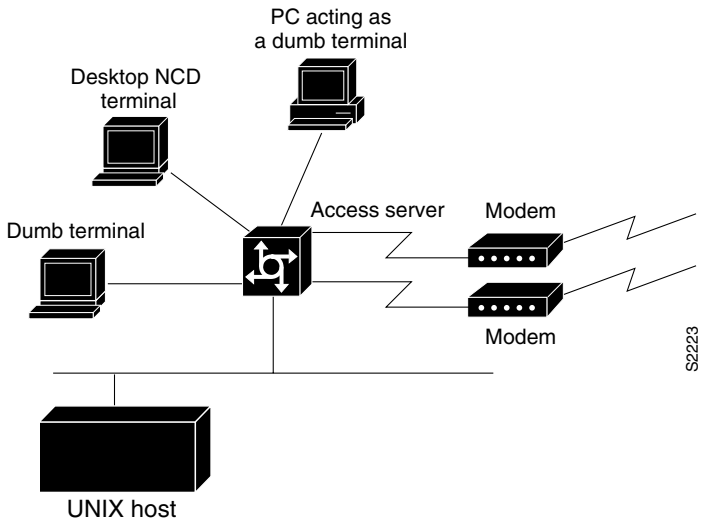
Terminal services permit asynchronous devices to be connected to a LAN or WAN through network and terminal-emulation software including Telnet, rlogin, NASI, the Digital local-area transport (LAT) protocol, and IBM TN3270. (See Figure 7.)

Access services permit terminals to connect with remote hosts using virtual terminal protocols including Telnet, NASI, LAT, TN3270, rlogin, and X.25 packet assembler/disassembler (PAD). You can use a router that supports access services to function as a terminal server to provide terminal access to devices on the network.

A host can also connect directly to an access server. In IBM environments, TN3270 allows a standard ASCII terminal to emulate a 3278 terminal and access an IBM host across an IP network.

In Digital environments, LAT support provides a terminal with connections to VMS hosts. X.25 PAD allows terminals to connect directly to an X.25 host over an X.25 network through the router. X.25 PAD eliminates the need for a separate PAD device. This connection requires use of one of the synchronous serial interfaces on the router supporting access services.

Figure 7 Terminal-to-Host Connectivity



Protocol Translation

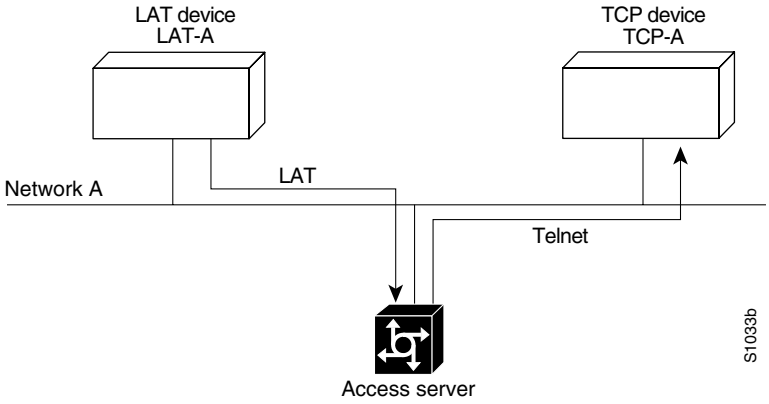
Protocol translation services are essentially an extension of terminal services. A user running a TCP/IP-based application can connect to a host running a different virtual terminal protocol, such as the Digital LAT protocol. The Cisco IOS software converts one virtual terminal protocol into another protocol. Protocol translation enables users to make connections to X.25 machines using X.25 PAD.

Routers translate virtual terminal protocols to allow communication between devices running different protocols. Protocol translation supports Telnet (TCP), LAT, and X.25. One-step protocol translation software performs bidirectional translation between any of the following protocols:

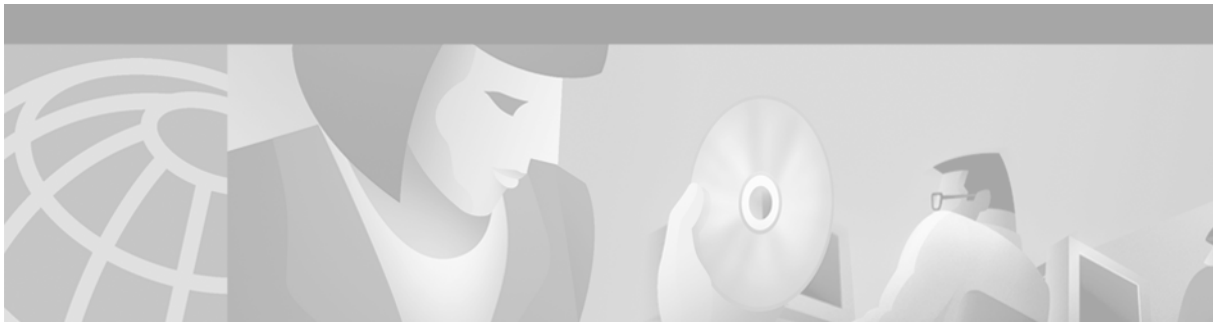
- X.25 and TCP
- X.25 and LAT
- LAT and TCP

Figure 8 illustrates LAT-to-TCP protocol translation.

Figure 8 LAT-to-TCP Protocol Translation



Connecting to IBM hosts from LAT, Telnet, rlogin, and X.25 PAD environments requires a two-step translation process. In other words, users must first establish a connection with the router, then use the TN3270 facility to make a connection to the IBM host.



Configuring Terminal Operating Characteristics for Dial-In Sessions

This chapter describes how to set operating characteristics for remote terminal service connections. It includes the following main sections:

- Terminal Operating Characteristics Overview
- Selecting a Preferred Connection Protocol
- Configuring Communication Parameters for Terminal Ports

For a complete description of the terminal characteristic commands in this chapter, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter.

Terminal Operating Characteristics Overview

In line configuration mode, you can set terminal operating characteristics that will be in operation for that line until the next time you change the line parameters. Alternatively, you can change the line setting locally (temporarily) with **terminal** EXEC commands. Both tasks are described in this chapter.

Selecting a Preferred Connection Protocol

Your first task is to select a preferred connection protocol, then configure the appropriate communication parameters. The preferred transport type is your preferred connection protocol. To configure the router to support specific protocols, perform the tasks described in the following sections:

- Specifying the Transport Protocol
- Specifying a Local Transport Protocol

Specifying the Transport Protocol

Use the **transport preferred** command to specify which transport protocol is used on connections. Use the **transport input** and **transport output** commands to explicitly specify the protocols allowed on individual lines for both incoming and outgoing connections.

Note Cisco routers do not accept incoming network connections to asynchronous ports (TTY lines) by default. You must specify an incoming transport protocol, or specify the **transport input all** command before the line will accept incoming connections. For example, if you are using your router as a terminal server to make console-port connections to routers or other devices, you will not be able to use Telnet to connect to these devices. You will receive the message "Connection Refused."

For routers that support the Digital local-area transport (LAT) protocol, the default protocol for outgoing connections is LAT. For those that do not support LAT, the default protocol for outgoing connections is Telnet. For incoming connections, all the supported network protocols are accepted (the default protocol is the **all** keyword).

To specify transport protocols, use one or more of the following commands in line configuration mode:

Command	Purpose
`Router(config-line)# transport input {all | lat | mop | nasi | none | pad | rlogin | ssh | telnet | v120}`	Defines which protocols can be used to connect to a specific line.
`Router(config-line)# transport output {all | lat | mop | nasi | none | pad | rlogin | telnet | v120}`	Determines the protocols that can be used for outgoing connections from a line.
`Router(config-line)# transport preferred {all | lat | mop | nasi | pad | rlogin | telnet | v120}`	Specifies the protocol for the router to use if the user did not specify a protocol.
`Router(config-line)# transport preferred none`	Prevents errant connection attempts.

The IOS software accepts a host name entry at the EXEC system prompt as a Telnet command. If you enter the host name incorrectly, the router interprets the entry as an incorrect Telnet command and provides an error message indicating that the host does not exist. The **transport preferred none** command disables this option so that if you enter a command incorrectly at the EXEC prompt, the software does not attempt to make a Telnet connection to a host that it cannot find.

The **transport preferred** command setting specifies a search order when attempting to resolve names that might be valid for multiple protocols. If the address or service does not match the preferred protocol, all other valid output protocols are searched to find a valid match.

Specifying a Local Transport Protocol

You can configure the Cisco IOS software to save local parameters between sessions. These local parameters are set with **terminal** EXEC commands.

To specify the preferred protocol to use for the current session when a command does not specify one, use the following command in EXEC mode:

Command	Purpose
`Router> terminal transport preferred {all | lat | mop | nasi | none | pad | rlogin | telnet | v120}`	Specifies the protocol for the Cisco IOS software to use for the current session if the user did not specify a protocol.

The preferred transport type is your preferred connection protocol. This setting specifies a protocol search order that the Cisco IOS software uses when it attempts to resolve a device name that you enter, but you do not specify a connection protocol. For example, if you want to connect to a TCP/IP host named host1 and want to use Telnet, you enter the **telnet host1** command. However, if your preferred connection protocol is set to Telnet, you could enter only the **host1** argument and be connected to the device. A host name might be valid for multiple protocols. If the address or service does not match the preferred protocol, all other valid connection protocols are searched to find a valid match for the name.

For router software images that support LAT, the default protocol for outgoing connections is LAT. For router software images that do not support LAT, the default protocol for outgoing connections is Telnet. For incoming connections, all the supported network protocols are accepted (the default protocol is the **all** keyword).

The Cisco IOS software accepts a host name entry at the EXEC prompt as a Telnet command. If you enter the host name incorrectly, the Cisco IOS software interprets the entry as an incorrect Telnet command and provides an error message indicating that the host does not exist. The **transport preferred none** command disables this option so that if you enter a command incorrectly at the EXEC prompt, the Cisco IOS software does not attempt to make a Telnet connection.

Configuring Communication Parameters for Terminal Ports

To configure communication parameters, perform the tasks described in the following sections:

- Configuring Sessions on a Line (Required)
- Configuring Local Session Parameters (As Required)
- Changing the Default Privilege Level for Lines (As Required)
- Enabling Password Checking at Login (As Required)
- Establishing Terminal Session Limits (As Required)
- Displaying Line Connection Information After the Login Prompt (As Required)

Configuring Sessions on a Line

The Cisco IOS software supplies the following default serial communication parameters for terminal and other serial device operation:

- 9600 bits per second (bps) line speed
- 8 data bits
- 2 stop bits
- No parity bit

To change the default parameters as necessary to meet the requirements of the terminal or host to which you are connected, use any of the following commands in line configuration mode:

Command	Purpose

`Router(config-line)# speed bps`
or
`Router(config-line)# txspeed bps`
or
`Router(config-line)# rxspeed bps`
	Sets the line speed. Choose from line speed, transmit speed, or receive speed.

`Router(config-line)# databits {5 | 6 | 7 | 8}`	Sets the data bits.
`Router(config-line)# stopbits {1 | 1.5 | 2}`	Sets the stop bits.
`Router(config-line)# parity {none | even | odd | space | mark}`	Sets the parity bit.

Configuring Local Session Parameters

To change these parameters as necessary to meet the requirements of the terminal or host to which you are attached, use the following commands in EXEC mode, as needed:

Command	Purpose

`Router> terminal speed bps`
or
`Router> terminal txspeed bps`
or
`Router> terminal rxspeed bps`
	Sets the line speed for the current session. Choose from line speed, transmit speed, or receive speed.

`Router> terminal databits {5 | 6 | 7 | 8}`	Sets the data bits for the current session.
`Router> terminal stopbits {1 | 1.5 | 2}`	Sets the stop bits for the current session.
`Router> terminal parity {none | even | odd | space | mark}`	Sets the parity bit for the current session.

Changing the Default Privilege Level for Lines

To change the default privilege level for a given line or a group of lines, use the following command in line configuration mode:

Command	Purpose
`Router(config-line)# privilege level level`	Specifies a default privilege level for a line.

Enabling Password Checking at Login

You can enable password checking on a particular line so that the user is prompted to enter a password at the system login screen. You must then also specify a password. To do so, use the following commands in line configuration mode:

	Command	Purpose
Step 1	`Router(config-line)# login`	Enables password checking on a per-line basis using the password specified with the **password** command.
Step 2	`Router(config-line)# password` *password*	Assigns a password to a particular line.

You can enable password checking on a per-user basis, in which case authentication is based on the username specified with the **username** global configuration command. To enable password checking on a per-user basis, use the following commands in line configuration mode:

	Command	Purpose
Step 1	`Router(config-line)# login local`	Enables password checking on a per-user basis using the username and password specified with the **username** global configuration command.
Step 2	`Router(config-line)# login tacacs` or `Router(config-line)# login authentication` {**default** | *list-name*}	Selects the TACACS style user ID and password-checking mechanism.

Use the **login tacacs** command with TACACS and extended TACACS. Use the **login authentication** command with AAA/TACACS+.

By default, virtual terminals require passwords. If you do not set a password for a virtual terminal, the router displays an error message and closes the attempted connection. Use the **no login** command to disable this function and allow connections without a password.

For other access control tasks and password restrictions, including the **enable password** global configuration command that restricts access to privileged mode, see the *Cisco IOS Security Configuration Guide*, Release 12.2.

Establishing Terminal Session Limits

You might need to control terminal sessions in high-traffic areas to provide resources for all users. You can define the following limitations for terminal sessions:

- The maximum number of sessions
- The idle session timeout interval or the absolute timeout interval

To establish terminal session limits, use the following commands in line configuration mode:

	Command	Purpose
Step 1	`Router(config-line)# session-limit` *session-number*	Sets the maximum number of simultaneous sessions.[1]
Step 2	`Router(config-line)# session-timeout` *minutes* [**output**] or `Router(config-line)# absolute-timeout` *minutes*	Sets the idle session timeout interval. Sets the absolute timeout interval.
Step 3	`Router(config-line)# logout-warning` [*seconds*]	Warns users of impending timeouts set with the **absolute-timeout** command.

1. There is no inherent upper limit to the number of sessions you can create.

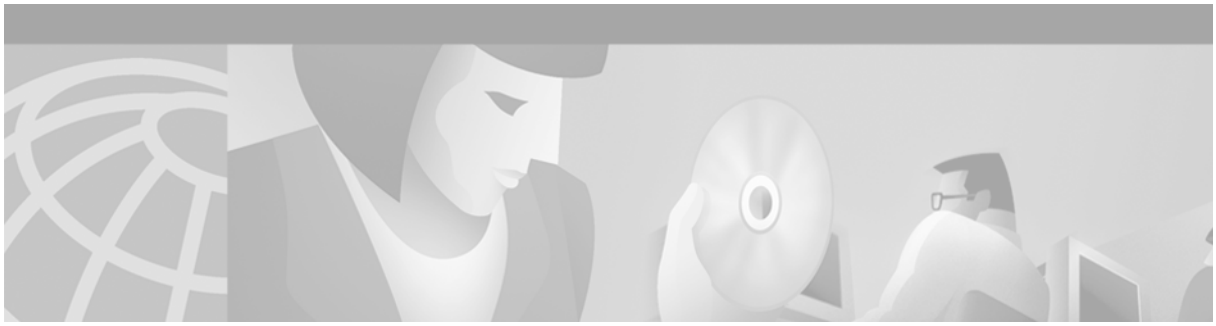
Note The **absolute-timeout** command overrides any timeouts set through the AppleTalk Remote Access (ARA) protocol.

Displaying Line Connection Information After the Login Prompt

You can display the host name, line number, and location of the host each time an EXEC session is started or an incoming connection is made. The line number banner appears immediately after the EXEC banner or incoming banner. This feature is useful for tracking problems with modems because it lists the host and line for the modem connection. Modem type information is also included if applicable.

To provide line information after the login prompt, use the following command in global configuration mode:

Command	Purpose
`Router(config)# service linenumber`	Provides service line number information after the EXEC banner or incoming banner.



Configuring Dial-In Terminal Services

This chapter describes how to configure support for asynchronous character stream calls running Telnet, rlogin, local-area transport (LAT), XRemote, or TN3270. It includes the following main sections:

For a complete description of the dial-in terminal services commands in this chapter, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

Dial-In Terminal Service Overview

Inbound asynchronous character stream calls are routed to virtual terminal lines and virtual asynchronous interfaces, which are used to terminate incoming character steams that do not share a physical connection with the access server or router (such as a physical interface). A virtual asynchronous interface is the place where inbound Telnet, LAT, V.120, TN3270, and packet assembler/disassembler (PAD) calls or sessions terminate on the router. Virtual terminal lines are used for attaching to the router in a nonphysical way.

Configuring support for terminal service connections means enabling network devices running the same protocol to connect across a LAN or WAN through network and terminal-emulation software.

The following sections describe how to configure these supported dial-in terminal services:

- Configuring Telnet and rlogin—Of all protocol suites, TCP/IP is the most widely implemented on networks of all media types. TCP/IP is the current standard for internetworking and is supported by most computer vendors, including all UNIX-based workstation manufacturers. TCP/IP includes Telnet and rlogin.
- Configuring LAT—The proprietary LAT terminal connection protocol from Digital Equipment Corporation used with Digital minicomputers.
- Configuring TN3270—IBM 3278 terminal emulation provides TN3270-based connectivity to IBM hosts over serial lines.
- Configuring XRemote—The X Window Systems terminal protocol from Network Control Devices, Inc., provides network functionality to remote X terminals.

Each section provides examples of how to configure and connect to a terminal service.

Configuring Telnet and rlogin

Telnet and rlogin are protocols that enable TCP/IP connections to a host. Telnet, a virtual terminal protocol that is part of the TCP/IP protocol suite, is the more widely used protocol. The rlogin protocol is a remote login service developed for the Berkeley Software Distribution (BSD) UNIX system. It provides better control and output suppression than Telnet, but can only be used when the host (typically, a UNIX system) supports rlogin. The Cisco IOS implementation of rlogin does not subscribe to the rlogin "trusted host" model. That is, a user cannot automatically log in to a UNIX system from the router, but must provide a user ID and a password for each connection.

Telnet allows a user at one site to establish a TCP connection to a login server at another site, then passes the keystrokes from one system to the other. Telnet can accept either an IP address or a domain name as the remote system address. In short, Telnet offers three main services:

- Network virtual terminal connection
- Option negotiation
- Symmetric connection

The Cisco implementation of Telnet supports the following Telnet options:

- Remote echo
- Binary transmission
- Suppress go ahead
- Timing mark
- Terminal type
- Send location
- Terminal speed
- Remote flow control
- X display location

Telnet and rlogin Configuration Task List

To configure Telnet and rlogin, perform the tasks in the following sections:

- Configuring Telnet and UNIX rlogin (Required for Service)
- Making Telnet and UNIX rlogin Connections (Required for Making Connections)
- Using UNIX Style Syntax for rlogin Connections (Optional)

The section "Monitoring TCP/IP Connections" later in this chapter provides tasks for maintaining TCP/IP connections.

Configuring Telnet and UNIX rlogin

To configure support for Telnet or rlogin calls, use the following commands beginning in line configuration mode.

Command	Purpose
`Router(config-line)# telnet speed default-speed maximum-speed`	Negotiates speeds on reverse Telnet lines.
`Router(config-line)# telnet refuse-negotiations`	Causes Telnet to refuse to negotiate full-duplex, remote echo requests on incoming connections.
`Router(config-line)# telnet transparent`	Sets line to send a RETURN (CR) as a CR followed by a NULL instead of a CR followed by a LINE FEED (LF).
`Router(config-line)# telnet sync-on-break`	Sets the line to send a Telnet SYNCHRONIZE signal when it receives a Telnet BREAK signal.
`Router(config-line)# telnet break-on-ip`	Sets the line to cause the system to generate a hardware BREAK signal on the EIA/TIA-232 line that is associated with a reverse Telnet connection when a Telnet Interrupt-Process command is received on that connection.
`Router(config)# ip tcp chunk-size number`	In global configuration mode, optimizes the line by setting the number of characters output before the interrupt executes.
`Router(config-if)# ip alias ip-address tcp-port`	In interface configuration mode, assigns an IP address to the service provided on a TCP port.
`Router(config)# busy-message hostname d message d`	In global configuration mode, defines a message that the router displays whenever a Telnet or rlogin connection to the specified host fails.
`Router(config)# login-string hostname d message [%secp] [%secw] [%b] d [%m] d`	In global configuration mode, defines a message that the router displays whenever a Telnet or rlogin connection to the specified host succeeds.
`Router(config-line)# notify`	Sets up a line to notify a user that has multiple, concurrent Telnet connections when output is pending on a connection other than the current one.
`Router(config-line)# refuse-message d message d`	Defines a "line-in-use" message to indicate that the line is currently busy.

The **telnet speed** command sets the line speed to match line speeds on remote systems in reverse Telnet, on host machines hooked up to an access server or router to access the network, or on a group of console lines hooked up to the access server or router when disparate line speeds are in use at the local and remote ends of the connection. Line speed negotiation adheres to the Remote Flow Control option, defined in RFC 1080.

The **telnet refuse-negotiations** command suppresses negotiation of the Telnet Remote Echo and Suppress Go Ahead options.

The **telnet transparent** command is useful for coping with different interpretations of end-of-line handling in the Telnet protocol specification.

The **telnet sync-on-break** command sets the line to cause a reverse Telnet line to send a Telnet SYNCHRONIZE signal when it receives a Telnet BREAK signal. The Telnet SYNCHRONIZE signal clears the data path, but the line still interprets incoming commands.

Enter the **telnet break-on-ip** command to control the translation of Telnet Interrupt-Process commands into X.25 BREAK indications, and to work around the following situations:

- Several user Telnet programs send a Telnet Interrupt-Process command, but cannot send a Telnet BREAK signal.
- Some Telnet programs implement a BREAK signal that sends a Telnet Interrupt-Process command.
- Some EIA/TIA-232 hardware devices use a hardware BREAK signal for various purposes.

When the **telnet break-on-ip** command is used with a correctly operating host, Cisco IOS software implements the Telnet SYNCHRONIZE and ABORT OUTPUT signals, which can stop output within one packet worth of data from the time the user types the interrupt character. Enter the **ip tcp chunk-size** command to configure a faster response to user interrupt characters. Changing the number of characters output, or chunk size, affects neither the size of the packet used nor the TCP window size, either of which would cause serious efficiency problems for the remote host and for the access server or router. Instead, the system software checks the Telnet status after the number of characters specified, causing only a relatively minor performance loss.

Use the **ip alias** command to configure connections to an IP address to act identically to connections made to the primary IP address of the server on the TCP port. A user trying to connect is connected to the first free line in a rotary group using the Telnet protocol.

With the **login-string** command options, you can set a pause, prevent a user from issuing commands during a pause, send a BREAK character, and use a percent sign (%) in the login string. The **busy-message** command and **login-string** command are only useful with two-step protocol translation sessions. For more information about protocol translation, see the chapter "Configuring Protocol Translation and Virtual Asynchronous Devices" in this publication.

For actual sample configurations on how to configure Telnet and rlogin, see the section "Telnet and rlogin Examples" later in this chapter.

Making Telnet and UNIX rlogin Connections

To provide Telnet and rlogin connection capabilities, use the following commands in EXEC mode:

	Command	Purpose

Step 1	`Router> connect host [port] [keyword]`
	or
	`Router> telnet host [port] [keyword]`
		Logs in to a host that supports Telnet. Refer to the descriptions for the **connect** and **telnet** commands in the *Cisco IOS Terminal Services Command Reference*, Release 12.2, for a list of supported keywords.[1]

Step 2	`Router> show hosts`	Displays a list of available hosts.
Step 3	`Router> show tcp`	Displays the status of all TCP connections.
Step 4	`Ctrl^`	Logs out of the host by entering the default escape sequence.[2]
Step 5	Choose from the following list of escape sequences, according to your task: Press **Ctrl^ b** if your task is to break. Press **Ctrl^ c** if your task is to interrupt a process (IP). Press **Ctrl^ h** if your task is to erase a character (EC). Press **Ctrl^ o** if your task is to abort an output display (AO). Press **Ctrl^ t** if your task is to confirm you are at the host. Press **Ctrl^ u** if your task is to erase a line (EL).	Logs out of the host by entering a special escape sequence.[2] These special Telnet sequences map generic terminal control functions to operating system-specific functions.
Step 6	`Ctrl^ ?`	Lists the available Telnet commands at any time during the active Telnet session.[2]

Step 7	`exit`
	or
	`logout`
		Exits a Telnet or rlogin session.

1. Cisco IOS software provides a robust collection of connection options. The options allow for enhanced sessions allowing, for example, encrypted sessions, Kerberos login, and File Transfer Protocol and World Wide Web connections. Additionally, it is possible to suppress system messages, including IP addresses and server names, displayed during session connection and disconnection. This function allows transparent TCP connections and can be useful when an asynchronous tunnel connection is being made.
2. Press and hold the **Ctrl** and **Shift** keys while pressing the **6** key. You can enter the command character as you hold down the **Ctrl** key or with **Ctrl** released; you can enter the command characters as either uppercase or lowercase letters.

With the Cisco IOS implementation of TCP/IP, you are not required to enter the **connect** or **telnet** commands to establish a Telnet connection. You can just enter the learned host name as long as the host name is different from a command word for the router. Telnet must be the default (you can make it the default with the **transport preferred** command). Use the **show hosts** EXEC command to display a list of the available hosts. Use the **show tcp** EXEC command to display the status of all TCP connections. The Cisco IOS software assigns a logical name to each connection, and several commands use these names to identify connections. The logical name is the same as the host name, unless that name is already in use or you change the connection name with the **name-connection** EXEC command. If the name is already in use, the Cisco IOS software assigns a null name to the connection. For an example of making a Telnet connection, see the section "Telnet and rlogin Examples" later in this chapter.

After you enter the **rlogin** command, you can have several concurrent rlogin connections open and switch between them. To open a new connection, exit the current connection by entering the escape sequence (**Ctrl-Shift-6** then **x** [**Ctrl^x**] by default) to return to the system command prompt, then open

a new connection. For an example of making an rlogin connection or switching between connections, see the sections "rlogin Connection Example" or "Switch Between Telnet and rlogin Sessions Example" later in this chapter.

Note We recommend that you use Encrypted Kerberized Telnet whenever you establish a Telnet session to a router or access server, which protects the integrity of the device. For information about Encrypted Kerberized Telnet, refer to the "Configuring Network Access Security" chapter in the *Cisco IOS Security Configuration Guide*, Release 12.2.

Using UNIX Style Syntax for rlogin Connections

The **rlogin** command supports the standard BSD UNIX **-l** option. Before this addition was introduced, the **rlogin** command allowed remote users to log in using the **/user** *username* option, which was not compatible with the standard UNIX **rlogin -l** *username* option.

This feature is supported on all of Cisco TCP/IP-enabled routers and access servers.

To set up this UNIX feature, use one of the following the following commands in EXEC mode:

Command	Purpose
Router# **rlogin** *hostname*	Enters the name of the host to which you are connecting.
Router# **rlogin** *hostname* [**-l** *hostname*] [**/user** *hostname*]	Enters the user name.
Router# **rlogin** *hostname* [**-l** *hostname*] [**/user** *hostname*] **debug**	(Optional) Enters the **debug** mode to troubleshoot the connection from the remote site to the host.
Router# **rlogin** *hostname* [**-l** *hostname*] [**/user** *hostname*] **/quiet**	(Optional) Enters the **/quiet** keyword to make a transparent connection from the remote site to the host.

When you are done with the UNIX session, use the **exit** command to end it.

Monitoring TCP/IP Connections

To display the status of a TCP connection or view a summary of the TCP connection endpoints in the system, use the following commands in user EXEC mode:

Command	Purpose
Router> **show tcp** [*line-number*]	Displays the status of a TCP connection.
Router> **show tcp brief** [**all**]	Displays a summary of the TCP connection endpoints in the system.

Telnet and rlogin Examples

This section provides the following examples:

Telnet Connection Example

The following example routes packets from the source system named host1 to kl.sri.com, then to 10.1.0.11, and finally back to host1:

```
Router> connect host1 /route:kl.sri.com 10.1.0.11 host1
```

The following example connects to a host with logical name host1:

```
Router> host1
```

Telnet Connection Without and With Messages Suppressed Example

The following examples show how to suppress the onscreen messages displayed during login and logout of a Telnet session.

The following example shows the messages displayed when a connection is made *without* using the optional **/quiet** keyword with the **telnet** EXEC command to suppress messages from the operating system:

```
Router# telnet Server3

Translating "Server3"...domain server (172.18.89.42) [OK]
Trying Server3--Server3.cisco.com (172.18.89.42)... Open
Kerberos:       No default realm defined for Kerberos!


login: User2
Password:
        Welcome to OpenVMS VAX version V6.1 on node CRAW
    Last interactive login on Tuesday, 15-DEC-1998 11:01
    Last non-interactive login on Sunday,  3-JAN-1999 22:32

Server3) logout
   User2        logged out at  16-FEB-2000 09:38:27.85
[Connection to Server3 closed by foreign host]
Router#
```

The following example shows the limited messages displayed when connection is made using the optional **/quiet** keyword:

```
Router# telnet Server3 /quiet

login: User2
Password:
```

```
        Welcome to OpenVMS VAX version V6.1 on node CRAW
     Last interactive login on Tuesday, 15-DEC-1998 11:01
     Last non-interactive login on Sunday,  3-JAN-1999 22:32

Server3) logout
    User2        logged out at  16-FEB-2000 09:38:27.85
Router#
```

The **/quiet** keyword is useful for making transparent connections during asynchronous tunnel connections. The keyword can be used with any of the EXEC connection commands—**connect**, **telnet**, and **rlogin**.

Note The Cisco IOS software offers the **ip telnet quiet** global configuration command, which also suppresses onscreen messages during Telnet connections. The **ip telnet quiet** command is set globally, and is useful to Internet service providers that want to permanently suppress onscreen system connection messages that often include information such as server names and IP addresses. Refer to the *Cisco IOS Dial Technologies Command Reference*, Release 12.2, for more information about the **ip telnet quiet** command.

rlogin Connection Example

The following example makes an rlogin connection to a host at address 172.31.21.2 and enables the message mode for debugging:

```
Router> rlogin 172.31.21.2 debug
```

rlogin UNIX-Style Syntax Example

The following example illustrates how a user named jsmith can use the **rlogin ?** help command and the debug mode to establish and troubleshoot a remote connection to the host named Alviso:

```
Router> rlogin ?
  WORD IP address or hostname of a remote system
Router> rlogin Alviso ?
  -l     Specify remote username
  /user  Specify remote username
  debug  Enable rlogin debugging output
  <cr>
Router> rlogin Alviso -l ?
  WORD  Remote user name
Router> rlogin Alviso -l jsmith ?
  debug  Enable rlogin debugging output
  <cr>
Router> rlogin Alviso -l jsmith debug
```

Switch Between Telnet and rlogin Sessions Example

You can switch between sessions by escaping one session and resuming a previously opened session. The following example shows how to escape out of a connection to the host named host1 and to resume connection 2. You escape out of the current session and return to the EXEC prompt by entering the command sequence **Ctrl-Shift-6** then **x**. Resume the connection with the **resume** command.

```
host1% ^^X
Router> resume 2
```

You can omit the command name and simply enter the connection number to resume that connection. The following example illustrates how to resume connection 3:

```
Router> 3
```

To list all the open sessions associated with the current terminal line, use the **where** command.

List Supported Telnet Commands Example

At any time during an active Telnet session, you can list the Telnet commands by pressing the escape sequence keys (by default Ctrl-Shift-6) followed by a question mark at the system prompt:

```
Ctrl-^ ?
```

A sample of this list follows:

```
Router> ^^?

[Special telnet escape help]
^^B  sends telnet BREAK
^^C  sends telnet IP
^^H  sends telnet EC
^^O  sends telnet AO
^^T  sends telnet AYT
^^U  sends telnet EL
```

Note In screen output examples that show two caret (^^) symbols together, the first caret represents the Ctrl key and the second caret represents the keystroke sequence Shift-6. The double caret combination (^^) means hold down the Ctrl key while you press the Shift and the 6 keys.

Using Cisco DialOut for Telnet Connections

The Cisco DialOut feature enables users on a workstation operating Windows to send faxes or connect to service provider services outside the LAN by using modems attached or internal to a network access server. The Cisco DialOut feature extends the functionality of Telnet by enabling users to control the activity of these modems from their desktop computers using standard communications software.

The Cisco DialOut feature has two components:

- Telnet Extensions for Dialout—Network access server component
- The DialOut Utility—Client/desktop component

Both components are required and neither can function as a stand-alone feature.

The Telnet Extensions for Dialout component uses reverse Telnet to access modems attached to the network access server. This component enables the network access server to interface with the client/desktop component of the Cisco DialOut feature and to return CARRIER DETECT signals to the communications software so that the software can determine when to start dialing a particular number.

Telnet extensions allow the communications software running on the desktop computer of the client to control modem settings such as baud rate, parity, bit size, and stop bits.

To enable this feature, you only need to configure the access server or router for reverse Telnet and configure the appropriate lines to send and receive calls.

The client/desktop component of Cisco DialOut feature must be installed on the client workstation before this feature can be used. For information about installing and using the client/desktop component of the Cisco Dial-Out feature, and configuring the access server, see the *DialOut Utility User Guide* Cisco publication at Cisco.com.

Configuring Stream TCP

Stream TCP connections, or raw TCP or TCP-Clear connections as they are sometimes called, are used to transport a stream of 8-bit characters as-is over an IP network, between a TCP client and TCP server system. This method is used to transport legacy asynchronous application data through an IP network, for example, with a Point-of-Sale (PoS) terminal connecting to an application server.

To establish a Stream TCP connection from an EXEC session, use the **/stream** keyword with the **telnet** command. You will also generally want to configure the line to provide for data transparency. See the following procedure for the steps to do this.

Stream TCP Autocommand Procedure

In the following procedure, a line is configured so that any connection into it is automatically connected using Stream TCP to the application server at the specified IP address and TCP port (IP address 10.1.2.3 and TCP port 4321 in the examples).

Step 1 Configure the line for data transparency using the following configuration as an example:

```
Router# configure terminal

Router(config)# line 33
Router(config-line)# no motd-banner
Router(config-line)# no exec-banner
Router(config-line)# no vacant-message
Router(config-line)# escape-character NONE
Router(config-line)# no hold-character
```

Step 2 Configure the autocommand:

```
Router(config-line)# autocommand telnet 10.1.2.3 4321 /quiet /stream
```

Step 3 Configure the **telnet-faststream** option (this is an optional step). On platforms that support this feature such as the Cisco AS5800 access servers, you may want to configure the **telnet-faststream autocommand** option to provide for Stream TCP performance enhancements. An example of how this option can be entered follows:

```
Router(config-line)# autocommand-options telnet-faststream
```

Configuring LAT

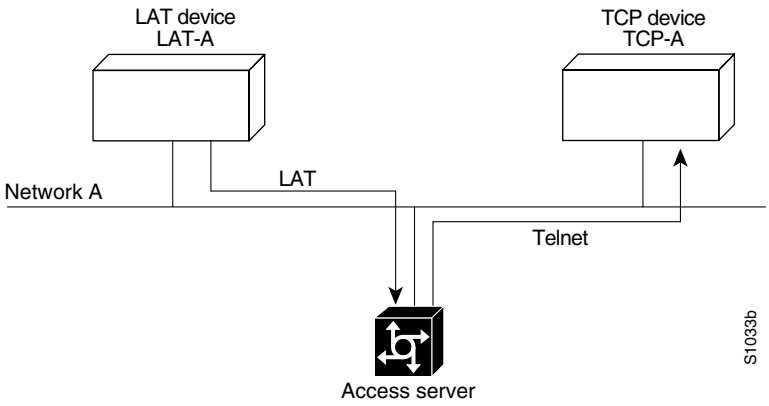
The LAT protocol is the one used most often to connect to Digital hosts. LAT is a Digital-proprietary protocol. Cisco provides LAT technology licensed from Digital. This section describes how to configure the LAT transmission protocol.

The LAT protocol allows a user to establish a LAT connection to a host at another site, then pass the keystrokes from one system to the other. A user can establish a LAT connection through a router to a LAT host simply by entering the host name. The Cisco IOS software supports the LAT 5.2 specification.

LAT Overview

Unlike TCP/IP, LAT was designed to be used on LANs and it cannot be routed because it does not have a routing layer. However, a bridge or combined bridge and router, such as a Cisco router, can be used to carry LAT traffic across a WAN. Protocol translation can be used to carry LAT traffic over a WAN by first translating LAT to X.25 or Telnet, as shown in Figure 9.

Figure 9 Comparing LAT and TCP/IP Protocol Stacks



The following sections describe the Cisco implementation of LAT in more detail:

- LAT Functionality
- LAT Services
- LAT Groups
- LAT Sessions and Connection Support
- Connecting a VMS Host Using LAT
- Port Names When Configuring a LAT Printer
- Additional LAT Capability

LAT Functionality

The LAT protocol is asymmetrical; it has master and slave functionality. First, the LAT master starts a LAT circuit by sending a circuit start message, and then a LAT slave responds with its own circuit start message. From 1 to 255 LAT sessions can then be multiplexed on a circuit.

In a typical setup, where the terminal of the user is connected to a router, the router acts as the master, and the target VMS host acts as the slave.

For example, the following command results in the device named router1 acting as the master (or server) and the target VMS host named wheel acting as the slave (or host).

```
router1> lat wheel
```

A router can also act as a slave when the user connects from one access server to another. For example, the following command results in router1 acting as the master (server) and router2 acting as the slave (host).

```
router1> lat router2
```

In a LAT host-initiated connection, the VMS system always acts as the LAT slave. For example, a print job originating from a VMS system initiates or triggers the router to which the printer is connected to act as the LAT master. In short, the master-slave relationship also applies to host-initiated sessions from a LAT slave.

LAT Services

Resources such as modems, computers, and application software are viewed in a LAT network as *services* that any user in the network can use. A LAT node can offer one or more such LAT services, and more than one LAT node can offer the same LAT service.

A LAT node that offers one or more services, collectively called *advertised services*, broadcasts its services in the form of Ethernet multicast messages, called LAT *service announcements*. Conversely, a LAT node can listen for LAT service announcements on the network. These messages are cached in a dynamic table of known LAT services, collectively called *learned services*.

The Cisco IOS software supports both learned and advertised LAT services; therefore, it also supports incoming and outgoing LAT sessions. The services rating of its advertised nodes is determined dynamically but can also be set statically.

To establish outgoing connections to a LAT service, the Cisco IOS software searches for the service in the learned services cache. If one or more nodes is offering the same service, the node with the highest rating is chosen. For example, a LAT connection to a service offered by a VAX cluster connects to the node in that cluster with the smallest load and thus the highest service rating. These connections are how load balancing works in relation to a group of nodes offering the same service.

To establish an incoming connection, a LAT session connects from another LAT node to the service advertised by the local LAT node.

LAT Groups

Because any user can access any of the services on a LAT network, a LAT server manager uses the concept of *group codes* to allow or restrict access to the services.

When both the router and the LAT host share a common group code, a connection can be established between the two. If the default group codes have not been changed on either side, a user on any router can connect to any learned service on the network.

However, if you define groups for access servers or routers and LAT hosts, you can partition these services into logical subnetworks. You can organize the groups so that users on one device view one set of services, and users on another device (or another line on the same device) view a different set. You might also design a plan that correlates group numbers with organizational groups, such as departments. The section "LAT Configuration Task List" later in this chapter describes how to enter group code lists in your configuration file.

The services of a LAT host node cannot be accessed individually; access is granted, per node, on an all-or-none basis.

LAT Sessions and Connection Support

A LAT session is a two-way logical connection between a LAT service and the router. The connection is transparent to the user at a console connected to a LAT session; to the user it appears that connection has been made directly to the desired device or application program. There is no inherent upper limit to the number of LAT sessions you can create from an asynchronous terminal to the router.

A host print job connected to a router is called a *host-initiated connection*. The Cisco IOS software maintains a queue of hosts requesting connection by sending periodic status messages to the requesting host.

You can establish host-initiated connections by specifying a port number or by defining a service. These same services are used for connections from other access servers or routers.

Note If a connection request is received that specifies a service and a destination port number, the port number is used to determine the line number for the connection. This function allows a user to connect to a specified port simply by specifying any service on the server and a port number. (Earlier versions of the Cisco IOS software ignored the service name on inbound connections.)

Connecting a VMS Host Using LAT

Connection to a VMS host is slightly different if you are connecting to a VMS host running VMS Version 5.4 or earlier than when connecting to a VMS host running VMS Version 5.5 or later software.

VMS Version 5.4 or Earlier System

If a host-initiated connection is received that specifies a destination port number that corresponds to a virtual port on the router, a virtual EXEC process will be created to allow the user to log in. This process can be used, in conjunction with the Digital **set host/dte** command on VMS, to connect to a router named router1 from a VMS host node, as shown in the following example:

```
$lcp :==$latcp
$lcp create port lta300:
$lcp set port lta300:/service=able /node=router1
$set host/dte lta300:
```

VMS Version 5.5 or Later System

To connect to a VMS host running VMS Version 5.5 or later software, you must turn on the outgoing connections of the VMS LAT hosts and use the Digital **set host/lat** command, as shown in the following example:

```
$lcp :== $latcp
$lcp set node/connection =outgoing
$set host/lat able
```

Port Names When Configuring a LAT Printer

When you configure a LAT printer, the LAT port name is the line number without a "TTY" designation on the **show lines** command output. For example, if you configure terminal line 10 (named ABLE) to be a LAT printer port, you must use the OpenVMS command to associate an arbitrary LAT device to the LAT port name, as follows:

```
$lcp :== $lcp
$lcp create port lta300:
$lcp set port/node=ABLE/port=10 lta300:
```

The LAT port name is the line number without the "TTY," regardless of whether the format of the TTY line number is decimal or octal.

Additional LAT Capability

The Cisco IOS software fully supports the LAT protocol suite, and provides the following features:

- High-speed buffering—Handles a full screen of data (2000 characters) at full speed without requiring additional flow control.
- Protocol transparency—Handles connections transparently. The user needs no protocol information to establish a connection.
- Simplified configuration management—Uses logical names for LAT group codes to simplify the network structure.
- Maintenance Operation Protocol (MOP)—Supports the Digital protocol to support the request ID message, periodic system ID messages, and the remote console carrier functions for Ethernet interfaces.

LAT Configuration Task List

The Cisco IOS software LAT protocol is supplied with a default configuration and does not require additional configuration for you to use it.

To enable LAT and customize LAT for your particular network environment, perform the tasks described in the following sections:

- Configuring Basic LAT Services (Required for Service)
- Enabling Inbound Services (As Required)
- Controlling Service Announcements and Service Solicitation (As Required)
- Configuring Traffic Timers (As Required)
- Optimizing Performance (As Required)
- Defining LAT Access Lists (As Required)
- Enabling Remote LAT Modification (As Required)
- Making LAT Connections (Required for Making Connections)

The section "Monitoring and Maintaining LAT Connections" later in this chapter provides tips for maintaining LAT connections. The section "LAT Configuration and Connection Examples" later in this chapter provides LAT configuration examples.

Configuring Basic LAT Services

To enable basic LAT services, use the following commands beginning in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# lat enabled`	Enables the LAT protocol. LAT is disabled by default.
Step 2	`Router(config-if)# lat node node-name`	Gives the router a LAT node name that is different than the host name.
Step 3	`Router(config-line)# lat out-group {groupname number | range | all}`	(Optional) Defines the group list for an outgoing connection on a specified line.
Step 4	`Router(config)# lat group-list groupname {number | range | all} [enabled | disabled]`	(Optional) Specifies logical names for group lists.
Step 5	`Router(config)# lat service-group {groupname | number | range | all} [enabled | disabled}`	(Optional) Specifies groups to be advertised.
Step 6	`Router(config-line)# lat remote-modification`	(Optional) Enables remote LAT modification of line characteristics.

Use the **lat out-group** command to define the list of services to which a user can connect. You create this list by defining the group code lists used for connections from specific lines. You can limit the connection choices for an individual line by defining the group code lists for an outgoing connection. When a user initiates a connection with a LAT host, the line of the user must share a common group number with the remote LAT host before a connection can be made.

Use the **lat group-list** command to specify a name for group lists to simplify the task of entering individual group codes. A name makes it easier to refer to a long list of group code numbers. To display the defined groups, use the **show lat groups** command.

Use the **lat service-group** command to specify a group code mask to use when advertising all services for a node. You can enter more than one group code by listing the numbers. You can also enter both a group code name and group codes.

Use the **lat remote-modification** line configuration command to configure a LAT line so that a remote LAT node can change the operating characteristics of the line.

Enabling Inbound Services

Just as LAT services are offered by host computers, they also can be offered by access servers and routers, because they implement both the host and server portions of the LAT protocol. This capability allows connections from either hosts or local access servers or routers. A host connected to a local device is called a *host-initiated connection*.

The tasks described in this section define support for host-initiated connections. This support includes refining the list of services that the router will support. An incoming session can be to either a port or a service. The port name is the terminal line number, as reported by the **show users all** EXEC command.

To enable inbound services, use the following commands in global configuration mode as needed:

Command	Purpose
`Router(config)# lat service service-name password password`	Sets the LAT password for a service.
`Router(config)# lat service service-name ident identification`	Sets the LAT service ID for a specific service.
`Router(config)# lat service service-name rating static-rating`	Specifies a static service rating for a specific service.
`Router(config)# lat service service-name rotary group`	Configures a LAT rotary group.
`Router(config)# lat service service-name autocommand command`	Associates a command with a specific service for auto-execution.
`Router(config)# lat service service-name enabled`	Enables inbound connections to a specific service.

Use the **show lat advertised** EXEC command to display LAT services offered to other systems on the network.

A service must be specifically enabled, but not all of the attributes in the previous task table are necessary in a particular environment.

Controlling Service Announcements and Service Solicitation

You can configure the Cisco IOS software to support the service responder feature that is part of the LAT Version 5.2 specification.

Specifically, the DECserver90L+, which has less memory than other Digital servers, does not maintain a cache of learned services. Instead, the DECserver90L+ solicits information about services as they are needed.

LAT Version 5.2 nodes can respond for themselves, but LAT Version 5.1 nodes, for example, VMS Version 5.4 or earlier nodes, cannot. Instead, a LAT Version 5.2 node configured as a service responder can respond in proxy for those LAT Version 5.1 nodes.

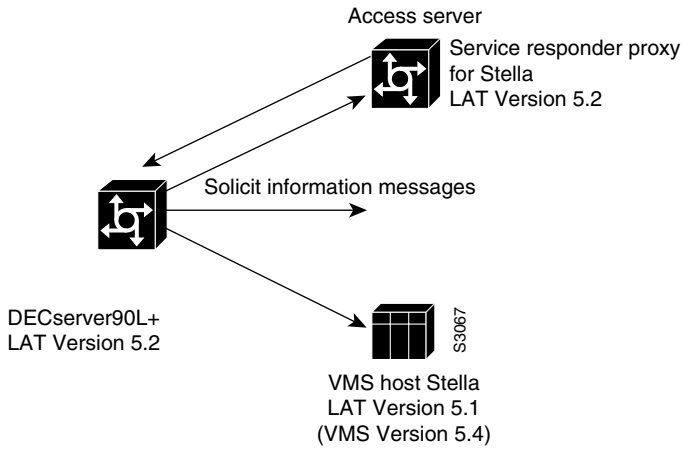
The Cisco IOS software can be configured as a LAT service responder. Of course, if all your nodes are LAT Version 5.2 nodes, you need not enable the service responder features.

To control service announcements and service solicitations, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# lat service-responder`	Enables a proxy node to respond to solicit-information multicast messages.
Step 2	`Router(config)# no lat service-announcements`	Disables periodic broadcasts of service advertisements.
Step 3	`Router(config)# lat service-timer interval`	Adjusts the time between service announcements.

Use the **lat service-responder** command to configure the Cisco IOS software to respond to solicit information requests addressed to LAT Version 5.1 nodes. This function allows nodes that do not cache service advertisements to interoperate with nodes that do not respond to solicit requests. Figure 10 shows how a router can act as a proxy for LAT servers.

Figure 10 Router as Proxy for LAT Server



The DECserver90L+ broadcasts a solicit information request in search of service for address Stella. The VMS host, Stella, is unable to respond to the request because it is running LAT Version 5.1. The access server is running LAT Version 5.2 with service responder enabled and informs the DECserver90L+ of the address for Stella.

Use the **no lat service-announcements** command to disable periodic broadcasts of service announcements. If service announcements are enabled, the LAT node will periodically broadcast service advertisements. If service announcements are disabled, the LAT node will not send service announcements, so a remote node requiring connection to the local node must use solicit-information messages to look up node information. Disable service announcements only if all of the nodes on the LAN support the service responder feature.

Use the **lat service-timer** command to adjust the time between LAT service advertisements for services offered. This command is useful in large networks with many LAT services and limited bandwidth.

Configuring Traffic Timers

You can customize the environment for sending LAT messages. The Cisco IOS implementation of LAT allows you to set the following features:

- The number of retransmissions before declaring a system unreachable
- The interval of time LAT waits before sending a keepalive message on an idle connection
- The interval of time LAT waits between transmission of messages

These features affect all LAT connection types.

To enable these features, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# lat retransmit-limit` *number*	Sets the message retransmit limit.
Step 2	`Router(config)# lat ka-timer` *seconds*	Sets the keepalive timer.
Step 3	`Router(config)# lat vc-timer` *milliseconds*	Sets the virtual circuit timer.

Optimizing Performance

To optimize performance for your LAT environment, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# lat vc-sessions number`	Sets the maximum number of sessions on a LAT virtual circuit. The maximum (and default) number of sessions is 255.
Step 2	`Router(config)# lat host-buffers receive-buffers`	Allows a LAT host node to receive more than one message at a time.
Step 3	`Router(config)# lat server-buffers receive-buffers`	Allows a LAT server node to receive more than one message at a time.
Step 4	`Router(config)# lat host-delay number`	Specifies the delay acknowledgment for incoming LAT slave connections, where *number* is milliseconds.

Use the **lat host-buffers** command to set the number of messages received by a host at one time. Increasing this number can enhance performance. Before LAT Version 5.2, LAT allowed only one outstanding message at one time on a virtual circuit. This restriction could limit the performance of the Cisco IOS software when it processed a large number of messages because only one Ethernet packet of data could be in transit at a time. During virtual circuit startup, each side communicates to the other how many outstanding messages it is willing to accept.

Use the **lat server-buffers** command to set the number of messages received by a server at one time. Increasing this number can enhance performance. Before LAT Version 5.2, LAT allowed only one outstanding message at one time on a virtual circuit. This restriction could limit the performance of Cisco IOS software when it processed a large number of messages because only one Ethernet packet of data could be in transit at a time. With LAT Version 5.2, nodes can indicate that they are willing to receive more than one message at a time. During virtual circuit startup, each side communicates to the other how many outstanding messages it is willing to accept.

Use the **lat host-delay** command to set a user-defined delay for the acknowledgment for incoming LAT slave connections. This command is useful in situations where you need to control the delay. For example, if data is being transferred between a Digital server (using LAT) and a UNIX host (using Telnet) via a protocol translator, the protocol translator imposes the LAT delay on the Telnet and the LAT service, where Telnet may time out due to the LAT restriction.

Defining LAT Access Lists

Because LAT groups were not intended to implement security or access control, the Cisco IOS software supports *access lists* to provide these functions. An access list is a sequential collection of permit and deny conditions that serve to restrict access to or from LAT nodes on a specific terminal line. Each access list statement defines a permit or deny condition and a matching criterion for the node name.

When a LAT connection is attempted (either incoming or outgoing), the node name of the destination service (*not* the service name) is compared against the regular expression. If they match, the connection is permitted or denied as specified.

To define access lists and conditions, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router# configure terminal`	Enters global configuration mode.
Step 2	`Router(config)# lat access-list` *number* {**permit** | **deny**} *node-name*	Specifies an access condition.
Step 3	`Router(config)# line` *line-number*	Enters line configuration mode.
Step 4	`Router(config-line)# access-class` *access-list-number* {**in** | **out**}	Restricts incoming and outgoing connections between a particular terminal line or group of lines and the node names in an access list.

Enabling Remote LAT Modification

You can configure a LAT line so that a remote LAT node can change the operating characteristics of the line. To enable remote LAT modification, use the following command in line configuration mode:

Command	Purpose
`Router(config-line)# lat remote-modification`	Enables remote LAT modification of line characteristics.

Making LAT Connections

The LAT protocol is most often used to connect routers to Digital hosts. LAT is a Digital-proprietary protocol, and the Cisco IOS software uses LAT technology licensed from Digital to allow the following LAT services:

- Make a LAT connection
- Define a group code list for outgoing LAT connections
- Switch between LAT sessions
- Use Digital commands on the server
- Exit a LAT session

For actual LAT connection examples, see the section "LAT Configuration and Connection Examples" later in this chapter.

To enable specific LAT connections or services, use the following commands in EXEC mode:

	Command	Purpose
Step 1	`Router> lat` *name* [**node** *node-name* | **port** *portname* | **/debug**]	Connects to a LAT host.[1]
Step 2	`Router> terminal lat out-group` {*groupname* | *number* | *range*}	(Optional) Defines a temporary list of services to which you or another user can connect by defining the group code lists used for connections from specific lines.

	Command	Purpose
Step 3	`Router> show lat services [service-name]`	(Optional) Lists available LAT services.
Step 4	`Router> help`	(Optional) Lists the subset of Digital commands that the Cisco IOS software supports.

1. You can quit the connection by pressing **Ctrl-C** or complete the connection by entering the password for a given service.

You can also set your preferred connection protocol to any available connection protocol supported in the Cisco IOS software. Your preferred connection protocol is also referred to in the Cisco IOS software as a "preferred transport type." If your preferred connection protocol is set to **lat**, you can use the **connect** command in place of the **lat** command. To configure a preferred connection protocol, use the **transport preferred** command. When your preferred connection protocol is set to **none** or to another protocol, you must use the **lat** command to connect to a LAT host.

To specify a temporary list of services to which you or another user can connect, you must define the group code lists used for connections from specific lines. You limit the connection choices for an individual line by defining the group code lists for an outgoing connection. To define a group code list, use the **terminal lat out-group** command. When a user initiates a connection with a LAT host, the line of the user must share a common group number with the remote LAT host before a connection can be made. The group code range *must be* a subset of the configured group code range of the line.

You can have several concurrent LAT sessions open and switch between them. To open a subsequent session, first enter the escape sequence (Ctrl-Shift-6 then x [Ctrl^x] by default) to suspend the current session. Then open a new session. To list the available LAT services, enter the **show lat services** EXEC command.

When you are done with the LAT session, use the **exit** command to end it, then terminate the active LAT session by entering the Ctrl-C key sequence.

Monitoring and Maintaining LAT Connections

To monitor and maintain LAT connections, use the following commands in EXEC mode as needed:

Command	Purpose
`Router> clear entry number`	Deletes an entry from the queue.
`Router> show entry`	Displays queued host-initiated connections.
`Router> show lat advertised`	Displays LAT services offered to other LAT systems.
`Router> show lat groups`	Displays defined LAT groups.
`Router> show lat nodes`	Displays information about LAT nodes.
`Router> show lat services [service-name]`	Displays information about LAT learned services.
`Router> show lat sessions [line-number]`	Displays active LAT sessions.
`Router> show lat traffic`	Displays traffic and resource utilization statistics.

Command	Purpose
Router> **show node** [**all** | *node-name*] [**counters** | **status** | **summary**]	Displays information about LAT nodes. Information is displayed in the same way as in the Digital interface.
Router> **show service** [*service-name*]	Displays LAT learned services.

LAT Configuration and Connection Examples

This section provides the following LAT examples:

- Basic LAT Service Example
- LAT Service with Selected Group Codes Example
- Displaying LAT Services on the Same LAN Example
- Establishing an Outbound LAT Session Example
- Logically Partitioning LAT Services by Terminal Line Example
- LAT Rotary Groups Example
- Associating a Rotary Group with a Service Example
- LAT Access List Example
- LAT Connection Examples

Basic LAT Service Example

The following example establishes the LAT service named ABLE for your router. Subsequently, your router advertises ABLE (with default group code 0) on the LAN. Other LAT nodes can connect to you using LAT service ABLE, provided the group codes on the LAT nodes and the group codes for ABLE intersect. By default, most LAT nodes, such as OpenVMS Version 5.5 hosts, have user group code set to 0, so you have default access to ABLE.

```
! Create LAT service with password protection and
! identification string using the following global configuration commands.
 lat service ABLE password secret
 lat service ABLE ident Welcome to my machine
```

LAT Service with Selected Group Codes Example

The following example establishes the LAT service named ABLE from your router with selected group codes 1, 4 through 7, and 167. This configuration limits inbound access to those LAT nodes that have group codes that intersect with those for LAT service ABLE.

```
! Establish a LAT group list.
 lat group-list HUBS 1 4-7 167
!
! Enable LAT group list for the service-group.
 lat service-group HUBS enabled
!
```

```
! Create LAT service with password protection and
! identification string.
 lat service ABLE password secret
 lat service ABLE ident Welcome to my machine
```

Displaying LAT Services on the Same LAN Example

The following example demonstrates how you can check which LAT services are on the same LAN as your router. Note that the LAT service named ABLE is also listed, with the "Interface" column listing the interface as "Local."

```
Router> show lat services

Service Name      Rating    Interface     Node (Address)
CAD                16       Ethernet0     WANDER
ABLE               16       Local
CERTIFY            33       Ethernet0     STELLA
```

Establishing an Outbound LAT Session Example

The following example establishes a LAT session to remote LAT service HELLO using an interactive session:

```
Router> lat HELLO
```

Logically Partitioning LAT Services by Terminal Line Example

The following example illustrates how LAT services are logically partitioned by terminal line. At the example site, lines 1 through 7 go to the shop floor, lines 8 through 11 go to the Quality Assurance department, and lines 12 through 16 go to a common area.

```
! Define LAT groupnames.
 lat group-list DEFAULT 0
 lat group-list FLOOR 3
 lat group-list QA 4

line 1 7
 lat out-group FLOOR enabled
 lat out-group DEFAULT disabled
line 8 11
 lat out-group QA enabled
 lat out-group DEFAULT disabled
 line 12 16
lat out-group DEFAULT QA FLOOR enabled
```

LAT Rotary Groups Example

The following example illustrates how to configure a range of lines for rotary connections and then establishes the LAT service named Modems for rotary connection:

```
! Establish rotary groups.
line 3 7
 rotary 1
!
! Establish modem rotary service.
```

```
!
 lat service Modems rotary 1
 lat service Modems enabled
```

Associating a Rotary Group with a Service Example

The following example defines a service that communicates with a specific line and defines a rotary with only that line specified. You can establish rotary groups using line configuration commands and the **rotary** line configuration command.

```
hostname ciscots
! Service name for the access server as a whole.
lat service ciscopt enable
! Set up some lines with unique service names.
line 1
 rotary 1
 lat service ciscopt1 rotary 1
 lat service ciscopt1 enable
!
line 2
 rotary 2
 lat service ciscopt2 rotary 2
 lat service ciscopt2 enable
```

LAT Access List Example

The following example illustrates incoming permit conditions for all IP hosts and LAT nodes with specific characters in their names and a deny condition for X.25 connections to a printer. Outgoing connections, however, are less restricted.

```
! Permit all IP hosts, LAT nodes beginning with "VMS" and no X.25
! connections to the printer on line 5.
!
access-list 1 permit 0.0.0.0 255.255.255.255
lat access-list 1 permit ^VMS.*
x29 access-list 1 deny .*
!
line 5
 access-class 1 in
!
! Meanwhile, permit outgoing connections to various places on all the
! other lines.
!
! Permit IP access within cisco.
access-list 2 permit 172.30.0.0 0.0.255.255
!
! Permit LAT access to the Stella/blue complexes.
lat access-list 2 permit ^STELLA$
lat access-list 2 permit ^BLUE$
!
! Permit X25 connections to infonet hosts only.
x29 access-list 2 permit ^31370
!
line 0 99
 access-class 2 out
```

The following example illustrates how to define access lists that permit all connections, thereby conforming to software behavior prior to Cisco IOS Release 9.0. Remember that the value supplied for the *list* argument in both variations of the **access-class** commands is used for *all* protocols supported by

the Cisco IOS software. If you are already using an IP access list, it will be necessary to define LAT (and possibly X.25) access lists permitting connections to all devices, to emulate the behavior of earlier software versions.

```
access-list 1 permit 172.30.0.0 0.0.255.255
access-list 1 permit 172.30.0.0 0.0.255.255
!
line 1 40
 access-class 1 out
! Define LAT access list that permits all connections.
 lat access-list 1 permit .*
```

LAT Connection Examples

The following example establishes a LAT connection from the router named router to host eng2:

```
Router> lat eng2
Trying ENG2...Open
         ENG2 - VAX/VMS V5.2
Username: JSmith
Password: <password>
    Welcome to VAX/VMS version V5.2 on node ENG2
    Last interactive login on Friday,  1-APR-1994 19:46
```

The system informs you of its progress by displaying the messages "Trying <system>..." and then "Open." If the connection attempt is not successful, you receive a failure message.

The following example establishes a LAT connection from the router named router to our-modems and specifies port 24, which is a special modem:

```
Router> lat our-modems port 24
```

The following example establishes a LAT connection from the router named router to our-modems and specifies a node named eng:

```
Router> lat our-modems node eng
```

The following example uses the LAT session debugging capability:

```
Router> lat Eng2 /debug
Trying ENG2...Open
        ENG2 - VAX/VMS V5.2
Username: JSmith
Password: <password>
    Welcome to VAX/VMS version V5.2 on node ENG2
    Last interactive login on Tuesday, 5-APR-1994 19:02
[Set Flow out off, Flow in on, Format 8:none, Speed 9600/9600]
[Set Flow out off, Flow in on, Format 8:none, Speed 9600/9600]
$ set ter/speed=2400
[Set Flow out off, Flow in on, Format 8:none, Speed 2400/2400]
```

A variety of LAT events are reported, including all requests by the remote system to set local line parameters. The messages within brackets ([ ]) are the messages produced by the remote system setting the line characteristics as the operating system defaults.

The following example defines a group code list for the outgoing group 4 LAT connection:

```
Router> terminal lat out-group 4, 6-189
```

Configuring TN3270

IBM 3270 display terminals are among the most widely implemented and emulated terminals for host-based computing in the computing community. Information in this section describes the TN3270 terminal emulation environment and how to use and create files that allow terminals connected to the access server or router to be used for TN3270 operation.

This section does not describe how to configure a TN3270 server. For information about configuring TN3270 server support in the Cisco IOS software, see the *Cisco IOS Bridging and IBM Networking Configuration Guide*, Release 12.2. The following sections are included:

TN3270 Overview

TN3270 terminal emulation software allows any terminal to be used as an IBM 3270-type terminal. Users with non-3270 terminals can take advantage of the emulation capabilities to perform the functions of an IBM 3270-type terminal. The Cisco IOS software supports emulation of the following terminal types:

- IBM 3278-2 terminal with an 80-by-24 display
- IBM 3278-2 terminal with a 24-by-80 display
- IBM 3278-3 terminal with a 32-by-80 display
- IBM 3278-4 terminal with a 48-by-80 display
- IBM 3278-5 terminal with a 27-by-132 display

True IBM 3270-type terminals use a character format referred to as Extended Binary Coded Decimal Interchange Code (EBCDIC). EBCDIC consists of 8-bit coded characters and was originally developed by IBM. Emulation is made possible by the termcap protocol. Termcap functions translate the keyboard and terminal characteristics for ASCII-type terminals into those required for an IBM host.

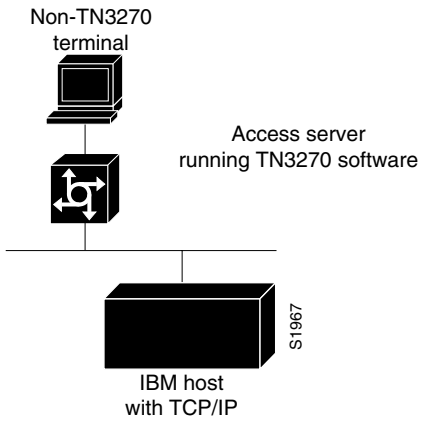
Formally, a termcap is a two-part terminal-handling mechanism. It consists of a database and a subroutine library. The database describes the capabilities of each supported terminal, and the subroutine library allows programs to query the database and to make use of the values it contains. For more information about defining termcaps, refer to the commercially available book *termcap & terminfo*, by Jim Strang, Tim O'Reilly, and Linda Mui.

The Cisco IOS software includes a default termcap entry for Digital VT100 terminal emulation. More samples are available directly from Cisco at http://www.cisco.com/warp/public/494/1.html. This URL is subject to change without notice.

TN3270 emulation capability allows users to access an IBM host without using a special IBM server or a UNIX host acting as a server. (See Figure 11.) The IBM host must directly support TCP/IP or have a front-end processor that supports TCP/IP.

A two-step translation method connects IBM hosts from LAT, TCP, and X.25/PAD environments. (See the chapter "Configuring Protocol Translation and Virtual Asynchronous Devices" later in this publication for more information about two-step translations.) In general, TN3270 support allows outgoing TN3270 connections only. In other words, LAT, TCP, and X.25/PAD users must first establish a connection with the access server or router, then use the TN3270 facility from the Cisco IOS software to make a connection to the IBM host.

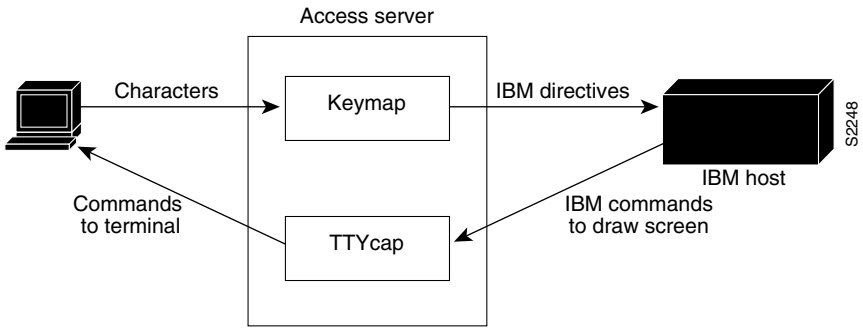
Figure 11 Typical TN3270 Connection Environment



Keymaps and ttycaps

Figure 12 shows how the keymapping and TTYcap functionality in the Cisco IOS software allows IBM hosts and non-IBM terminals to communicate.

Figure 12 Keymaps and TTYcaps



Keymaps and TTYcaps have the following functionality:

- Keymap—Keyboard map file. Terminals send a key sequence for every key used to send packets to an IBM host. The keymapping function in the Cisco IOS software identifies special sequences and converts them to directives to the IBM host. A minimal level of keymapping is supported by default. Several keys can convert to the same IBM directives.
- TTYcap—Terminal emulation file. IBM devices and software send commands to the terminal, including cursor position, clear screen, and so on. The TTYcap functionality in the Cisco IOS software changes IBM directives into the terminal language. By default, protocol translation on access servers and routers conforms to the American National Standards Institute (ANSI) terminal standard, which is VT*xxx* terminal compatible.

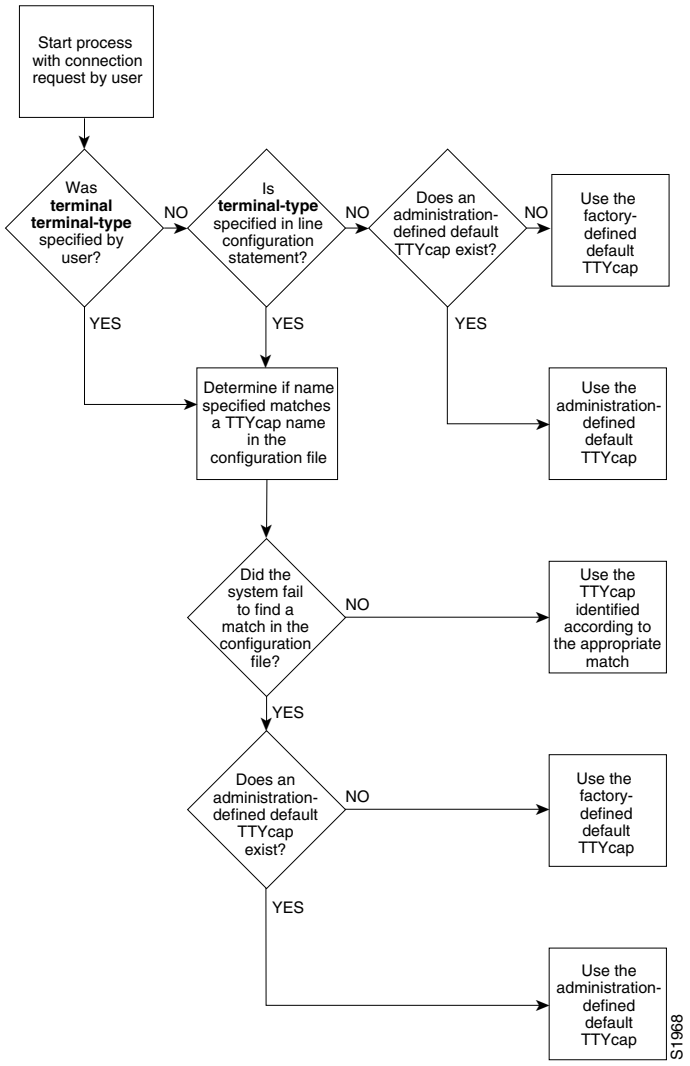
Startup Sequence Priorities

At system startup, the Cisco IOS software uses the following decision sequence when selecting a TTYcap:

1. Use a user-supplied terminal emulation filename.
2. Use a terminal emulation filename specified using line configuration commands.
3. Use a default terminal emulation filename supplied by the administrator.
4. Use the default VT100 emulation.

Figure 13 illustrates the decision process used by the Cisco IOS software to choose a TTYcap for a specific TN3270 session.

Figure 13 Decision Diagram for Cisco IOS Software TTYcap Selection Process



At system startup, the Cisco IOS software uses the following decision sequence when selecting a keymap:

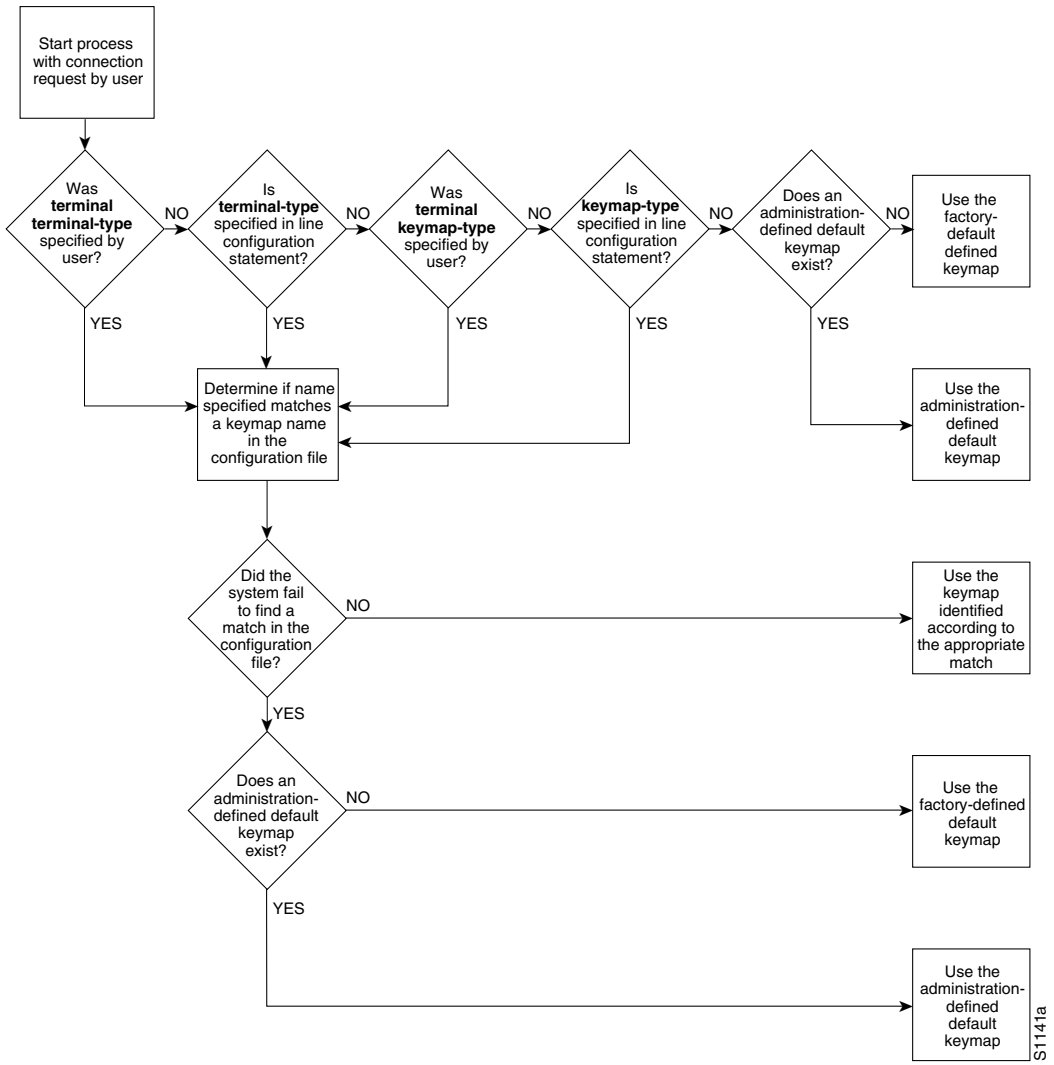
1. Use a user-supplied keyboard map filename.
2. Use a keyboard map filename specified using line configuration commands.
3. Use a user-supplied terminal emulation filename.
4. Use a terminal emulation filename specified using line configuration commands.
5. Use the default keyboard map filename supplied by the administrator.
6. Use the default VT100 emulation.

The software uses the following criteria to determine the file to use:

- If a filename is specified by the user but fails to match any name in the configuration file, the access server or router adopts the default specified by the administrator. If one has not been specifically defined, the factory-default emulation file is adopted.
- If a filename is specified for line configuration that does not match any name in the configuration file, the access server or router adopts the default specified by the administrator. If one has not been specifically defined, the factory-default VT100 emulation file is used.

Figure 14 illustrates the decision process used by the Cisco IOS software to choose a keymap for a specific TN3270 session. When one of the first four priority checks fails (that is, the name specified does not match any name in the configuration file), the same rules listed for the terminal emulation file apply.

Figure 14 Decision Diagram for Cisco IOS Software Keymap Selection Process



Using the Default Terminal Emulation File to Connect

By default, an ASCII terminal and keyboard connected to the Cisco device emulate a Digital VT100 terminal type.

To connect to an IBM host, enter the **tn3270** command from EXEC mode. This command will make the connection using the terminal emulation file selected using the startup sequence priorities outlined in "Startup Sequence Priorities" earlier in this section.

Refer to the "Configuring TN3270 Connections" section later in this document for more information about making connections.

Copying a Sample Terminal Emulation File

If the default file does not work for your terminal and keyboard type or the host that you connect to, you might be able to find a usable file from the growing list of sample terminal emulation files created by Cisco engineers and customers. You can obtain the TN3270 examples from Cisco.com. Numerous emulation files are listed in the examples, which allow various terminal types to emulate an IBM 3270-type terminal.

To obtain these sample configuration files, perform the following steps:

Step 1 Obtain a sample configuration file from the following URL. The *TN3270 Keymap Examples* document appears. Note that this URL is subject to change without notice.

```
http://www.cisco.com/warp/public/494/1.html

TN3270 Keymap Examples
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
! TN3270 examples file
! For use with the TN3270 on the cisco terminal server
! If you have requests for additions, contact tac@cisco.com
! If you have contributions, send them to remaker@cisco.com
!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
! Example of a ttycap for a televideo 925
! Taken from standard TTYCAP from BSD Unix
!
ttycap televideo \
v8|vi|tvi925|925|televideo model 925:\
        :hs:am:bs:co#80:li#24:cm=\E=%+ %+ :cl=\E*:cd=\Ey:ce=\Et:\

:al=\EE:dl=\ER:im=:ei=:ic=\EQ:dc=\EW:mr=\EG4:mk=\EG1:md=\EG4:me=\EG0:\
        :ho=^^:nd=^L:bt=\EI:pt:so=\EG4:se=\EG0:sg#1:us=\EG8:ue=\EG0:ug#1:\
        :up=^K:do=^V:kb=^H:ku=^K:kd=^V:kl=^H:kr=^L:kh=^^:ma=^V^J^L :\
        :k1=^A@\r:k2=^AA\r:k3=^AB\r:k4=^AC\r:k5=^AD\r:k6=^AE\r:k7=^AF\r:\
        :k8=^AG\r:k9=^AH\r:k0=^AI\r:ko=ic,dc,al,dl,cl,ce,cd,bt:\
        :ts=\Ef:fs=\Eg:ds=\Eh:sr=\Ej:xn:ti=\EG0:to=\EG0:\
        :is=\El\E"^M\E3^M        \E1        \E1        \E1        \E1
\E1        \E1        \E1        \E1        \E1^M
!
! Example of a keymap for a 925
! Borrowed from MAP3270 of the BSD TN3270
!
...
```

Step 2 Use a text editor or word processing application to copy the sample terminal emulation file into the configuration file.

Step 3 Load the configuration file onto the host or network. (Refer to the chapter "Loading System Images and Configuration Files" in the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2, for information on loading configuration files.)

This procedure adds new terminal emulation capability to the configuration file. Each time the system is started up, or booted, the settings in the file will be used as the default for terminal emulation.

TN3270 Configuration Task List

To configure TN3270, perform the tasks in the following sections:

- Configuring TN3270 Connections (Required for Service)
- Mapping TN3270 Characters (As Required)
- Starting TN3270 Sessions (Required for Making Connections)

The section "TN3270 Configuration and Connection Examples" later in this chapter provides examples of making TN3270 connections.

Configuring TN3270 Connections

The tasks in this section indicate how to create TTYcap and keymap files, and configure your lines for a TN3270 connection.

To create a TTYcap and keymap file, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ttycap ttycap-name termcap-entry`	Creates a custom terminal emulation file, or TTYcap.
Step 2	`Router(config)# keymap keymap-name keymap-entry`	Creates a custom keyboard emulation file, or keymap.

To configure your line for the TN3270 connection, use the following commands in line configuration mode:

	Command	Purpose
Step 1	`Router(config-line)# terminal-type terminal-name`	Specifies the type of terminal connected to the line.
Step 2	`Router(config-line)# keymap-type keymap-name`	Specifies the keyboard map for a terminal connected to the line.

To customize the TN3270 connection environment, use the following commands in global configuration mode. (These tasks are optional).

	Command	Purpose
Step 3	`Router(config)# tn3270 datastream {extended | normal}`	Enables TN3270 extended features.
Step 4	`Router(config)# tn3270 null-processing [3270 | 7171]`	Enables null processing.
Step 5	`Router(config)# tn3270 reset-required`	Specifies a reset whenever a 3278-x terminal keyboard locks up.

To use a custom emulation file, you must load the emulation settings into the system configuration file. This step establishes the settings in the file as the terminal and keyboard defaults and provides several ways in which the emulation settings can be used within the system, as follows:

- You can provide default settings for all terminals in the network or terminals on a specific host.
- You can set up your system to boot, or load, a specific configuration file using configuration commands described in the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2.
- You can temporarily override default settings using terminal EXEC commands.
- Load in the files by using the local **terminal terminal-type** and **terminal keyboard-type** EXEC command*s*.
- You can configure line-specific emulation types for terminal negotiations with a remote host.

If you intend to use an alternate TTYcap and keymap, you must assign the following two characteristics:

- Terminal type
- Keymap type

The terminal and keymap type information is used by the Cisco IOS software when negotiating connections with hosts. Use the **terminal-type** and **keymap-type** line configuration commands to assign TTYcap and keymap line characters. You must assign the terminal and keyboard type to the line if you intend to use alternate TTYcap and keymap files.

Use the **tn3270 datastream** command to cause an "-E" to be appended to the terminal type string sent to the IBM host. This command allows you to use the extended TN3270 features.

If a user enters data, uses an arrow key to move the cursor to the right on the screen, and then enters more data, the intervening spaces are filled in with nulls. To specify how nulls are handled, enter the **tn3270 null-processing** command either with the argument **3270**, where nulls are compressed out of the string (as on a real 3278-x terminal), or use the **7171** argument, where nulls are converted to spaces as on a 7171 controller.

On a 3278-x terminal, the keyboard is locked and further input is not permitted after an input error (due to field overflow, invalid entry, and so on), until the user presses the RESET key. Most TN3270 implementations leave the keyboard unlocked and remove any error message on the next key input after the error. Use the **tn3270 reset-required** command to enable a reset in these situations.

Mapping TN3270 Characters

To control the mapping of EBCDIC and ASCII characters, use the following commands in the modes indicated, as needed:

Command	Purpose
`Router(config)# tn3270 character-map ebcdic-in-hex ascii-in-hex`	In global configuration mode, creates character mappings by configuring a two-way binding between EBCDIC and ASCII characters.
`Router(config)# no tn3270 character-map {all | ebcdic-in-hex} [ascii-in-hex]`	In global configuration mode, resets character mappings to their default settings.
`Router> show tn3270 character-map {all | ebcdic-in-hex}`	In EXEC mode, displays character mappings.
`Router> show tn3270 ascii-hexval`	In EXEC mode, displays the hexadecimal value of an ASCII character.[1]

Command	Purpose
`Router(config-line)# tn3270 8bit display`	In line configuration mode, temporarily configures the Cisco IOS software to use the 8-bit mask.
`Router(config-line)# tn3270 8bit transparent-mode`	In line configuration mode, temporarily configures the Cisco IOS software to use the 8-bit mask if you use a file-transfer protocol such as Kermit in 8-bit mode.

1. After you enter the **show tn3270 ascii-hexval** command, enter the ASCII character whose hexadecimal value you want to display.

When you create character mappings between extended EBCDIC or extended ASCII characters, you must configure the Cisco IOS software for the correct data character bit length. The default mask used for TN3270 connections is a 7-bit mask. In certain situations, you must use an 8-bit display. When an 8-bit mask has been set by the **data-character-bits** {**7** | **8**} line configuration command or the **terminal data-character-bits** {**7** | **8**} EXEC command, you can temporarily configure the software to use the 8-bit mask by entering the **tn3270 8bit display** line configuration command.

When you use a file-transfer protocol such as Kermit in 8-bit mode or you use 8-bit graphics, which rely on transparent mode, use the **tn3270 8bit transparent-mode** line configuration command to configure the software for the 8-bit mask.

Starting TN3270 Sessions

You use TN3270 terminal emulation to connect to an IBM 3278-type host. Your system administrator must configure a default terminal emulation file that permits the terminal to communicate with the host. How to specify alternate terminal emulations is described in the section "Configuring TN3270 Connections" earlier in this chapter.

Unlike with Telnet and LAT connections, you *must* enter the **tn3270** command to make a connection to an IBM 3278-type host. To start a TN3270 session, use the following command in EXEC mode:

Command	Purpose
`Router> tn3270 host`	Begins a TN3270 session.

To terminate an active TN3270 session, enter the escape sequence (Ctrl-Shift-6 then x [Ctrl^x] by default) and enter the **disconnect** command at the EXEC prompt. You can also log out of the remote system by issuing the command specific to that system (such as **exit**, **logout**, **quit**, **close**, or **disconnect**). For an example of making TN3270 connections, see the next section, "TN3270 Configuration and Connection Examples."

TN3270 Configuration and Connection Examples

This section provides the following examples to help you define custom terminal and keyboard emulation files, and to configure your system to use those files:

- Custom Terminal Emulation File Example
- Custom Keyboard Emulation File Example
- Line Specification for a Custom Emulation Example

Custom Terminal Emulation File Example

The following example allows a Televideo 925 terminal to emulate an IBM 3270-type terminal. The file is part of the global **ttycap** command and is included in the system configuration file. Notice that a carriage return (^M) indicates the last character in the file.

```
ttycap ttycap1 \
v8 | vi | tvi925 | 925 | televideo model 925:\
        :so=\EG4:se=\EG0:\
        :hs:am:bs:co#80:li#24:cm=\E=%+ %+ :cl=\E*:cd=\Ey:ce=\Et:\
        :al=\EE:dl=\ER:im=:ei=:ic=\EQ:dc=\EW:\
        :ho=^^:nd=^L:bt=\EI:pt:so=\EG4:se=\EG0:sg#1:us=\EG8:ue=\EG0:ug#1:\
        :up=^K:do=^V:kb=^H:ku=^K:kd=^V:kl=^H:kr=^L:kh=^^:ma=^V^J^L :\
        :k1=^A@\r:k2=^AA\r:k3=^AB\r:k4=^AC\r:k5=^AD\r:k6=^AE\r:k7=^AF\r:\
        :k8=^AG\r:k9=^AH\r:k0=^AI\r:ko=ic,dc,al,dl,cl,ce,cd,bt:\
        :md=\E(:me=\E):ti=\E):te=\E(:\
        :ts=\Ef:fs=\Eg:ds=\Eh:sr=\Ej:xn:\
        :is=\El\E"^M\E3^M      \E1        \E1        \E1       \E1       \E\
1        \E1        \E1        \E1        \E1^M
```

Custom Keyboard Emulation File Example

The following example allows a keyboard to emulate an asynchronous connection to an IBM 7171 keyboard. The file is part of the **keymap** global configuration command and is included in the system configuration file.

```
keymap ibm7171 \
vt100av | vt100 | vt100nam | pt100 | vt102 | vt125{ \
enter = '^m';\
erase = '^?'; reset = '^g'; clear = '^z'  |  '\EOM';\
nl = '^j'; tab = '^i'; btab = '^b';\
left = '\EOD'; right = '\EOC'; up = '\EOA'; down = '\EOB';\
home = '^h'; delete = '^d'; eeof = '^e'  |  '\E^?'; einp = '^w'; insrt = '\EOn';\
pfk1 = '\EOP'  |  '\E1'; pfk2 = '\EOQ'  |  '\E2'; pfk3 = '\EOR'  |  '\E3';\
pfk4 = '\EOw'  |  '\E4'; pfk5 = '\EOx'  |  '\E5'; pfk6 = '\EOy'  |  '\E6';\
pfk7 = '\EOt'  |  '\E7'; pfk8 = '\EOu'  |  '\E8'; pfk9 = '\EOv'  |  '\E9';\
pfk10 = '\EOq'  |  '\E0'; pfk11 = '\EOr'  |  '\E-';\
pfk12 = '\EOs'  |  '\E='; pfk13 = '\EOp\EOP'  |  '^f13';\
pfk14 = '\EOp\EOQ'  |  '^f14'; pfk15 = '\EOp\EOR'  |  '^f15';\
pfk16 = '\EOp\EOw'  |  '^f16'; pfk17 = '\EOp\EOx'  |  '^f17';\
pfk18 = '\EOp\EOy'  |  '^f18'; pfk19 = '\EOp\EOt'  |  '^f19';\
pfk20 = '\EOp\EOu'  |  '^f20'; pfk21 = '\EOp\EOv'  |  '^f21';\
pfk22 = '\EOp\EOq'  |  '^f22'; pfk23 = '\EOp\EOr'  |  '^f23';\
pfk24 = '\EOp\EOs'  |  '^f24';\
pa1 = '^p1'  |  '\EOS';\
pa2 = '^p2'  |  '\EOm';\
pa3 = '^p3'  |  '\EOl';\
}
```

Line Specification for a Custom Emulation Example

The following example sets up a line with specific terminal and keyboard characteristics that are used during negotiation with a host upon connection. The line configuration commands in the example must follow the global **ttycap** and **keymap** global configuration commands containing the emulation settings to be used.

```
line 3
 terminal-type ttycap1
 keymap-type ibm7171
```

Character Mapping Examples

The following example shows the configuration of the EBCDIC and ASCII character mappings listed in Table 3:

```
tn3270 character-map 0x81 0x78
tn3270 character-map 0x82 0x79
tn3270 character-map 0x83 0x7A
```

Table 3 Sample EBCDIC and ASCII Character Mapping

EBCDIC	ASCII
a	x
b	y
c	z

The following example displays all nonstandard character mappings:

```
Router# show tn3270 character-map all

EBCDIC 0x81 <=> 0x78 ASCII
EBCDIC 0x82 <=> 0x79 ASCII
EBCDIC 0x83 <=> 0x7A ASCII
```

The following example shows the standard key mapping for the letters d and c:

```
Router# show tn3270 character-map 83

EBCDIC 0x83 <=> 0x63 ASCII = `c'
EBCDIC 0x84 <=> 0x64 ASCII = `d'
```

The following example unmaps a specific key, first with the optional *ascii-in-hex* argument and then without the argument:

```
Router# configure terminal

Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# no tn3270 character-map 0x80 0x78
Router(config)# ^Z

Router# show tn3270 character-map all

EBCDIC 0x82 <=> 0x79 ASCII
EBCDIC 0x83 <=> 0x7A ASCII
```

```
Router# configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# no tn3270 character-map 0x82
Router(config)# ^Z
Router# show t3270 character-map all

EBCDIC 0x82 <=> 0x79 ASCII
```

The following example displays character mappings, then removes all mappings with the **all** keyword:

```
Router# show tn3270 character-map all

EBCDIC 0x81 <=> 0x78 ASCII
EBCDIC 0x82 <=> 0x79 ASCII
EBCDIC 0x83 <=> 0x7A ASCII

Router# configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# no tn3270 character-map all
Router(config)# ^Z

Router# show tn3270 character-map all
```

TN3270 Connection Example

The following example establishes a terminal session with an IBM host named finance:

```
Router> tn3270 finance
```

To terminate an active TN3270 session, log out of the remote system by entering the command specific to that system (such as **exit**, **logout**, **quit**, or **close**). You can also enter the escape sequence (**Ctrl-Shift-6** then **x** [**Ctrl^x**] by default) and enter the **disconnect** command at the EXEC prompt. Because the **disconnect** command can "hang" a port, we recommend that you avoid using it routinely when you exit a session.

Configuring XRemote

The X Window System, also called X, is a network-based graphics window system originally developed for workstations running UNIX. Cisco has developed an XRemote application that allows the XRemote capabilities of X terminals to run on an access server or router.

Previous window systems for terminals were *kernel-based* and therefore were closely linked to the operating system running on the workstation itself. They typically only ran on discrete systems, such as a single workstation. The X Window System is not part of any operating system, but instead, is composed of application programs. Thus, the X Window System enables flexible, graphics-based network computing across a wide range of operating systems and hardware platforms.

X and the Client/Server Model

The underlying architecture of the X Window System is based on a *client/server* model. The system is split into two parts: *clients* and *display servers*. Clients are application programs that perform specific tasks, and display servers provide specific display capabilities and track user input. These two parts can

reside on the same computer or can be separated over a network. In an X terminal environment, such as in NCD terminal implementations, the display server resides on the display station and the client resides on a host computer.

Because the X Windows System employs this client/server partitioning and is independent of both the hardware and operating environment, X terminal users can access different types of computers to simultaneously access several applications and resources in a multivendor environment. A user at an X terminal can concurrently run and display a calendar program on a VAX, a spreadsheet program on a PC, and a compiler on a workstation.

XRemote Overview

XRemote is a protocol developed specifically to optimize support for the X Window System over a serial communications link. Its compression and decompression algorithms are designed to handle bit-mapped displays and windowing systems.

There are two basic parts to XRemote:

- Server-side helper process
- Client-side helper process

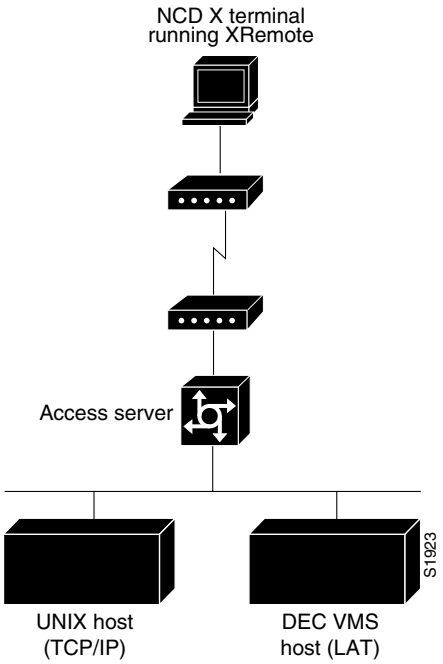
These two helper processes communicate with each other using the XRemote protocol. The client-side helper communicates with X clients using the standard X protocol. The server-side helper communicates with the server using the standard X Window System. The server-side helper might operate as part of the X server or it might be external and accessed across the network; for example, the server-side helper can operate in an access server or router at your house or work site. If the server-side helper is in the X terminal, it must have XRemote programmable read-only memory (PROM) installed.

XRemote enables a user of a display station to run the X Window System via 9600-baud (and faster) modem connections with performance that is superior to using conventional serial protocols, such as Serial Line Internet Protocol (SLIP). An X display station must either implement XRemote or be connected to a network configuration that includes an access server or router.

Connection Capability

The Cisco implementation of XRemote is fully compatible with the NCD XRemote protocol. Figure 15 illustrates an XRemote connection between an X terminal and an access server. In Figure 15, the server-side helper runs on the X terminal, and the client-side helper runs on the access server.

Figure 15 XRemote Session from an X Display Server Running XRemote



Remote Access to Fonts

Remote access to fonts is provided in three ways:

- Using the industry-standard protocol for transporting X traffic over TCP/IP networks
- Using the Digital protocol for transporting X traffic over LAT networks
- Using the Internet standard TFTP for TCP/IP networks

A single XRemote user can use any combination of TCP/IP and LAT client connections and any combination of TFTP and LAT font access.

XRemote Configuration Task List

To configure XRemote, perform the tasks described in the following sections:

- Configuring XRemote (Required for Service)
- Selecting Fonts for X Terminal Applications (Optional)
- Making XRemote Connections (Required for Making Connections)

The section "Monitoring XRemote Connections" provides tips on maintaining XRemote connections.

Configuring XRemote

To allow host connections using the XRemote feature from NCD and the access server or router, use the following commands. Before starting the following tasks, verify that a modem is externally or internally connected with your access server or router. Unless specified otherwise, all commands in this task table are entered in global configuration mode.

	Command	Purpose[1]
Step 1	`Router(config)# xremote tftp host hostname`	Defines a specific TFTP font server as the source for fonts.
Step 2	`Router(config)# xremote tftp buffersize buffersize`	Sets the buffer size used for loading font files.
Step 3	`Router(config)# xremote tftp retries retries`	Increases the number of times that the font loader tries to load the fonts.[2]
Step 4	`Router> show xremote`	(Optional) In EXEC mode, displays current XRemote connections and monitors traffic.
Step 5	`Router> show xremote line number`	(Optional) In EXEC mode, displays XRemote traffic and line statistics.

1. The X Server for the X terminal and the network and serial parameters for the X terminal must be configured as described in the publications for the specific X terminal you are using. In general, the X terminal configuration determines the mode of operation for the terminal, the source of font information, and the source of remote configuration information (when applicable).
2. This feature is particularly useful when the font servers are known to be heavily loaded.

In general, you can use any modem that provides acceptable performance for your application. The following guidelines apply to an XRemote operation using a modem (see the user manual for your modem for specific connection procedures):

- Attach cables and set up your modem for use with XRemote (access over asynchronous lines only), or cable the X terminal directly to the access server or router.
- Disable any error correction and compression features of the modem. Because XRemote implements its own compression and error correction, the compression and error correction from the modem actually impair performance.
- If you must use a flow control mechanism, hardware flow control (such as RTS/CTS or DTR/DSR) is recommended. Software flow control (such as XON/XOFF) is discouraged.
- The modem should incur minimal delays in round-trip transmissions, even when transmitting small packets, and transmissions should be transparent to the data stream.
- The modem should provide true full-duplex transmission at 9600 baud or faster. Half-duplex modems are not suitable for use with XRemote.

Refer to the chapters in the part "Modem and Dial Shelf Configuration and Management" in *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2, for more information about configuring modems.

When the X terminal requests that a font file be loaded, the Cisco IOS software must first load the font file into an internal buffer before passing it to the X terminal. The default value for this buffer is 70000 bytes, which is adequate for most font files, but the size can be increased as necessary for nonstandard font files using the **xremote tftp buffersize** global configuration command. This task can be performed for both TFTP and LAT font access.

Selecting Fonts for X Terminal Applications

The NCD terminal contains a small set of built-in fonts in local ROM. You should use these fonts because loading fonts over a serial line can increase application startup time. The default for an NCD terminal is to use built-in fonts, unless you log in using DECwindows over LAT. When using DECwindows over LAT, the standard DECwindows fonts are used automatically.

To select fonts, perform the tasks described in the following sections:

- Accessing Nonresident Fonts Using TFTP
- Selecting DECwindows Fonts

Accessing Nonresident Fonts Using TFTP

When an X terminal application requests a font that is not stored in ROM for the terminal, the X terminal makes a request for a font file from the access server or router. The Cisco IOS software uses the TFTP to load the font from the font server, and then passes the font to the X terminal using the XRemote protocol. Loading fonts from the access server or router to the X terminal can take 30 to 45 seconds, depending on the size of the font file.

An X server can display only the fonts it finds in the directories in its font path. The default font path for the X server includes only the built-in fonts. To access fonts stored on a host, you must add the font directories from the host to the font path of the X server, which is done using the UNIX command **xset** with the **fp+** argument to add fonts to the end of the font path of the server.

For example, to allow your display station to access the 100 dots-per-inch (dpi) fonts found in the standard font directory, enter the following command at the host system prompt:

```
host_prompt% xset fp+ /usr/lib/x11/ncd/fonts/100dpi
```

For more information, see the *NCDware XRemote User's Manual*.

Selecting DECwindows Fonts

Downloading of fonts occurs automatically when you initiate a remote DECwindows login session using the **xremote lat** EXEC command. Using the **xremote lat** EXEC command instead of relying on TFTP to download the fonts, the fonts are read in via the LAT protocol.

If you want to use DECwindows fonts while running standard X applications on a UNIX host, you need to use the UNIX **xset** command or an application that sends an XSetFontPath request to set a font path. You might want to use the UNIX **xset** command if you are primarily a TCP/IP user, but also run some DECwindows applications.

Enter the **xset** command, or launch the application that sends an XSetFontPath request, to set the following path:

```
/LAT/SERVICE
```

In this path, SERVICE is a LAT service name with DECwindows support; case is not significant.

When the Cisco IOS software sees a request for font files in that directory, it uses LAT instead of TFTP to access the specified service.

Making XRemote Connections

You use the XRemote protocol with an X display station and a modem to connect to remote hosts via TCP/IP and LAT. This section outlines the steps for starting XRemote in several typical environments and for exiting XRemote sessions. It includes the following sections:

- Connecting Through Automatic Session Startup with an XDMCP Server
- Connecting Through Automatic Session Startup with a DECwindows Login via LAT
- Connecting Through Manual XRemote Session Startup
- Establishing XRemote Sessions Between Servers
- Exiting XRemote Sessions

When possible, use the automated processes. Make sure that your system administrator has already configured a path for loading fonts.

You can run the XRemote protocols between two servers. This capability is useful if you use an X display server that does not support XRemote, or if an X display station is connected to a LAN and you want to use the LAN rather than a dial-in link to connect to a server. (Note that XRemote is faster when the X display station connects to a server over a dial-in link.) Refer to the section "Establishing XRemote Sessions Between Servers" later in this chapter.

For an example of making an XRemote connection, see the "XRemote Configuration and Connection Examples" section later in this chapter.

Connecting Through Automatic Session Startup with an XDMCP Server

If your host computer supports a server for X Display Manager Control Protocol (XDMCP) (such as the xdm program included in X11R4 or later), you can use automatic session startup to make an XRemote session connection. To do so, use the following command in EXEC mode:

Command	Purpose
`Router> xremote xdm [hostname]`	Creates a connection with XRemote and an XDMCP server.

This command sends an XDMCP session startup request to the host computer. If you do not specify a host name, a broadcast message is sent to all hosts. The first host to respond by starting up a session is used.

The server and X terminal stay in XRemote mode until either the display manager terminates the session, or a reset request is received from the X terminal.

Connecting Through Automatic Session Startup with a DECwindows Login via LAT

If your host computer supports DECwindows login sessions, you can use automatic session startup to make an XRemote session connection, when the system administrator at the remote host configures support for DECwindows over LAT. To start the connection, use the following command in EXEC mode:

Command	Purpose
`Router> xremote lat service`	Creates a connection with XRemote and DECwindows over LAT.

After you enter this command, expect the following to occur:

- The XRemote font server loads several initial fonts for the DECwindows login display.
- The terminal displays the Digital logo and DECwindows login box.

Log in to the system. Upon completion of login, more fonts are loaded, and the remote session begins.

Note Because of heavy font usage, DECwindows applications can take longer than expected to start when you use XRemote. After the application starts, performance and access times should be normal.

Connecting Through Manual XRemote Session Startup

If you do not use a host computer that supports XDMCP or LAT, you must use manual session startup. To use manual session startup, perform the tasks described in the following sections:

- Enabling XRemote Manually (Required for Manual Sessions)
- Connecting to the Remote Host Computer (Required for Manual Sessions)
- Setting the Location of the X Display (Required for Manual Sessions)
- Starting Client Applications (Required for Manual Sessions)
- Returning to the EXEC Prompt (Required for Manual Sessions)
- Reenabling XRemote Manually (Required for Manual Sessions)

Enabling XRemote Manually

To prepare the XRemote server for manual startup, use the following command in EXEC mode:

Command	Purpose
`Router> xremote`	Prepares the XRemote server for manual startup.

After you enter this command, instructions prompt you through the process of manually enabling XRemote.

Note In manual operation, the server and X terminal remain in XRemote mode until all clients disconnect or the server receives a reset request from the X terminal. A session might terminate during startup because you invoked transient X clients that set some parameters and then disconnected (such as **xset** or **xmodmap** parameters). There must always be one session open or the connection is reset.

Connecting to the Remote Host Computer

To connect to a host, use one of the following commands in EXEC mode:

Command	Purpose
`Router>` **`telnet`** or `Router>` **`lat`** or `Router>` **`rlogin`**	Prepares the server for XRemote manual startup.

After entering the command, you can log in as usual.

Setting the Location of the X Display

Note If you are using a version of Telnet on the remote host that supports the "X Display Location" option (RFC 1096), skip this section and go on to the "Starting Client Applications" section.

Once you are logged in to the remote host computer, inform the host computer of your X display location that the server provided when you enabled XRemote manually. For most versions of the UNIX operating system, the X display location is set by using the **setenv** command to set the Display environment variable. Refer to the online X(1) manual page available from UNIX for more information.

On VAX/VMS systems, use the **SET DISPLAY** command to set the X display location. For more information, refer to the *VMS DCL Dictionary*.

Note To set the location of the X display for VAX/VMS client systems, you must install either the TCP/IP transport from Digital or a third-party TCP/IP transport. Contact your VAX/VMS system administrator for the appropriate TCP/IP transport name.

Starting Client Applications

When you ave set the location of the Xdisplay, you can start your client applications for your host operating system, as specified in the documentation for the client applications.

The server accepts the X connection attempt from the client application and places the client in a dormant state.

Returning to the EXEC Prompt

If it is possible to log out of the host computer and keep your X clients running in the background, you can do so now. This capability conserves resources on both the host and the server that would otherwise be inaccessible until you exited from the XRemote state.

If you cannot log out of the host computer and keep your clients running, return to the EXEC prompt for the access server using the escape sequence (Ctrl-Shift-6 then x [Ctrl^x] by default).

Reenabling XRemote Manually

To begin a manual remote session again, see the "Enabling XRemote Manually" section earlier in this chapter. If the X clients connected successfully, the session is put into XRemote mode, and the clients complete their startup.

If no clients are found, you see the following message: "No X clients waiting - check that your display is darkstar:2018"

Check your hosts to determine whether an error has occurred when the session started. The most likely causes are that there is an improperly specified display location, or the host computer did not recognize the name of your server.

Establishing XRemote Sessions Between Servers

If you are on an X display server that does not support XRemote, you can still run the XRemote protocols. An X display server (such as a PCX, MacX, or UNIX workstation) connected to an Ethernet network can dial out through an access server on a conventional modem to access an X client program on a host residing on another network. The access server provides the server-side helper process.

To run XRemote, connect to one of the XRemote ports.

Note The NCD helper process does not support X display devices that use a maximum request and response size larger than 64 kbps.

Find out from your administrator whether the connection from your X display server is configured as an individual line or a rotary connection.

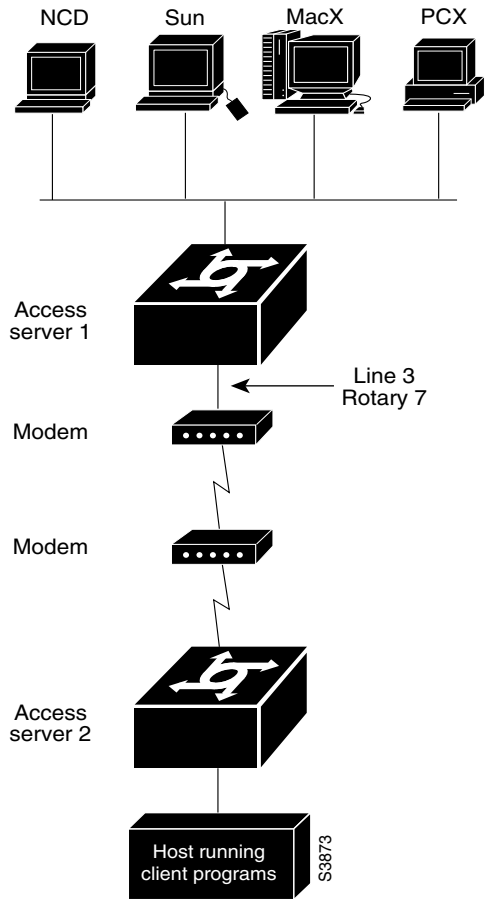
Depending upon the connection configuration, use one of the following connection methods:

- To connect to an individual line, use Telnet to connect from the X display server to port 9000 plus the decimal value of the line number.
- To make a rotary connection, use Telnet to connect from the X display server to port 10000 plus the decimal value of the line number.

For information about how to configure individual lines and rotary connections, see the chapters "Preparing Modem and Asynchronous Interfaces" and "Configuring Additional Modem Features" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2.

Figure 16 illustrates a configuration in which a display server is not running XRemote. In this configuration, the server-side XRemote helper is running on the access server named Access Server 1, and the client-side XRemote helper is running on the access server named Access Server 2.

Figure 16 XRemote Session Between Servers



Exiting XRemote Sessions

When you exit XRemote, you must quit all active X connections, usually with a command supported by your X client system. Usually when you quit the last connection (all client processes are stopped), XRemote closes and you return to the EXEC prompt. Refer to your X client system documentation for specific information about exiting an XRemote session.

Monitoring XRemote Connections

To list XRemote connections and monitor XRemote traffic through the router, use the following commands in EXEC mode as needed:

Command	Purpose
`Router>` **`show xremote`**	Lists XRemote connections and monitors XRemote traffic through the router or access server.
`Router>` **`show xremote line`** *`number`*	Lists XRemote connections and monitors XRemote traffic for specific lines on an XRemote server.

XRemote Configuration and Connection Examples

These examples are provided to help you understand how to make XRemote connections:

Standard XRemote Configuration Example

The following example shows how to specify IBM-1 as the host name of the TFTP font server, how to specify 7 retry attempts at accessing the server, and how to reduce the buffer size to 20,000 bytes:

```
xremote tftp host IBM-1
xremote tftp retries 7
xremote tftp buffersize 20000
```

Connecting Through Automatic Session Startup with XDMCP Server Example

The following example starts a session with a remote host named star:

```
Router> xremote xdm star
```

Connecting Through Automatic Session Startup with DECwindows Login via LAT Example

The following example begins connection with a LAT service named WHIRL:

```
Router> xremote lat WHIRL
```

Enabling XRemote Manually Example

The following example shows how a successful manual XRemote session begins:

```
Router> xremote
XRemote enabled; your display is dialup:2006
Start your clients and type XRemote again
```

The system replies with a message informing you of your X display location. Use this information to tell the host the location of your X display server.

If no clients are found, you see the following message: “No X clients waiting - check that your display is darkstar:2006”

Check your hosts to determine whether an error has occurred when the session started. The most likely causes are that there is an improperly specified display location or the host computer did not recognize the name of your server.

Connecting an X Display Terminal Example

To make a connection from an X display terminal through a server to a host running client programs, perform the following steps:

Step 1 Enter the **xremote** command at the EXEC prompt:

```
Router> xremote
```

Step 2 Read and follow the instruction from the host:

```
XRemote enabled; your display is dialup:2006
Start your clients and type XRemote again
```

Step 3 Connect to the client:

```
Router> telnet eureka
Trying EUREKA.NOWHERE.COM (172.16.1.55)... Open

SunOS UNIX (eureka)
```

Step 4 Log in at the prompt:

```
login: deal
Password:
Last login: Fri Apr 1 17:17:46 from dialup.nowhere.com
SunOS Release (SERVER+FDDI+DBE.patched) #14: Fri Apr 8 10:37:29 PDT 1994
```

Step 5 At the client prompt, enter the display name from Step 2 in this procedure and the **xterm** command:

```
eureka% setenv DISPLAY dialup:2006
eureka% xterm &
[1] 15439
```

Step 6 Disconnect from the client:

```
eureka% logout

[Connection to EUREKA closed by foreign host]
```

Step 7 Begin the XRemote session:

```
Router> xremote
Entering XRemote
```

The server and X terminal stay in XRemote mode until either the display manager terminates the session, or a reset request is received from the X terminal:

```
Connection closed by foreign host.
eureka%
```

Making XRemote Connections Between Servers Example

This section describes two ways to make XRemote connections between servers.

The following process explains how an XRemote connection is established for a configuration such as the one shown in Figure 16 in the section "Establishing XRemote Sessions Between Servers" earlier in this chapter. This procedure assumes that the administrator has set the display environment variable to identify and match the X display terminal of the user.

From the PCX, MacX, or UNIX machine in Figure 16, the user connects to port 9003 on the access server named Access Server 1. If your administrator has configured a rotary number 7, the user connects to port 10007. For more information about rotary groups, refer to the chapter "Configuring Additional Modem Features" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2.

Following is a summary of the connection process:

1. Access Server 1 connects the user to a modem.
2. The modem calls Access Server 2.
3. The user enters the **xremote** command at the Access Server 2 prompt.
4. The user connects to the remote host from Access Server 2 using the **telnet** command.
5. The user starts the X client program that runs on the remote host and displays on the X display server (PCX, MacX, or UNIX host).
6. The user escapes from the remote host back to Access Server 2, or logs out if clients were run in the background, and enters the **xremote** command again at the Access Server 2 prompt.

The following procedure shows a second way to make an XRemote connection between servers. The number 9016 in the first line of the display indicates a connection to individual line 16. If the administrator had configured a rotary connection, the user would enter 10000 plus the number of the rotary (instead of 9016).

Step 1 Enter the **telnet** command to make the connection:

```
space% telnet golden-road 9016
Trying 172.31.7.84 ...
Connected to golden-road.cisco.com.
Escape character is '^]'.
```

Step 2 Supply the password for TACACS verification:

```
User Access Verification

Password: <password>
Password OK

 --- Outbound XRemote service ---
Enter X server name or IP address: innerspace
Enter display number [0]:

Connecting to tty16... please start up XRemote on the remote system
```

Step 3 Dial in to the remote system using the modem, and then log in:

```
atdt 13125554141
DIALING
RING
CONNECT 14400

User Access Verification
Username: deal
Password:
  Welcome to the cisco dial-up access server.
```

Step 4 Enter the **xremote** command at the EXEC prompt, then follow the instructions from the host:

```
Router> xremote
XRemote enabled; your display is dialup:2006
Start your clients and type XRemote again
```

Step 5 Connect to the client:

```
Router> telnet sparks
Trying SPARKS.NOWHERE.COM (173.19.1.55)... Open

SunOS UNIX (sparks)

login: deal
Password: <password>
Last login: Fri Apr 1 17:17:46 from dialup.nowhere.com
SunOS Release (SERVER+FDDI+DBE.patched) #14: Fri Apr 8 10:37:29 PDT 1994
```

Step 6 At the client prompt, enter the display name from Step 4 and the **xterm** command:

```
sparks% setenv DISPLAY dialup:2006
sparks% xterm &
[1] 15439
```

Step 7 Disconnect from the client:

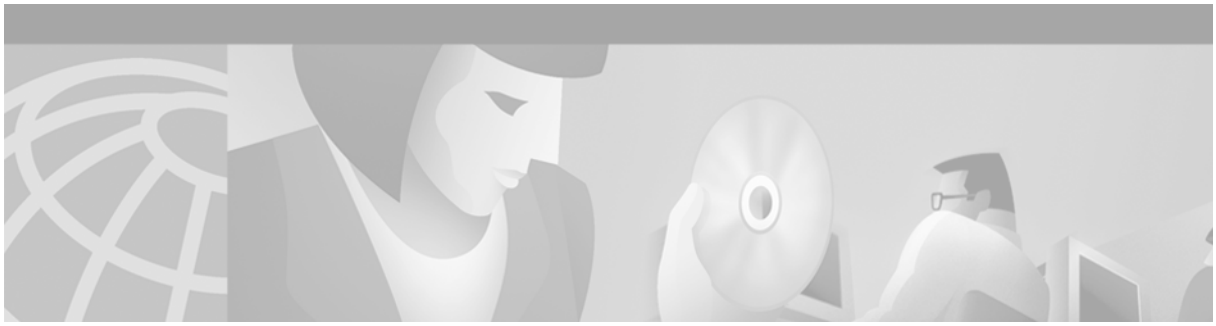
```
sparks% logout

[Connection to SPARKS closed by foreign host]
```

Step 8 Begin the XRemote session.

```
Router> xremote
Entering XRemote
```

When the connection is closed by the foreign host, the Xterm window appears on the local workstation screen:

```
Connection closed by foreign host.
sparks%
```



Configuring AppleTalk Remote Access

This chapter describes how to configure your router to act as an AppleTalk Remote Access (ARA) server. It includes the following main sections:

This chapter does not describe how to configure or use the client Macintosh. Refer to the Apple Computer, Inc. *Apple Remote Access Client User's Guide* and the *Apple Remote Access Personal Server User's Guide* for information about how to set up and use the ARA software on your Macintosh.

For a complete description of the commands in this chapter, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter.

ARA Overview

The Cisco implementation of ARA gives Macintosh users direct access to information and resources in remote AppleTalk networks over standard telephone lines. For example, if you have a PowerBook at home and need to get a file from your Macintosh at the office, ARA software can make the connection between your home and office computers over telephone lines.

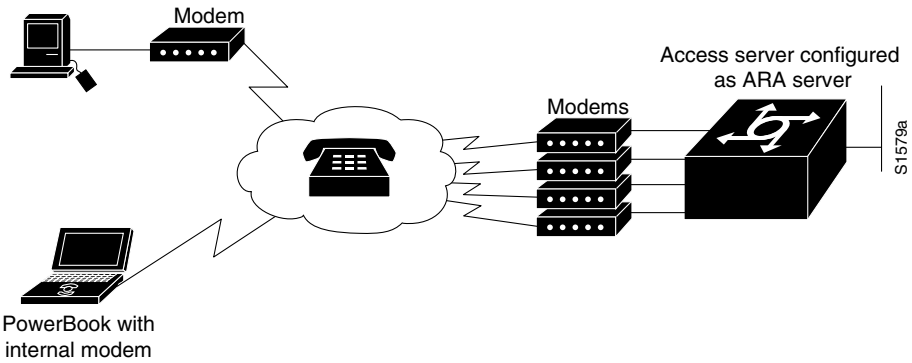
You can configure your router to act as an ARA server by enabling AppleTalk and ARA protocol on physical terminal (TTY) or virtual terminal lines. Configuring your router to act as an ARA server allows remote Macintosh users to dial in, become a network node, and connect to devices on other networks. ARA protocol support is transparent to the Macintosh end user. Macintosh users can also use Serial Line Internet Protocol (SLIP) to access remote IP network resources and PPP to access both AppleTalk and IP resources.

The following Macintosh and Cisco IOS software support is required for ARA connectivity:

- Macintosh running ARA software and a connection control language (CCL) script.
- Router configured as an ARA server.

Figure 17 shows how your router can act as an ARA server between remote Macintosh computers (in Figure 17, a Power Macintosh and a PowerBook) and devices on another network.

Figure 17 ARA Configuration Overview



ARA Configuration Task List

To set up the Cisco IOS software to act as an ARA server, perform the tasks described in the following sections:

- Connecting Cables (Required)
- Configuring the Line and the Modem (Required)
- Configuring ARA (Required)
- Configuring ARA to Start Up Automatically (Optional)
- Configuring ARA Security (Optional)
- Connecting to an AppleTalk Network from a Client Running a Different Virtual Terminal Protocol (Optional)

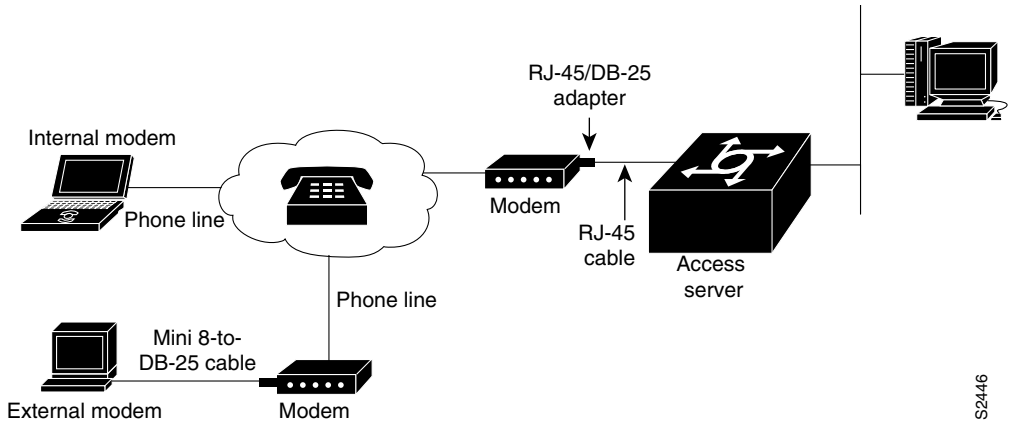
To enable remote clients running PPP to dial in and access AppleTalk resources on a network, you must configure AppleTalk Control Protocol (ATCP). To configure ATCP, refer to the section "Configuring AppleTalk and PPP" in the chapter "Configuring Asynchronous SLIP and PPP" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2.

The section "Making ARA Connections" later in this chapter provides connection information. Refer to the "Monitoring an ARA Server," "Monitoring the AppleTalk Network," and "Troubleshooting ARA Connections" sections for information about maintaining and troubleshooting the ARA server and AppleTalk network. The section "ARA Configuration and Connection Examples" provides configuration examples.

Connecting Cables

Figure 18 shows how to connect a Macintosh using internal and external modems.

Figure 18 ARA Server Cabling and Connections



Use the MMOD version of the RJ-45-to-DB-25 adapter (labeled "Modem" if the adapter is from Cisco) to connect a "rolled" RJ-45 cable from the router to the modem. Use a high-speed modem cable with hardware flow control to connect a modem to your Macintosh (see the user documentation for your modem for more specific information).

Some Cisco access servers such as the Cisco AS5800 and Cisco AS5300 have internal modems. Therefore there are no modem cables for you to connect.

For more information about connecting cables, see the installation and configuration or product user guide that came with your router.

Configuring the Line and the Modem

To configure the line, perform the following steps:

Step 1 Specify the maximum common line speed for the modem and the access server. The access server supports 4-fold compression of data, so you can use the speeds shown in the following list:

- 115,200 bits per second (bps) for use with modems that support a transmission rate of 28,800
- 57,600 bps for use with modems that support a transmission rate of 14,400
- 38,400 bps for use with modems that support a transmission rate of 9,600

Note See your modem guide to ensure that the modem can support these maximum line speeds.

Step 2 Set hardware flow control. Use the **flowcontrol hardware** command to enable hardware flow control.

Note The Cisco IOS software does not support modems that do not support hardware flow control.

Step 3 Specify your modem control parameters. Use the **modem inout** command to configure the line for both incoming and outgoing calls, or use the **modem dialin** command to configure the line for incoming calls only.

Step 4 Configure security on your dial-in lines. Use the **aaa new-model** command to enable the authentication, authorization, and accounting (AAA) process on the router, the **aaa authentication arap** command to create an authentication list, and the **arap authentication** command to apply the authentication list to a line or set of lines configured for ARA.

For more information about configuring lines and modem control, refer to the chapter "Preparing Modem and Asynchronous Interfaces" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2. For information about configuring security, refer to the *Cisco IOS Security Configuration Guide*, Release 12.2.

Note The **autobaud** command is not supported with ARA and should never be used.

Configuring ARA

To allow ARA connections to pass through the access server or router, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# appletalk routing`	Enables AppleTalk.[1]
Step 2	`Router(config)# arap network [network-number] [zone-name]`	Creates a new network or zone for ARA clients when they dial in. The *network-number* argument must be a unique network number.
Step 3	`Router(config-if)# appletalk send-rtmps`	In interface configuration mode, ensures that a new internal network is advertised by enabling the Routing Table Maintenance Protocol (RTMP). You need to configure an AppleTalk interface using the discovery mode in the Cisco IOS software. To do so, an interface on the router must be connected to a network that has at least one other router configured for AppleTalk.
Step 4	`Router(config-if)# appletalk routing`	Returns to global configuration mode and turns on AppleTalk routing.
Step 5	`Router(config)# line [tty | aux | vty] line-number [ending-line-number]`	Enters line configuration mode.
Step 6	`Router(config-line)# arap enable`	Enables ARA on a line.

1. For more information about configuring AppleTalk, refer to the chapter "Configuring AppleTalk" in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*.

If you discover that an AppleTalk network already exists, the zone and cable range must match the existing configuration. To identify existing cable ranges and zone names, configure the Cisco IOS software for discovery mode. You must manually configure an AppleTalk interface on a segment for which there are no AppleTalk routers. For more information, refer to the chapter "Configuring AppleTalk" in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*, Release 12.2.

Configuring ARA to Start Up Automatically

Refer to this section after you have configured AppleTalk routing, created an internal ARA network or zone, and enabled ARA. At this point, you can enable optional tasks.

To configure the Cisco IOS software to allow an ARA session to start automatically, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# autoselect {arap | ppp | slip | during-login}`	Configures a line to automatically start an ARA session.
Step 2	`Router(config)# line x`	Enters line configuration mode (x = the line you want to configure in Step 3).
Step 3	`Router(config-line)# arap dedicated`	Enters line configuration mode and dedicate a line to function only as an ARA connection.
Step 4	`Router(config-line)# arap timelimit [minutes]`	Sets the maximum length of an ARA session for a line. The default is unlimited length connections.
Step 5	`Router(config-line)# arap warningtime [minutes]`	Determines when a disconnect warning message is displayed, in number of minutes before the line is disconnected. This command is valid only when a session time limit is set.

The **autoselect** command permits the router to start an ARA session automatically when it detects the start character for an Appletalk Remote Accesses Protocol (ARAP) packet. The Cisco IOS software detects either a Return character, which is the start character for an EXEC session, or the start character for the ARA protocol. By entering the **autoselect** command with the **during-login** keyword, you can display the username or password prompt without pressing the Return key. While the username or password prompts are displayed, you can choose to answer these prompts or to start sending packets from an autoselected protocol.

Normally a router avoids line and modem noise by clearing the initial data received within the first few seconds. However, when the autoselect PPP feature is configured, the router flushes characters initially received and then waits for more traffic. This flush causes timeout problems with applications that send only one carriage return. To ensure that the input data sent by a modem or other asynchronous device is not lost after line activation, enter the **flush-at-activation** line configuration command.

For information about using ARA with TACACS, Extended TACACS, and AAA/TACACS+, refer to the section "Configuring ARA Security" in this chapter, and the *Cisco IOS Security Configuration Guide*, Release 12.2.

Note When you use the autoselect function, the activation character should be set to the default, Return, and exec-character-bits to 7. If you change these defaults, the application cannot recognize the activation request.

To customize the AppleTalk configuration even further, you can perform the following additional tasks:

- Disable checksum generation and verification.
- Configure MacIP.

For more information about these and other tasks you can perform to customize your AppleTalk configuration, refer to the chapter "Configuring AppleTalk" in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*, Release 12.2.

Configuring ARA Security

The following three types of security can be used with ARA:

- ARA Server Security, including required manual password entry, limited network visibility, and no guest access.
- Local or Remote Security Database, including username and password authentication and access lists.
- TACACS and TACACS+ Security for ARA, including TACACS, AAA/TACACS+, and Kerberos.

The following sections describe these tasks. Refer to the *Cisco IOS Security Command Reference*, Release 12.2, for information about commands listed in these tasks.

ARA Server Security

Security features that are specific to the ARA protocol are described in the following sections:

- Requiring Manual Password Entry
- Limiting Network Visibility
- Disallowing Guests

Requiring Manual Password Entry

You can control access by requiring users to enter their password manually at the time they log in. To force manual password entry, use the following command in line configuration mode:

Command	Purpose
`Router(config-line)# arap require-manual-password`	Requires manual password entry.

Limiting Network Visibility

You can control Macintosh access to zones and networks by using **arap** commands to reference access control lists configured using AppleTalk **access-list** commands.

To control which zones the Macintosh user can see, use the following command in line configuration mode:

Command	Purpose
`Router(config-line)# arap zonelist` *zone-access-list-number*	Limits the zones the Macintosh user sees.

To control traffic from the Macintosh to networks, use the following command in line configuration mode:

Command	Purpose
`Router(config-line)# arap net-access-list` *net-access-list-number*	Controls access to networks.

Disallowing Guests

A guest is a user that connects to the network without the need to give a name or a password. To prohibit Macintosh guests from logging in through the router, use the following command in line configuration mode. Use the optional **if-needed** argument to allow users to log in as guests if they are already authenticated with a username or password.

Command	Purpose
`Router(config-line)# arap noguest [if-needed]`	Prohibits guests from logging in to the ARA network.

Note Do not use the **arap noguest** command if you are using modified CCL scripts and the **login tacacs** command.

Local or Remote Security Database

To prevent unauthenticated users from accessing your network resources, you configure a username and password database. This database can be local on the router or can be stored on a remote security server (a PC or UNIX computer set up with a security database). To configure the Cisco IOS software to support either local or remote authentication, perform the tasks described in the following sections:

- Configuring Local Username Authentication (As Required)
- Enabling Remote TACACS or TACACS+ Server Authentication (As Required)

Configuring Local Username Authentication

To configure internal username authentication, use the following command in global configuration mode. Enter this information for each supported user.

Command	Purpose
`Router(config)# username name [user-maxlinks link-number] password secret`	Specifies a username and password. Optionally, you can specify the maximum number of connections a user can establish. To use the **user-maxlinks** keyword, you must also use the **aaa authorization network default local** command, and PPP encapsulation and name authentication on all the interfaces the user will be accessing.

When users try to log in to the access server, username and password prompts require them to authenticate themselves before they can have access to the router or the network.

Enabling Remote TACACS or TACACS+ Server Authentication

To enable the Cisco IOS software to use a remote TACACS or TACACS+ authentication database, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# tacacs-server host {hostname | ip-address}`	Specifies the IP address or the host name of the remote TACACS+ server host. This host is typically a UNIX system running TACACS+ software.
Step 2	`Router(config)# tacacs-server key shared-secret-text-string`	Specifies a shared secret text string used between the router and the TACACS+ server. The router and TACACS+ server use this text string to encrypt passwords and exchange responses.

After you specify these commands in the Cisco IOS software, you must populate the remote username database to all users to whom you want to provide network access. When users try to log in to the router, username and password prompts require them to authenticate themselves before they can have access to the router or the network.

TACACS and TACACS+ Security for ARA

You can prevent unauthenticated users from accessing your network resources using the following security mechanisms:

- TACACS and AAA/TACACS+ user authentication, with username and password information stored on a TACACS or TACACS+ server
- Kerberos, which is configured through the AAA facility

For more information about each of these security mechanisms, refer to the *Cisco IOS Security Configuration Guide*, Release 12.2.

To configure TACACS and TACACS+ security to authenticate clients that are using ARA to dial in, perform the tasks described in the following sections:

- Enabling Standard and Extended TACACS for ARA Authentication (Required)
- Enabling AAA/TACACS+ for ARA Authentication (Required)
- Modifying Scripts to Support a Standard EXEC Security Dialog (Optional)—This modification is only necessary if you are running standard TACACS on both your router and your TACACS server.

Enabling Standard and Extended TACACS for ARA Authentication

To use extended TACACS, you must already have set up an extended TACACS server using the Cisco extended TACACS server software, available from the ftp.cisco.com directory. Refer to the README file in this directory for more information. The following two authentication methods are used with standard TACACS:

- You issue the **arap use-tacacs** command. The remote user logs in by entering the appropriate username at the ARA username prompt and password at the password prompt.
- You issue the **arap use-tacacs** command and the **single-line** keyword. The remote user logs in by entering *username*password* at the ARA username prompt, and **arap** at the password prompt.

Note The **arap use-tacacs** command provides TACACS security without the need to modify CCL scripts and respond to dialog boxes. The use of scripts is still a supported feature, and is described in the section "Modifying Scripts to Support a Standard EXEC Security Dialog" later in this chapter.

To configure the router to authenticate using TACACS, use the following commands in line configuration mode:

	Command	Purpose
Step 1	`Router(config-line)# arap use-tacacs [single-line]`	Enables TACACS under ARA.
Step 2	`Router(config-line)# login tacacs`	Enables login authentication using TACACS.

For an example of enabling TACACS for ARA authentication, refer to the section "ARA Configuration and Connection Examples" later in this chapter.

Enabling AAA/TACACS+ for ARA Authentication

To enable TACACS+ authentication for ARA sessions, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# aaa new-model`	Enables the AAA function in the Cisco IOS software.
Step 2	`Router(config)# aaa authentication arap | login {default | list-name} method1 [...[method4]}`	Creates an authentication list that you later apply to lines configured for ARA sessions or when you log in to the router.
Step 3	`Router(config)# line [tty] line-number [ending-line-number]`	Enters line configuration mode.

	Command	Purpose
Step 4	`Router(config-line)# arap authentication {default | list-name}`	Applies an ARA authentication list to lines configured for ARA.
Step 5	`Router(config-line)# login authentication {default | list-name}`	Applies a login authentication list to lines that users can log in to.

Modifying Scripts to Support a Standard EXEC Security Dialog

This section describes how to modify your CCL script to work with TACACS security and how to configure a line to use a TACACS server for user authentication.

Caution Because of the underlying structure of the ARA protocol, modem-layer error control is disabled during the exchange of username and password. This condition makes the exchange highly susceptible to line noise, especially at higher baud rates enabled by V.34 modems. For this reason, we do not recommend the use of modified scripts and encourage users to either upgrade to later versions of TACACS or to use the **arap use-tacacs single-line** command.

For information on how to use TACACS without modifying scripts, refer to the section "Enabling Standard and Extended TACACS for ARA Authentication" earlier in this chapter. For information about the **arap** commands, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2.

If you are currently using modified CCL scripts and want to migrate to nonmodified scripts, refer to the section "Modified and Unmodified CCL Scripts Sample Commands" later in this chapter for information on how to use both in the same environment.

For several popular modems, Cisco provides CCL files that you can use as examples to modify your CCL scripts to support TACACS security. This section explains how to use the CCL files provided by Cisco with TACACS security.

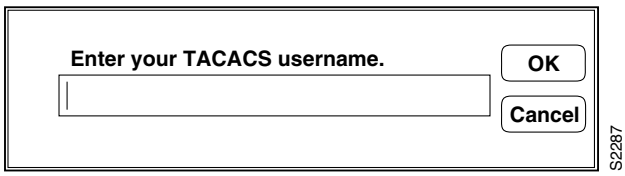
For more information about creating modem initialization scripts, use the ARA Modem Toolkit provided through the AppleTalk Programmers and Developers Association (APDA); it provides both syntax checking and a script tester.

The Macintosh client uses ARA CCL scripts to establish point-to-point links with the modem to the AppleTalk network. When the connection has been established, the script ends and ARA is activated. TACACS authentication occurs after the connection is established and the ARA script ends, but before the ARAP protocol becomes active.

Insert TACACS logic just before the end of a script. The CCL TACACS logic performs the following user authentication tasks:

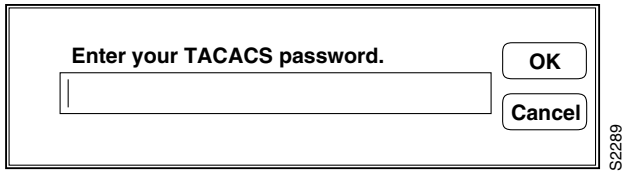
1. When the "Username:" prompt is received from the router, the TACACS server queries the user for a username, as shown in Figure 19.

Figure 19 TACACS Login Screen on the Macintosh Computer



2. When the "Password:" prompt is received from the router, the TACACS server queries the user for a password, as shown in Figure 20.

Figure 20 TACACS Password Screen on the Macintosh Computer



3. After a successful login, indicated by an EXEC prompt, the **arap** EXEC command is executed.
4. The script ends and ARA is activated on the client.

   CCL scripts control logical flow by jumping to labels. The labels are the numbers 1 through 128 and are not necessarily in sequential order in script files. The TACACS logic in the Cisco IOS software CCL files has label numbers from 100 through 127. In most environments, you can copy the complete TACACS logic from a sample file.

To create a new TACACS CCL file, perform the following steps:

Step 1 Copy the TACACS logic from a sample CCL script into the new CCL script.

In most cases, you can insert the TACACS logic at the appropriate place in your CCL script. The one case that requires extra attention is when the original CCL script has labels that conflict with the logic in the new file. The labels must be resolved on a case-by-case basis, usually by changing the label numbers used in the original CCL script. Be sure to read the manual that comes with the ARA Modem Toolkit before beginning.

Step 2 Locate the logical end of the CCL script and insert the **jump 100** command.

You can locate the logical end of the script by following its flow. Most scripts have the following basic structure:

- Initialize the modem.
- Dial the number.
- Exit.

The characteristic logical end of the script is as follows:

```
@label N
! N is any integer between 1 and 128.
if ANSWER N+1
! If we're answering the phone, jump directly
! to the label N+1.
pause 30
! We're not answering the phone, therefore we
! must be calling. Wait three seconds for the
! modems to sync up.
@label N+1
exit 0
! Quit and start up ARA.
```

It is common in this case to replace "pause 30" with "jump 100." In fact, this replacement is usually the only change made to the logic of the original CCL script.

Refer to the chapter "Preparing Modem and Asynchronous Interfaces" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2 for information about configuring a line to support your modem.

Enabling Kerberos Security for ARA Authentication

You can use Kerberos as an authentication method within ARA sessions. To do so, you configure Kerberos using the AAA/TACACS+ facility in the Cisco IOS software.

To enable Kerberos security, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# kerberos local-realm {kerberos-realm}`	Defines the name of the Kerberos realm in which the router is located.
Step 2	`Router(config)# kerberos realm {dns-domain | dns-host} kerberos-realm`	Defines the DNS domain of the Kerberos realm in which the router is located.
Step 3	`Router> show kerberos creds`	Displays the contents of your credentials cache.
Step 4	`Router> clear kerberos creds`	Deletes the contents of your credentials cache.

For more information about Kerberos authentication, refer to the *Cisco IOS Security Configuration Guide*, Release 12.2.

Using Access Lists to Control Access to AppleTalk Networks

An access list is a list of AppleTalk network numbers or zones that is maintained by the Cisco IOS software and used to control access to or from specific zones or networks. For more information about AppleTalk access lists, refer to the section "Control Access to AppleTalk Networks" in the chapter "Configuring AppleTalk" in the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*, Release 12.2.

Connecting to an AppleTalk Network from a Client Running a Different Virtual Terminal Protocol

ARA can run on any point-to-point link, such as a Public Switched Telephone Network (PSTN) or an X.25 WAN. This capability permits remote Macintosh users to dial in to a remote network and access AppleTalk services (such as file sharing and printing). For example, you can enable a Macintosh client on the remote side of an X.25 WAN to connect to an AppleTalk network through the router. To do so, you configure a vty on the router so that the client sees one of two scenarios:

- A client clicks **Connect** in an ARA application dialog box and connects to a vty on the router. ARA automatically starts up on the outgoing vty, and the client is connected to the AppleTalk network. This section describes how to configure the Cisco IOS software for this process.
- A client clicks **Connect** in an ARA application dialog box and connects directly through the router to the AppleTalk network. This process is described in the section "Configuring Tunneling of SLIP, PPP, or ARA" in the chapter "Configuring Protocol Translation and Virtual Asynchronous Devices" in this publication.

To enable ARA on virtual terminal lines and enable clients running different virtual terminal protocols to connect to an AppleTalk network through the router, use the following commands beginning in global configuration mode. The first four steps are required. The next eight steps are optional.

	Command	Purpose
Step 1	`Router(config)# appletalk routing`	Turns on AppleTalk routing.
Step 2	`Router(config)# arap network [network-number] [zone-name]`	Creates an internal AppleTalk network.
Step 3	`Router(config)# line vty line-number [ending-line-number]`	Enters line configuration mode.
Step 4	`Router(config-line)# arap enable`	Enables ARA on a line.
Step 5	`Router(config-line)# autocommand arap`	Configures automatic protocol startup.
Step 6	`Router(config-line)# arap dedicated`	Sets a dedicated ARA line.
Step 7	`Router(config-line)# arap timelimit [minutes]`	Sets the session time limit.
Step 8	`Router(config-line)# arap warningtime [minutes]`	Sets the disconnect warning time.
Step 9	`Router(config-line)# arap noguest`	Disallows guests.
Step 10	`Router(config-line)# arap require-manual-password`	Requires manual password entry.
Step 11	`Router(config-line)# arap zonelist zone-access-list-number`	Limits the zones the Macintosh user sees.
Step 12	`Router(config-line)# arap net-access-list net-access-list number`	Controls access to networks.

Making ARA Connections

If you are a Macintosh user, you can use ARA to connect to an AppleTalk network through a Cisco access server. The Cisco IOS Release 10.2 and later release software support ARA 2.0 and ARA 1.0 so that you can remotely dial in through asynchronous network devices using ARA to access AppleTalk services (such as file sharing and printing) elsewhere on the network. For example, you can dial in from an X.25 network and connect to an AppleTalk network through a router. To enable ARA and dial-in access, configure a vty on the router. You can also configure ARA on TTY lines.

Because there are no user commands for connecting to the network from your Macintosh client, the process is not described in this publication. To start a connection in most ARA client packages, you click the **Connect** button from within the client software.

Monitoring an ARA Server

To display information about a running ARA connection, use the following command in privileged EXEC mode (reached by entering the **enable** command and a password at the EXEC prompt):

Command	Purpose
`Router# show arap [line-number]`	Displays information about a running ARA connection.

The **show arap** command with no arguments displays a summary of ARA traffic since the router was last booted. The **show arap** command with a specified line number displays information about the connection on that line.

Monitoring the AppleTalk Network

The Cisco IOS software provides several commands that you can use to monitor an AppleTalk network. In addition, you can use Inter-Poll from Apple Computer, which is a tool to verify that a device is configured and operating properly. Use the commands described in this section to monitor an AppleTalk network using both Cisco IOS software commands and Inter-Poll.

To monitor the AppleTalk network, use any of the the following commands in EXEC mode:

Command	Purpose
Router> **show appletalk arp**	Lists the entries in the AppleTalk ARP table.
Router> **show appletalk interface** [**brief**] [*type number*]	Displays AppleTalk-related interface settings.
Router> **show appletalk macip-clients**	Displays the status of all known MacIP clients.
Router> **show appletalk macip-servers**	Displays the status of MacIP servers.
Router> **show appletalk macip-traffic**	Displays statistics about MacIP traffic.
Router> **show appletalk traffic**	Displays the statistics about AppleTalk protocol traffic, including MacIP traffic.
Router> **show appletalk zone** [*zone-name*]	Displays the contents of the zone information table.

Troubleshooting ARA Connections

Use ARA debugging enhancements to troubleshoot one or more asynchronous lines on an access server. These enhancements are supported on all Macintosh terminals and all Cisco routers and access servers that support the AppleTalk software feature set.

Allowing users to specify a single line via an additional parameter for troubleshooting produces the following benefits:

- Focused results—Users get only the information they need.
- Reduced server load—Heavily loaded servers are subject to developing ARAP problems which need to be fixed by debugging. However, debugging itself increases the server work load. By focusing on specific lines, the impact of debugging activity on the server is minimized.
- Targeting flexibility—By being able to debug on just the lines in a group of lines, users can solve problems in rotary groups in which there is no way to specify which line or group of lines a remote user will be assigned.

To enable ARAP debugging, use the following commands beginning in EXEC mode:

	Command	Purpose
Step 1	`Router# debug arap {internal | memory | mnp4 | v42bis}`	Enters debug mode and specifies the type of the debug. To debug internal ARA packets, specify the **internal** keyword. To debug the memory allocated to ARA, specify the **memory** keyword. To debug the serial protocol, specify the **mnp4** keyword. To debug compression, specify the **v42bis** keyword.
Step 2	`Router# debug arap internal [linenum [aux | console | tty | vty]]`	Replaces the *linenum* variable with a single line number. Specifies the target for the debug. Specify the **aux** keyword to debug an auxiliary line, the **console** keyword to debug a primary terminal line, the **tty** keyword to debug a physical terminal asynchronous line, or the **vty** keyword to debug a vty.

To verify if the debug level and target are set correctly, enter the **show debug** command:

```
Router# show debug

AppleTalk Remote Access:
ARAP MNP4 debugging is on for line 7
```

ARAP Debugging Examples

The following example sets ARAP debugging in memory mode on line 7. The **show debug** command confirms the configuration.

```
Router# debug arap mn 7
 ARAP MNP4 debugging is on for line 7
Router# debug arap mn 8
 ARAP MNP4 debugging is on for line 8
Router# debug arap mn 9
 ARAP MNP4 debugging is on for line 9
Router# show debug
 AppleTalk Remote Access:
   ARAP MNP4 debugging is on for line 7
   ARAP MNP4 debugging is on for line 8
   ARAP MNP4 debugging is on for line 9
```

Note You can debug several lines (for example, lines in a rotary), but you must turn on debugging one line at a time.

The following example sets ARAP debugging in internal mode on line 6, memory mode on line 10, and V.42*bis* compression mode on line 6. The **show debug** command confirms the configuration.

```
Router# debug arap in 6
 ARAP internal packet debugging is on for line 6
Router# debug arap me 10
 ARAP memory debugging is on for line 10
Router# debug arap v 6
 ARAP V.42bis debugging is on for line 6
```

```
Router# show debug
 AppleTalk Remote Access:
   ARAP V.42bis debugging is on for line 6
   ARAP internal packet debugging is on for line 6
   ARAP memory debugging is on for line 10
```

The following example sets ARAP debugging for each mode in succession and for all lines. The **show debug** command confirms the configuration.

```
Router# debug arap mnp4
 ARAP MNP4 debugging is on
Router# debug arap internal
 ARAP internal packet debugging is on
Router# debug arap v42bis
 ARAP V.42bis debugging is on
Router# debug arap memory
 ARAP memory debugging is on
Router# show debug
 AppleTalk Remote Access:
   ARAP MNP4 debugging is on
   ARAP V.42bis debugging is on
   ARAP internal packet debugging is on
   ARAP memory debugging is on
Router#
```

The following example sets all debugging (including ARAP debugging) for all modes and for all lines. The **show debug** command confirms the configuration. Note that turning on all debugging utilities can slow down performance.

```
Router# debug all
 This may severely impact network performance. Continue? [confirm] y
 All possible debugging has been turned on
Router# show debug
 "debug all" is in effect.
```

The following example turns off ARAP debugging. The **show debug** command confirms the configuration.

```
Router# undebug all
 All possible debugging has been turned off
Router# show debug
Router#
```

The following example shows debug output for two lines, 2 and 4. The boldfaced portion of this example shows that for line 2, `LA` is the MNP4 acknowledge frame, `31` is the sequence number of the last frame, and `08` is the window size.

```
ARAP MEM TTY 4: arap_getbuffer 94745C
 ARAP MEM TTY 4: arap_datagram_done 7BD324
 MNP4 TTY 4:mnp4_input()
 MNP4 TTY 2:mnp4_input()
 ARAP MEM TTY 2: arap_getbuffer 7BD158
 MNP4 TTY 2:Rcv LA Nr[31] Nk[08]
 ARAP MEM TTY 2: arap_datagram_done 7BD6BC
 MNP4 TTY 4:mnp4_input()
 ARAP SMARTBUF TTY 2: ring end 936C62, start 934ED4, need 58 bytes
 ARAP SMARTBUF TTY 2: new seq 161

 ARAP TTY 4: Received TICKLE
 ARAP TTY 4: --------- ACKing 125 ---------
 ARAP SMARTBUF TTY 2: ring end 936C28, start 934ED4, need 58 bytes
 ARAP SMARTBUF TTY 2: new seq 160
 ARAP SMARTBUF TTY 2: ring end 9342B4, start 9322EC, need 64 bytes
 ARAP SMARTBUF TTY 2: new seq 144
```

```
 ARAP SMARTBUF TTY 2: search...
 ARAP SMARTBUF TTY 2: search...
0 ddp; trailing; 1 ddp; trailing; 2 ddp; trailing; 3 ddp; trailing; 4 ddp; trailing; 5
ddp; 6 offset; 7 ddp; trailing; 8 ddp; 9 offset; 10 ddp; trailing; 11 ddp; trailing; 12
ddp; trailing; 13 ddp; trailing; 14 ddp; 15 ddp; trailing; 16 ddpARAP SMAR
@TBUF TTY 2: ring end 936C62, start 934ED4, need 58 bytes
 ARAP SMARTBUF TTY 2: new seq 161

 ARAP TTY 4: Received TICKLE
 ARAP TTY 4: --------- ACKing 125 ---------
 ARAP TTY 2: Received TICKLE
 ARAP TTY 2: --------- ACKing 114 ---------

 V42bis TTY 4: OUT uncomp (12): 0 10 16 33 0 9 1 195 255 255 255 255
 V42bis TTY 4: OUT comp (6): 10 38 229 203 3 0
 V42bis TTY 4: IN comp (6): 205 145 196 79 2 0
 V42bis TTY 4: IN uncomp (12): 0 10 16 143 0 9 0 0 255 255 255 255
 V42bis TTY 4: OUT uncomp (6): 0 4 16 143 0 0
 V42bis TTY 4: OUT comp (6): 182 244 235 0 2 0
 V42bis TTY 4: IN comp (6): 217 111 250 0 2 0
 V42bis TTY 4: IN uncomp (6): 0 4 16 33 0 0
 V42bis TTY 2: IN comp (5): 247 225 15 102 0
 V42bis TTY 2: IN uncomp (12): 0 10 16 132 0 9 255 219 255 255 255 255
 V42bis TTY 2: OUT uncomp (6): 0 4 16 132 0 0
 V42bis TTY 2: OUT comp (6): 126 63 196 65 2 0
.
.
.
```

ARA Configuration and Connection Examples

This section contains the following examples of and procedures for ARA configuration:

- ARA Server Configuration Procedure
- Dedicated ARA Line with User Authentication Example
- Autostart Multiple ARA Lines with User Authentication Example
- Telebit T-3000 Modem Setup Procedure
- Modified and Unmodified CCL Scripts Sample Commands
- ARA Router Support Example
- Extended AppleTalk Network Example
- Cable Range Expansion Example
- Extended Network in Discovery Mode Example
- TACACS Username Authentication Example
- TACACS Enabled for ARA Authentication Example
- AppleTalk Network Connection over a Foreign Protocol Example

ARA Server Configuration Procedure

The following sample procedure shows how to set up ARA functionality.

Log in to the router, use the **enable** command to enter your password if one is set, use the **configure** command to enter configuration mode, and add the following commands to your configuration:

```
appletalk routing
arap network 104 ARAP Dialin Zone
interface ethernet 0
 appletalk cable-range 0-0 0.0
! Puts router in discovery mode.
line 5 6
 modem inout
 speed 38400
 arap enabled
 autoselect
```

If you already know the cable range and the zone names you need, include the information in the configuration file. If you do not know this information, perform the following steps to use the discovery mode to allow the Cisco IOS software to learn about the AppleTalk network:

Step 1 Permit the Cisco IOS software to monitor the line for a few minutes.

Step 2 Log in and enter configuration mode.

Step 3 Display the configuration again (using the **more nvram:startup-config** command).

Step 4 Note the **appletalk cable-range** and **appletalk zone** variables.

Step 5 Manually add the information in those two entries and add any user accounts:

```
appletalk cable-range 105-105 105.222
appletalk zone Marketing Lab
username arauser password arapasswd
! Add as many users as you need.
```

Step 6 Save the configuration.

Step 7 Display the configuration again (using the **more nvram:startup-config** command) to make sure the configuration is correct.

Dedicated ARA Line with User Authentication Example

The following example configures line 2 as a dedicated ARA line with user authentication information on the ARA server; guests are not allowed to make ARA sessions:

```
username jsmith password woof
line 2
 arap dedicated
 arap noguest
```

Autostart Multiple ARA Lines with User Authentication Example

The following example enables ARA on lines 2 through 16. Username authentication is configured on the ARA server, and the lines are configured to automatically start an ARA session when an ARA user on a Macintosh attempts a connection.

```
username jsmith password woof
line 2 16
 autoselect
 arap enabled
 arap noguest
```

Telebit T-3000 Modem Setup Procedure

To set up a Telebit T-3000 modem that attaches to a router, which supports hardware flow control, perform the following steps. The Macintosh will use a CCL script to configure the attached modem.

Caution When you configure modems for ARA, turn off MNP4 error correction because it can cause connection failures for ARA 1.0 clients. For dedicated ARA lines, it is sufficient to turn off error correction completely in the modem; for multiuse lines it is preferable to leave all forms of non-MNP4 error correction enabled so that users of other protocols can achieve error-corrected connections. This restriction does not apply to installations that only receive calls from ARAP 2.0 clients.

Step 1 Start with the modem at factory defaults. (The preferred configuration for hardware flow control is AT&F9.) Use the **direct** command if you have a terminal attached to the modem, or use the T/D Reset sequence described in the Telebit T-3000 manual to reset the modem to the &F9 defaults.

Step 2 Attach a hardware flow control-capable cable between the modem and the device with which you are configuring the modem. (At this point, the modem is in hardware flow control mode, with autobaud-rate-recognition, and can detect your speed from 300 to 38,400 bps at 8-N-1. However, the modem must receive the flow control signals from the device to which you have the modem attached.)

Step 3 Send the modem the following AT commands:

ATS51=6 E0 Q1 S0=2 &D3 &R3 S58=2 &W

This sequence directs the modem to perform the following tasks:

- Lock your DTE interface speed to 38,400 bps.
- Turn “command echo” off.
- Do not send any result codes.
- Auto-answer on the second ring (Germany requires this setting, but elsewhere you can set it to answer on the first ring with “s0=1”).
- When data terminal ready (DTR) is toggled, reset to the settings in NVRAM.
- Clear To Send (CTS) is always enabled if hardware flow control is disabled.
- Use full-duplex request to send/clear to send (RTS/CTS) flow control.
- Write these settings to NVRAM.

Step 4 At this point, if you press the Return key or enter characters, no characters appear on your screen because the result codes are turned off. You can determine whether the modem is working by getting a list of its configuration registers using the AT command **AT&V.**

Step 5 After the modem is configured, connect it to the router with a modem-to-RJ-45 adapter and an RJ-45 cable to the lines that you plan to use.

The following Cisco IOS commands are compatible with the Telebit 3000 settings described in this section:

```
line 1 8
 arap enable
 autoselect
 no escape-character
 flowcontrol hardware
```

```
 modem dialin
 speed 38400
```

Modified and Unmodified CCL Scripts Sample Commands

If you are using modified CCL scripts and want to migrate to nonmodified scripts, you can set your system to accept logins using both modified CCL and unmodified scripts. Use the following commands in line configuration mode:

```
 autoselect arap
 autoselect during-login
 arap noguest if-needed
```

ARA Router Support Example

The following example configures the router for ARA support, as described in the comments (lines beginning with an exclamation point [!]):

```
! Enable AppleTalk on the router.
appletalk routing
!
interface Ethernet 0
 ip address 172.30.1.1 255.255.255.0
!
! On interface Ethernet 0, assign network number 103 to the physical cable and
! assign zone name "Marketing Lab" to the interface. Assign a zone name if
! you are creating a new AppleTalk internet. If the internet already exists,
! the zone and cable range must match exactly, or you can leave the cable
! range at 0 to enter discovery mode. The suggested AppleTalk address for the interface in
! this example is 103.1.
interface Ethernet 0
 appletalk cable-range 103-103 103.1
 appletalk zone Marketing Lab
! Configure a username and password for the router.
username jake password sesame
! On lines 4 through 8, InOut modems are specified, the lines are configured
! to automatically start an EXEC session or enable AppleTalk, AppleTalk Remote
! Access Protocol is enabled, the modem speed is specified as 38400 bps, and
! hardware flow control is enabled.
line 4 8
 modem InOut
 autoselect
 arap enabled
 speed 38400
 flowcontrol hardware
```

Note You must set your terminal emulator to match the speed that you set for the line.

Extended AppleTalk Network Example

The following example configures the interface for an extended AppleTalk network. It defines the zones named Orange and Brown. The cable range of 1 allows compatibility with nonextended AppleTalk networks.

```
appletalk routing
interface ethernet 0
```

```
appletalk cable-range 1-1
appletalk zone Orange
appletalk zone Brown
```

Cable Range Expansion Example

The following example changes the cable range and reenters the zone name. The initial configuration is as follows:

```
appletalk cable-range 100-103
appletalk zone Twilight Zone
```

The cable range is expanded as follows:

```
appletalk cable-range 100-109
```

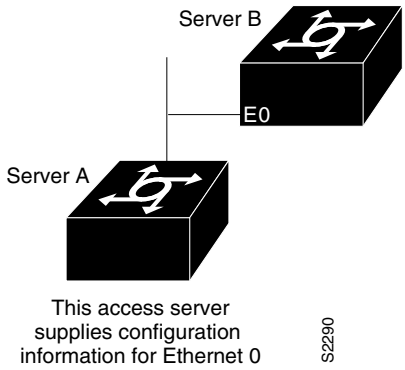
At this point, you must reenter the zone name as follows:

```
appletalk zone Twilight Zone
```

Extended Network in Discovery Mode Example

The following example configures an extended network in discovery mode. In Figure 21, the access server named Server A provides the zone and network number information to the interface when it starts.

Figure 21 Discovery Mode



The following example configures an extended network in discovery mode:

```
appletalk routing
interface ethernet 0
 appletalk cable-range 0-0 0.0
```

TACACS Username Authentication Example

The following example for TACACS and Extended TACACS configures line 1 for ARA and username authentication on a TACACS server:

```
line 1
 login tacacs
 arap enable
```

The following example configures AAA/TACACS+ on line 1 for ARA and username authentication on a TACACS server:

```
line 1
 login authentication
 arap authentication
```

TACACS Enabled for ARA Authentication Example

The following example shows regular TACACS enabled for ARA authentication:

```
line 3
 arap use-tacacs
```

The following example shows AAA/TACACS+ enabled for ARA authentication:

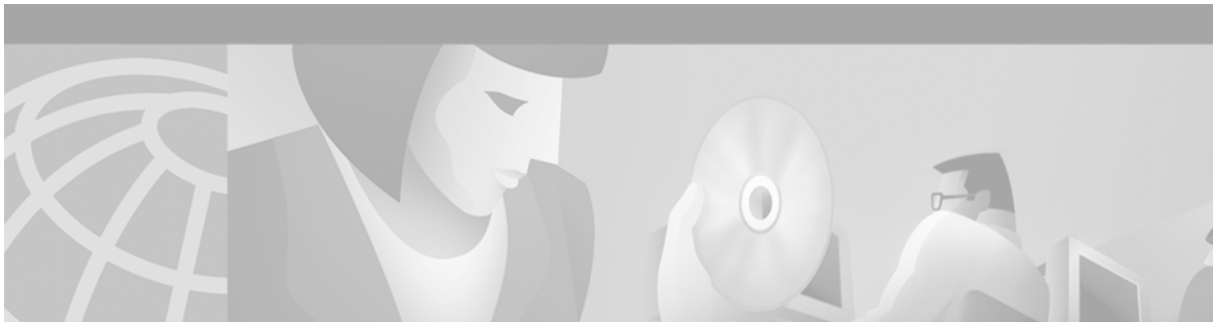
```
line 3
 aaa authentication arap
```

AppleTalk Network Connection over a Foreign Protocol Example

The following example enables a Macintosh client running ARA on a remote network to connect across an X.25 network, through the router, to an AppleTalk network. In this example, virtual terminal lines 0 through 19 are configured for ARA:

```
appletalk routing
line vty 0 19
 arap enable
 autocommand arap
 arap dedicated
 arap timelimit 45
 arap warningtime 5
 arap noguest
 arap require-manual-password
 arap net-access-list 611
```

The Macintosh client connects to any vty from 0 through 19. When the EXEC prompt appears, ARA begins automatically on the line (because of the **autocommand arap** command). The virtual terminal lines 0 through 19 are dedicated to ARA dial-in clients, and those clients have a 45-minute time limit. Five minutes before the line is disconnected, a warning message appears indicating that the session will be disconnected. Guest access is denied, and manual password entry is required. The AppleTalk access list 611 has been applied to the virtual terminal lines, meaning that access to other networks through these virtual terminal lines has been limited.



Configuring Support for NASI Clients to Access Network Resources

This chapter describes how to allow your router to function as a NetWare Asynchronous Support Interface (NASI) server. It includes the following main sections:

- NASI Server Overview
- Configuring the Router as a NASI Server

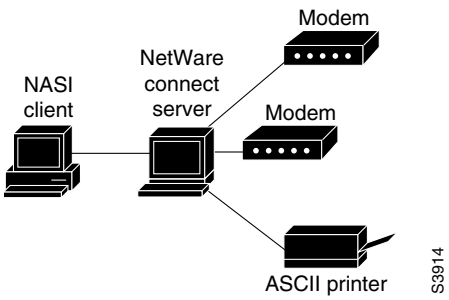
For a complete description of the commands mentioned in this chapter, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter.

NASI Server Overview

A NASI server enables a NASI client to connect to asynchronous network resources (such as modems) without the need for these resources to be located on the desktop of the client. (See Figure 22.)

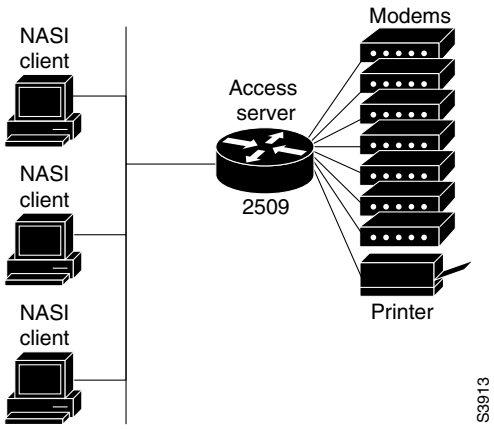
Figure 22 NASI Setup in a NetWare Environment



You can configure the Cisco IOS software to enable NASI clients to connect to asynchronous resources attached to your router. The NASI client can connect to any port on the router other than the console port to access network resources (see Figure 23). The NASI clients are connected to the Ethernet interface 0 on the router. When the user on the NASI client uses the Windows or DOS application to connect to the

router, a list of available terminal and virtual terminal lines appears, beginning with tty1. The user selects the desired outgoing terminal and virtual terminal port. TACACS+ security also can be configured on the router so that after the user selects a terminal and virtual terminal port, a username and password prompt appear for authentication, authorization, and accounting (AAA).

Figure 23 NASI Clients Accessing Asynchronous Resources Through an Access Server



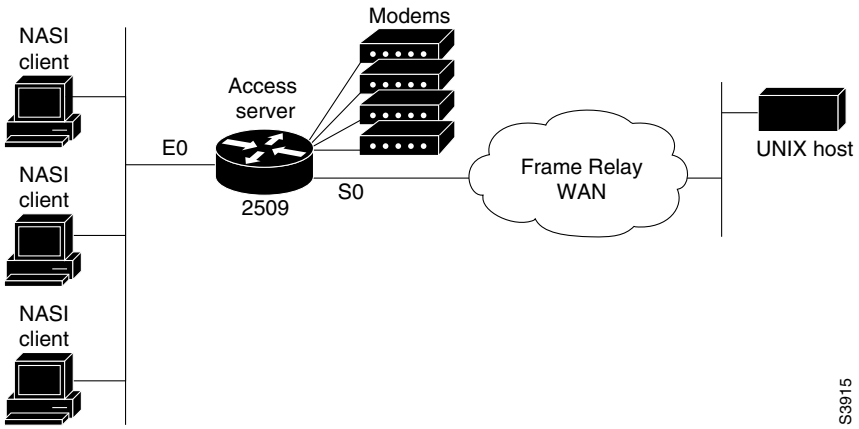
Note The Cisco IOS implementation of NASI functions best with NASI client software version 2.0 and later versions.

The NASI client can be on a local LAN or can be on a remote LAN. If it is on a remote LAN, the following two requirements must be met:

- A router routing Internet Protocol Exchange (IPX) forwards NetWare Connect Server Service Advertising Protocol (SAP) advertisements from the remote LAN to the LAN to which the local router is connected.
- The same router routing IPX spoofs Get Nearest Server (GNS) replies for the GNS requests that the client sends out.

The fact that you can connect to many different ports on the router means that you can provide access to more than one asynchronous device. When the user accesses the vty, the user can connect to the user EXEC facility and issue a Telnet or NASI command to access a remote network (see Figure 24). Only the first available vty appears in the list of available ports on the router (and it is named RCONSOLE).

Figure 24 NASI Clients Gaining Access to IP Hosts on a Remote Network



Configuring the Router as a NASI Server

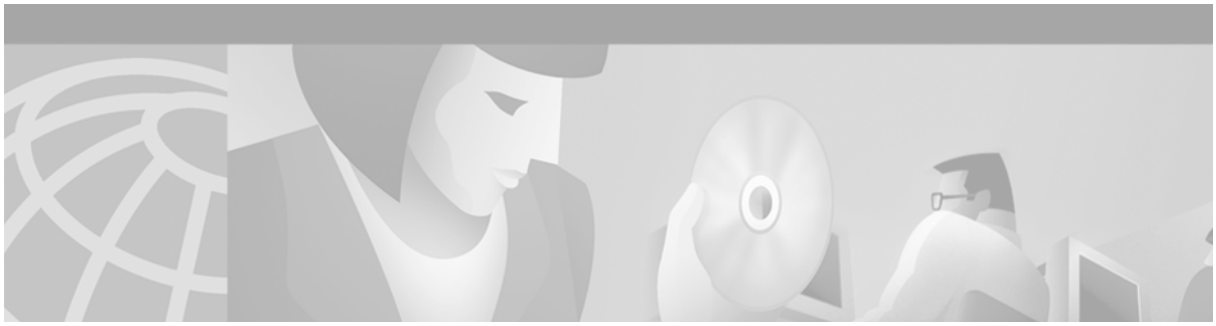
To configure your router as a NASI server, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ipx routing`	Enables IPX routing on the router.
Step 2	`Router(config)# ipx internal-network`	Defines an internal IPX network number.
Step 3	`Router(config)# interface` *type number*	Enters interface configuration mode.
Step 4	`Router(config-if)# ipx network` [*network* | `unnumbered`]	Enables IPX routing on an interface.
Step 5	`Router(config-if)# exit`	Exits to global configuration mode.
Step 6	`Router(config)# ipx nasi-server enable`	Enables NASI.
Step 7	`Router(config)# aaa authentication nasi` {*list-name* | `default`} {`methods list`}	(Optional) Configures TACACS+ security on all lines on the router.
Step 8	`Router(config)# line` [`aux` | `tty` | `vty`] *line-number* [*ending-line-number*]	Enters line configuration mode.
Step 9	`Router(config-line)# login authentication nasi` {*list-name* | `default`}	(Optional) Configures TACACS+ security on a per-line basis.

You also can configure SAP filters to filter SAP updates, and access lists to filter NASI traffic between interfaces on the router.

Note If a NASI server is already on the LAN segment connected to the router, the router cannot respond to GNS requests for NASI services.

If you have configured NASI on your router, you can use IPX client applications to make IPX dial-out connections to a shared pool of asynchronous devices. For example, a NASI client on the LAN can connect to a serial (synchronous or asynchronous) port on the router, which provides access to remote modems, printers, and networks. The command the user issues depends on the application being used to connect to the NASI server. NASI relies on Sequenced Packet Exchange (SPX).



Configuring the Cisco PAD Facility for X.25 Connections

This chapter describes how to use the internal packet assembler/disassembler (PAD) facility to make connections with remote devices over the X.25 protocol. This chapter includes the following sections:

- PAD Connection Overview
- X.3 PAD EXEC User Interface Configuration Task List
- X.28 PAD Emulation Configuration Task List
- Making X.25 PAD Calls over IP Networks
- Configuring PAD Subaddressing
- Configuring X.29 Reselect
- Using Mnemonic Addressing
- PAD Examples

Table 4 in this chapter summarizes the X.3 PAD parameters that you can set. For a complete description of each X.3 parameter supported by the standard X.28 mode or Cisco PAD EXEC user interface, see the appendix "X.3 PAD Parameters" at the end of this publication.

For a complete description of the commands in this chapter, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

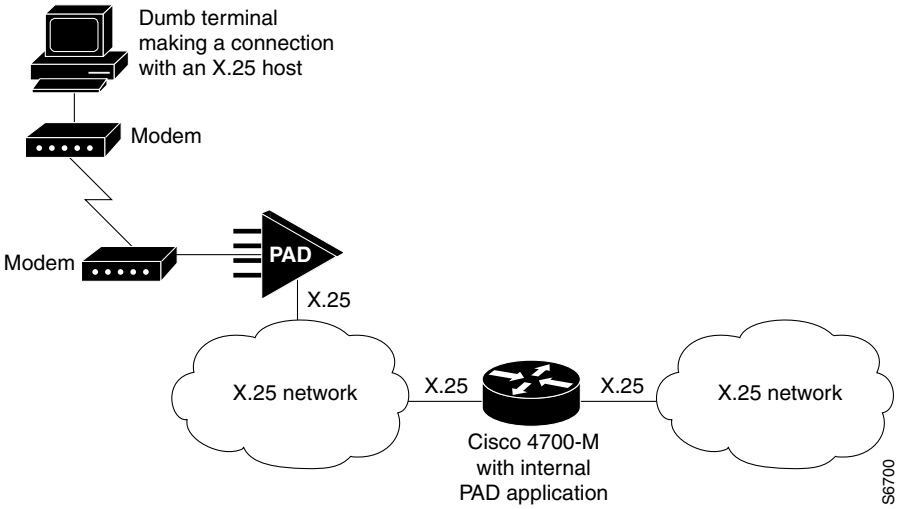
To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter.

PAD Connection Overview

PADs are configured to enable X.25 connections between network devices. A PAD is a device that receives a character stream from one or more terminals, assembles the character stream into packets, and sends the data packets out to a host. A PAD can also do the reverse. It can take data packets from a network host and translate them into a character stream that can be understood by the terminals. A PAD is defined by Recommendations X.3, X.28, and X.29 of the International Telecommunication Union Telecommunication Standardization Sector (ITU-T). (The ITU supersedes the Consultative Committee for International Telegraph and Telephone, or CCITT).

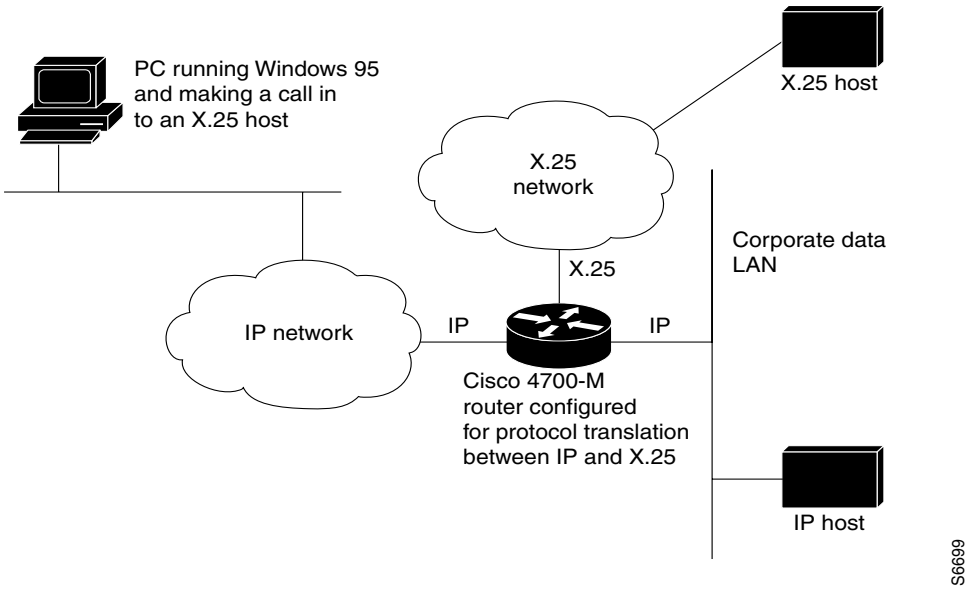
Figure 25 shows a remote X.25 user placing a call through an X.25 switched network to the internal PAD application on a Cisco 4700-M router, and to an X.25 host located inside a corporate data center.

Figure 25 Standard X.25 Connection Between a Dumb Terminal and an X.25 Host



PADs can also be configured to work with a protocol translation application. Figure 26 shows an example of a remote PC placing an analog modem call to an IP network, connecting to a Cisco 4500-M router, and allowing its IP packets to undergo IP-to-X.25 protocol translation. The remote PC, in turn, communicates with an internal PAD device in the Cisco router and establishes a connection with an X.25 host.

Figure 26 PC Dialing In to an X.25 Host Using Protocol Translation



Cisco IOS offers two ways of connecting to a PAD: using the **pad** EXEC user interface command to initiate an outgoing connection to a PAD, and using the **x28** EXEC command to access the Cisco universal X.28 PAD user emulation mode.

In X.28 PAD user emulation mode, you can perform the same functions available from the Cisco **pad** EXEC user interface; however, X.28 PAD user emulation mode adds functionality such as the ability to exchange PAD signals across an X.25 network, and is useful for connecting to systems using software designed to interact with an X.28 PAD. X.28 PAD user emulation mode is also useful when a reverse connection requires packetization according to the X.29 parameters.

Cisco PAD EXEC User Interface Connections

The Cisco IOS **pad** EXEC user interface initiates an outgoing call to a PAD host and in most cases is the preferred PAD connection method. You can have multiple PAD connections open at one time. Options are available for pausing and resuming connections, and setting X.3 PAD parameters at the command line.

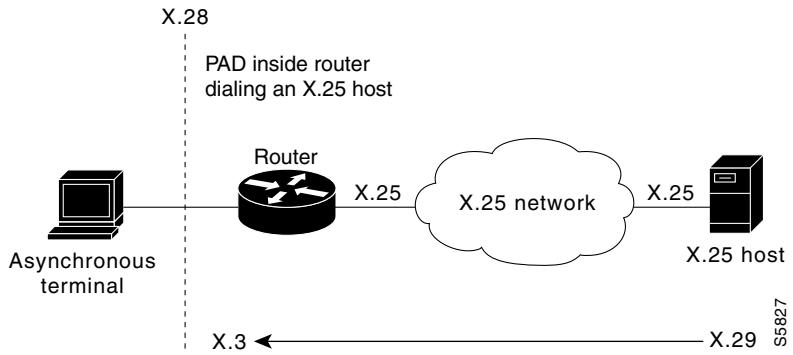
Cisco Universal X.28 PAD Emulation Mode

The Cisco IOS software provides a universal X.28 user emulation mode that enables you to interact with and control the PAD. X.28 emulation effectively turns the Cisco router into an X.28-compliant PAD device that provides a standard user interface between a DTE device and a PAD.

For asynchronous devices such as terminals or modems to access an X.25 network host, the packets from the device must be assembled or disassembled by a PAD. Using standard X.28 commands from the PAD, calls can be made into an X.25 network, X.3 PAD parameters can be set, or calls can be reset.

X.3 is the ITU-T recommendation that defines various PAD parameters used in X.25 networks. X.3 PAD parameters are internal variables that define the operation of a PAD. For example, parameter 9 is the crpad parameter. It determines the number of bytes to add after a carriage return. X.3 parameters can also be set by a remote X.25 host using X.29. (See Figure 27.)

Figure 27 Asynchronous Device Dialing In to an X.25 Host over an X.25 Network



Note Most Cisco routers have internal PAD devices. Use the Feature Navigator on Cisco.com to determine which software supports PAD connections.

X.28 enables PAD system administrators to dial in to X.25 networks or set PAD parameters using the X.28 standard user interface. This standard interface is commonly used in many European countries. It adheres to the X.25 ITU-T standards.

The X.28 interface is designed for asynchronous devices that require X.25 transport to access a remote or native asynchronous or synchronous host application. For example, dialup applications can use the X.28 interface to access a remote X.25 host. X.28 PAD calls are often used by banks to support applications in the "back office" such as ATM machines, point of sales authorization devices, and alarm systems. An ATM machine may have an asynchronous connection to an alarm host and a Cisco router. When the alarm is tripped, the alarm sends a distress call to the authorities via the Cisco router and an X.28 PAD call.

Cisco X.28 PAD calls can be transported over a public packet network, a private X.25 network, the Internet, a private IP-based network, or a Frame Relay network. X.28 PAD can also be used with protocol translation. Protocol translation and virtual asynchronous interfaces enable users to bidirectionally access an X.25 application with the PAD service or other protocols such as Digital, local-area transport (LAT), and TCP.

X.3 PAD EXEC User Interface Configuration Task List

To connect to a PAD using the EXEC user interface, perform the following tasks:

- Making a PAD Connection (Required)
- Switching Between Connections (Optional)
- Exiting a PAD Session (Optional)
- Monitoring X.25 PAD Connections (Optional)
- Setting X.3 PAD Parameters(Optional)

Making a PAD Connection

To log in to a PAD, use the following command in EXEC mode:

Command	Purpose
`Router> pad {x121-address | hostname} [/cud text] [/debug] [/profile name] [/quiet message] [/reverse] [/use-map]`	Logs in to a PAD.

You can exit a connection and return to the user EXEC prompt at any point.

To open a new connection, first exit the current connection by entering the escape sequence (Ctrl-Shift-6 then x [Ctrl^x] by default) to return to the EXEC prompt.

Switching Between Connections

You can have several concurrent sessions open and switch between them. The number of sessions that can be open is defined by the **session-limit** command, which is described in the *Cisco IOS Terminal Services Command Reference*, Release 12.2.

To switch between sessions by escaping one session and resuming a previously opened session, use the following commands in EXEC mode:

	Command	Purpose
Step 1	`Router> Ctrl-Shift-6` then `x` (`Ctrl^x`) by default	Escapes the current connection, if you have one open, and returns to EXEC mode.
Step 2	`Router> where`	From EXEC mode, lists the open sessions. All open sessions associated with the current terminal line are displayed.
Step 3	`Router> resume` [*connection*] [*keyword*]	Makes the connection using the session number displayed by the **where** command.

Note The Ctrl^x, **where**, and **resume** commands are available with all supported connection protocols.

Exiting a PAD Session

To exit a PAD session, enter the escape sequence (Ctrl-Shift-6 then x [Ctrl^x] by default) and enter the **disconnect** command at the EXEC prompt. You can also log out of the remote system by entering the command specific to that system (such as **exit**, **logout**, **quit**, **close**, or **disconnect**).

Monitoring X.25 PAD Connections

To display information about current open connections, use the following command in user EXEC mode:

Command	Purpose
`Router> show x25 pad`	Displays information about X.25 PAD connections that are open.

The information displayed by **show x25 pad** includes packet transmissions, X.3 parameter settings, and the current status of virtual circuits. The information displayed will help you set and change PAD parameters (see the section "X.3 Parameter Customization Example" for an example).

Setting X.3 PAD Parameters

To set X.3 PAD parameters, use one of the following commands in EXEC mode:

Command	Purpose
`Router> resume` [*connection*] [`/set` *parameter:value*] or `Router> x3` *parameter:value*	Sets X.3 PAD parameters.

Table 4 summarizes the X.3 PAD Parameters supported on Cisco devices. See the "X.3 PAD Parameters" appendix in this publication for more complete information about these parameters. Refer to the "ASCII Character Set and Hex Values" appendix in the *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.2, for a list of ASCII characters.

Table 4 Supported X.3 PAD Parameters

Parameter Number	ITU-T Parameter Name	ITU-T X.3 and Cisco Values
1	PAD recall using a character	Minimum value: 0; maximum value: 126; X.28 PAD user emulation mode default: 1. **Note** Not supported by PAD EXEC user interface.
2	Echo	Minimum value: 0; maximum value: 1; PAD EXEC mode and X.28 PAD user emulation mode default: 1.
3	Selection of data forwarding character	Minimum value: 0; maximum value: 255; PAD EXEC mode default: 2 (CR); X.28 PAD user emulation mode default: 126 (~).
4	Selection of idle timer delay	Minimum value: 0; maximum value: 255; PAD EXEC mode default: 1; X.28 PAD user emulation mode default: 0.
5	Ancillary device control	Minimum value: 0; maximum value: 2; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 1.
6	Control of PAD service signals	Minimum value: 0; maximum value: 255; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 2. **Note** Not supported by PAD EXEC user interface.
7	Action upon receipt of a BREAK signal	Minimum value: 0; maximum value: 31; PAD EXEC mode default: 4; X.28 PAD user emulation mode default: 2.
8	Discard output	Minimum value: 0; maximum value: 1; PAD EXEC mode and X.28 PAD user emulation mode default: 0.
9	Padding after Return	Minimum value: 0; maximum value: 255; PAD EXEC mode and X.28 PAD user emulation mode default: 0.
10	Line folding	Not supported.
11	DTE speed (binary speed of start-stop mode DTE)	Minimum value: 0; maximum value: 18; PAD EXEC mode and X.28 PAD user emulation mode default: 14.
12	Flow control of the PAD by the start-stop DTE	Minimum value: 0; maximum value: 1; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 1.
13	Line feed insertion (after a Return)	Minimum value: 0; maximum value: 7; PAD EXEC mode and X.28 PAD user emulation mode default: 0.
14	Line feed padding	Minimum value: 0; maximum value: 255; PAD EXEC mode and X.28 PAD user emulation mode default: 0.
15	Editing	Minimum value: 0; maximum value: 1; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Table 4 Supported X.3 PAD Parameters (continued)

Parameter Number	ITU-T Parameter Name	ITU-T X.3 and Cisco Values
16	Character delete	Minimum value: 0; maximum value: 127; PAD EXEC mode and X.28 PAD user emulation mode default: 127 (DEL).
17	Line delete	Minimum value: 0; maximum value: 127; PAD EXEC mode default: 21 (NAK or Ctrl-U); X.28 PAD user emulation mode default: 24 (CAN or Ctrl-X).
18	Line display	Minimum value: 0; maximum value: 127; PAD EXEC mode and X.28 PAD user emulation mode default: 18 (DC2 or Ctrl-R).
19	Editing PAD service signals	Minimum value: 0; maximum value: 126; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 2. **Note** Not supported by PAD EXEC user interface.
20	Echo mask	Minimum value: 0; maximum value: 255; PAD EXEC mode and X.28 PAD user emulation mode default: 0. **Note** Not supported by PAD EXEC user interface.
21	Parity treatment	Minimum value: 0; maximum value: 4; PAD EXEC mode and X.28 PAD user emulation mode default: 0.
22	Page wait	Not supported.

X.28 PAD Emulation Configuration Task List

To use the X.28 PAD mode, perform the following tasks as needed:

- Accessing X.28 Mode and Setting Options (Required)
- Exchanging PAD Command Signals (Optional)
- Customizing X.3 Parameters (Optional)
- Accepting Reverse or Bidirectional X.25 Connections (Optional)
- Setting PAD French Language Service Signals (Optional)

The section "Cisco Universal X.28 PAD Emulation Mode Examples" provides examples of making X.28 PAD connections.

Accessing X.28 Mode and Setting Options

To access the Cisco IOS universal X.28 emulation mode, use the **x28** EXEC command. This mode can also be accessed with the **autocommand** line configuration command. The **autocommand** command can be assigned to a particular line, range of lines, or login user ID. In this case, when a user connects to the line, the user sees an X.28 interface. Using the **noescape** option with the autocommand feature blocks users from getting into EXEC mode.

The default X.28 router prompt is an asterisk (*). After you see *, the standard X.28 user interface is available. You configure the PAD in this mode.

To enter X.28 mode and set different access and display parameters, use the following commands in EXEC mode:

Command	Purpose
`Router> x28 escape character-string`	Specifies a character string to use to exit X.28 mode and return to EXEC mode. This string becomes an added command to X.28 mode that, when entered by the user, terminates X.28 mode and returns to EXEC mode. The default escape string is **exit**.[1]
`Router> x28 nuicud`	Places the data entered in the network user identification (NUI) facility by the user into the Call User Data (CUD) field of the X.25 call request packet.[2]
`Router> x28 profile file-name`	Specifies a user-defined X.3 profile. If this option is specified, with a profile name, then the profile is used as the initial set of X.3 parameters.[3]
`Router> x28 reverse`	Reverses the charges of all calls dialed by the local router. The address of the destination device is charged for the call. This is the default configuration. Every call is placed with the reverse charge request set.
`Router> x28 verbose`	Displays detailed information about the X.25 call connection (for example, address of the remote DTE device and the facility block used).

1. If the **x28 noescape** command is set, then it is impossible to return to the EXEC mode from X.28 mode. Use with caution. This command is not accepted when using the console line.
2. Upon entry of the **x28 nuicud** command, the network user (NU) data will not be placed in the NUI facility of the call request. Instead it will be placed in the CUD field. If you configure the **x28 nuicud** command, all reverse charging requests set by the **x28 reverse** command are disabled.
3. Profiles are created with the **x29 profile** EXEC command. If the X.29 profile is set to **default**, the profile is applied to all incoming X.25 PAD calls, including the calls used for protocol translation.

Note See the section "PAD Mode Connection Examples" for examples of how the **x28** and **pad** commands work.

Exchanging PAD Command Signals

The Cisco IOS universal X.28 emulation mode allows you to interact with and control the PAD. During an exchange of control information, messages or commands sent from the terminal to the PAD are called PAD command signals. Messages sent from the PAD to the terminal are called PAD service signals.

Many X.25-related functions can be performed in X.28 mode by exchanging PAD signals, such as placing and clearing calls. Table 5 lists the PAD X.28 command signals supported in the Cisco universal X.28 emulation mode.

Table 5 Available PAD Command Signals

Command	Extended Command	Purpose
break	—	Simulates an asynchronous break.
call	—	Places a virtual call to a remote device.

Table 5 Available PAD Command Signals (continued)

Command	Extended Command	Purpose
command-signal	—	Specifies a call request without using a standard X.28 command, which is entered with the following syntax: *facilities*-*x121-address*D*call-user-data.* The hyphen (-) and "D" are required keywords.
clr	**clear**	Clears a virtual call.
help	—	Displays help information.
iclr	**iclear**	Requests the remote device to clear the call.
int	**interrupt**	Sends an Interrupt packet.
par? **par**	**parameter read**	Displays the current values of local parameters.
prof	**profile** *file-name*	Loads a standard or named profile.
reset	—	Resets the call.
rpar?	**rread**	Displays the current values of remote parameters.
rset?	**rsetread**	Sets and then reads values of remote parameters.
set	—	Changes the values of local parameters. (See the "Customizing X.3 Parameters" section later in this chapter.)
set?	**setread**	Changes and then reads the values of parameters.
stat	**status**	Requests status of a connection.
selection pad	—	Sets up a virtual call.

Note You can choose to use the standard or extended command syntax. For example, you can enter the **clr** command or **clear** command to clear a call. A command specified with standard command syntax is merely an abbreviated version of the extended syntax version. Both syntaxes function the same.

Placing a Call

To place a call to another X.25 destination, you specify the destination X.121 address optionally preceded by facility requests and optionally followed by CUD. As of Cisco IOS Release 12.0, Cisco only supports the reverse charge and NUI facilities.

To place a call, use the following commands in EXEC mode:

	Command	Purpose
Step 1	`Router> x28`	Enters X.28 mode. An asterisk prompt appears.
Step 2	`* call` *address*	Dials the address of the remote interface.

Note In X.28 mode, you can perform the same functions as those available with the Cisco **pad** EXEC user interface. However, X.28 mode adds functionality such as setting X.3 PAD parameters with industry-standard X.28 commands.

Clearing a Call

To clear a connection after you connect to a remote X.25 device, use the following commands in EXEC mode:

	Command	Purpose
Step 1	`* Ctrl-p`	From the remote host, escapes back to the local router.
Step 2	`Router> clr`	Clears the virtual call.

Customizing X.3 Parameters

To set an X.3 PAD parameter from a local terminal, use the following commands in EXEC mode:

	Command	Purpose
Step 1	`Router> x28`	Enters X.28 mode.
Step 2	`* par`	Displays the current X.3 PAD parameters.
Step 3	`* set` *parameter-number*`:` *new-value*	Changes the value of a parameter.
Step 4	`* par`	Verifies that the new PAD parameter was set correctly.

See Table 4 and the"X.3 PAD Parameters" appendix at the end of this publication for more information.

Accepting Reverse or Bidirectional X.25 Connections

Active lines operating in X.28 mode can receive incoming calls from the network, if they do not already have an active call. The user is notified of the call by the X.28 incoming call service signal. This feature extends the traditional capability of reverse PAD connections, which could only be received on lines that were not active.

The criteria to choose the line the call is intended for are the same as for reverse PAD connections. (The rotary is chosen from the subaddress portion of the destination address.) Because the normal rotary selection mechanism (which checks whether lines have an active EXEC) takes precedence, reverse connections to lines in X.28 mode only will work reliably to rotaries consisting of a single line.

Setting PAD French Language Service Signals

Extended dialog mode for PAD service signals is available in both the French and English languages with the PAD French Enhancement feature. The French language service signals are maintained in a table. When configured for the French language via PAD parameter 6, the PAD service signals map to

this table, giving the appropriate French equivalent output. The internal table maintenance is based on the contents of the Annex-C/X.28 standard. Section 3.5/X.28 outlines parameter 6 and how it relates to extended mode dialog in multiple languages.

The French language service signals are maintained in a table. When set for the French language via PAD parameter 6, the PAD service signals map to the French language service signals and provide the appropriate French equivalent output.

In X.28 Mode

To set French language service signals in X.28 mode, use the following commands beginning in EXEC mode:

	Command	Purpose
Step 1	`Router> x28`	Enters X.28 mode.
Step 2	`* set 6:9`	Sets the value of parameter 6 to 9 for French recognition.

Using an X.29 Profile

You can create an X.29 profile script that sets X.3 PAD parameters by using the **x29 profile** command. See the section "Creating an X.29 Profile Script" in the chapter "Configuring Protocol Translation and Virtual Asynchronous Devices" for more information about X.29 profiles.

To set French language service signals using an X.29 profile, use the following command in global configuration mode:

Command	Purpose
`Router(config)# x29 profile` *profilename* `6:9`	Sets the value of parameter 6 to 9 (on a defined set of X.3 parameters) for French recognition in an X.29 profile.

Verifying PAD French Enhancement

To verify that PAD French enhancement has been configured, enter the **parameter** command in X.28 EXEC mode (for either X.28 or X.29 profiles):

```
* parameter
   PAR 1:1 2:1 3:16 4:0 5:1 6:9 7:2 8:0 9:1 10:0 11:4 12:1 13:0 14:0 15:0 16:12 17:2 18:0
   19:0 20:0 21:0 22:0
```

Remote Access to X.28 Mode

Several ways to access X.28 PAD mode on the router are described in the following sections:

- Using an Asynchronous Line
- Using Incoming Telnet
- Using Incoming X.25

Using an Asynchronous Line

If an asynchronous line is configured with the **autocommand x28** command, the devices connected to the asynchronous line always get X.28 mode. Otherwise, an EXEC session is on the line and the **x28** command can be issued to start X.28 mode.

To set up X.28 mode on the router, perform the following the steps:

Step 1 Enter global configuration mode:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2 Bring up a one or more asynchronous lines and enter the **autocommand x28** command:

```
Router(config)# line 1 2
Router(config-line)# autocommand x28
```

Using Incoming Telnet

An incoming Telnet connection originates from a TCP/IP network. This connection method is used for a two-step connection from an IP device to an X.25 device.

To set up an incoming Telnet connection on the router, perform the following the steps:

Step 1 Telnet to the PAD facility inside the router.

Step 2 Instruct the PAD to connect to the X.25 device by configuring a range of virtual terminal lines to contain the **autocommand x28** command and the **rotary** *number* command:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# line vty 0 4
Router(config-line)# autocommand x28
Router(config-line)# rotary 1
Router(config-line)# exit
Router(config)#
```

Step 3 Assign an alternate IP address to the rotary port using the **ip alias** command:

```
Router(config)# ip alias aaa.bbb.ccc.ddd 3022
```

In this example, **22** is the rotary number assigned. The field **aaa.bbb.ccc.ddd** is an additional IP address assigned to the router for X.28 PAD mode incoming calls.

Step 4 The remote user accesses X.28 mode on the router by entering the **telnet aaa.bbb.ccc.ddd** command from the IP host. If required, login options can be specified on this vty.

```
ip-host% telnet 172.19.90.18

Trying 172.19.90.18...
Connected to 172.19.90.18.
Escape character is '^]'.
```

```
User Access Verification
Username: letmein
Password: guessme
*
```

Using Incoming X.25

An incoming X.25 connection originates from an X.25 network. This connection method is an unlikely scenario because most users likely are already connected to an X.25 host. However, this configuration is useful for circumventing security restrictions.

To set up incoming X.25 connection on the router, configure a range of virtual terminal lines with the **autocommand x28** command and specify a rotary number with the **rotary** *number* command.

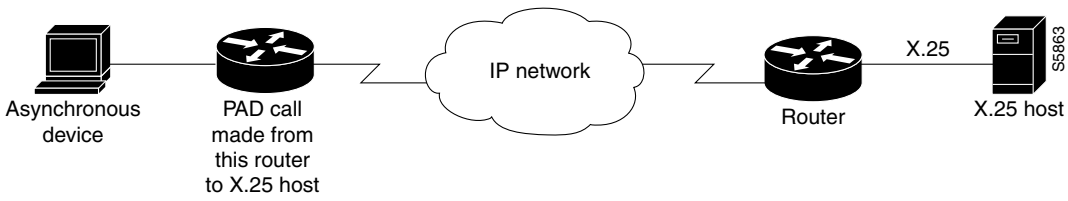
```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# line vty 0 4
Router(config-line)# autocommand x28
Router(config-line)# rotary 1
```

The remote user can now access X.28 mode by initiating a connection to the X.21 address AAAAxx, where AAAA is the X.21 address of the router and xx is the specified rotary number.

Making X.25 PAD Calls over IP Networks

PAD calls can be made to destinations that are not reachable over physical X.25 interfaces, but instead over TCP tunnels. PAD calls originating from a router on an IP link can reach an X.25 device. This feature is also known as PAD over XOT (X.25 over TCP). The **service pad to-xot** command and **service pad from-xot** global configuration command enable the PAD over XOT feature. Figure 28 shows PAD calls originating from a router in an IP network reaching an X.25 device.

Figure 28 PAD Dialing In to an X.25 Host over an IP Network



To allow PAD connections over XOT on the router, use the following commands beginning in privileged EXEC mode:

	Command	Purpose
Step 1	`Router# configure terminal`	Enters global configuration mode.

	Command	Purpose
Step 2	`Router(config)# service pad [from-xot] [to-xot]`	Specifies outgoing PAD calls over XOT or incoming XOT to PAD connections.
Step 3	`Router(config)# x25 host name x121-address` or `Router(config)# x25 route x121-address xot x121-address`	Depending on your application, specifies an X.121 address for the host name of the router or an X.25 route pointing out over XOT.[1]

1. The X.121 address of the **x25 host** command serves as a source address or sink address for PAD over XOT connections that do not have an interface. Protocol translation can also be used with incoming PAD calls over XOT, which is configured with the **translate x25** command.

Configuring PAD Subaddressing

In situations where the X.121 calling address is not sufficient to identify the source of the call, you can append a specified value to the calling address using the PAD subaddressing feature. PAD subaddressing allows you to create unique X.121 calling addresses by including either a physical port number or a value specified for a line as a subaddress to the X.121 calling address.

PAD subaddressing enables an X.25 host application to uniquely identify the source of an X.121 call. For example, in some bank security alarm applications, the central alarm host identifies the physical location of the alarm units from subaddressing information contained in the Call Request packet.

Note For an example showing PAD address substitution, see the section "Address Substitution for PAD Calls Example" in this chapter.

Before you can configure PAD subaddressing, you need to configure your router or access server to support X.25. For more information, refer to the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2.

To configure PAD subaddressing, use the following commands beginning in privileged EXEC mode:

	Command	Purpose
Step 1	`Router# configure terminal`	Enters global configuration mode.
Step 2	`Router(config)# line [aux | console | tty | vty] line-number [ending-line-number]`	Identifies the line(s) whose information will be appended to the X.121 address as the subaddress.
Step 3	`Router(config-line)# x25 subaddress {line | number}`	Creates a unique X.121 calling address by adding either a physical port number or a numeric value for a line as a subaddress to the X.121 calling address.

Configuring X.29 Reselect

Cisco supports X.29 reselect, which is a standard Triple-X PAD function supported in later versions of the X.3, X.28, and X.29 specifications. X.29 reselect is used in conjunction with mnemonics and autoconnect/autocall to the "first host." X.29 reselect is for security checking and DNS, such as the X.25 naming/selection of destinations within a public or private network. The primary (first) destination host acts much like a RADIUS/TACACS server. At a minimum, both the PAD and the "first host" used in the topology need to support X.29 reselect. X.29 reselect is transparent to network elements or switches. No Cisco IOS commands need to be entered to enable X.29 reselect. It is enabled by default.

Using Mnemonic Addressing

Mnemonic addressing enables you to connect to a remote host by using its mnemonic address, not the X.121 address. As the number of hosts grows within an X.25 network, system administrators need to remember numerous 14-digit X.121 addresses to connect to multiple host applications. To ease the burden of this administrative overhead, asynchronous PAD users can now access hosts by using mnemonic (abbreviated) addressing.

When the user specifies the mnemonic address in the **call** X.28 command, the mnemonic gets translated to an X.121 address in the local PAD. The resulting call request contains both the X.121 calling and called addresses.

Note For an example showing PAD address substitution, see the section "Address Substitution for PAD Calls Example" in this chapter.

Character Limitations

You can use the following formats to specify a mnemonic address:

- Any combination of numbers, letters, and special characters preceded by a dot, or period (.)
- Up to 250 characters in one address

Note All other facilities provided in X.28 emulation mode remain the same.

Mnemonic Format Options

This section provides examples of format options.

Example 1

Format

c <NUI, Facilities>-.<Mnemonic>*<call-user-data>

Description

This is the generalized format of the **call** command where you can specify NUI and facilities with -.mnemonics and an asterisk (*) before the call user data (CUD). The comma (,) separates individual facility specifications.

Example Syntax

```
Nsmith-.billing*xyz
```

In this example, the following facilities are specified:

```
smith = NUI and no facilities
billing = 31xx4085272478
xyz = CUD
```

Example 2

Format

c .<Mnemonic>*<call-user-data>

Description

No facilities, with CUD.

Example Syntax

```
c .billing*xyz
```

In this example, the following facility is specified:

```
billing = 31xx4085272478 with CUD of xyz
```

Example 3

Format

c <Mnemonic>

Description

No dot, no facilities, no CUD.

Example syntax

```
billing
```

In this example, the following facility is specified:

```
billing = 31xx4085272478
```

Example 4

Format

<Mnemonic>

Description

No dot, no facilities, no CUD.

Example Syntax

```
billing
```

In this example, the following facility is specified:

```
billing = 31xx4085272478
```

Facility Codes

Table 6 lists the supported facility codes that can be specified in the Call Request packet. The X.121 address is a *word* with decimal digits.

Table 6 Facility Codes

Code	Description
N *word*	NUI.
T *word*	Recognized Private Operating Agency (RPOA).
R	Reverse charge.
G *word*	Closed user group (*word* is one or two decimal digits).
O *word*	Closed user group with outgoing access (*word* is one or two decimal digits).
C	Charging information.
E *word*	Called address (*word* is up to 40 decimal digits).
F	Fast select with no restrictions.
S	Reselect prevention.
Q	Fast select with restrictions.

PAD Examples

This section provides the following PAD connection and configuration examples:

- PAD EXEC User Interface Connection Examples
- Cisco Universal X.28 PAD Emulation Mode Examples
- PAD XOT Examples
- PAD Subaddressing Examples

PAD EXEC User Interface Connection Examples

This section provides the following examples of making PAD connections using the **pad** command:

- PAD Mode Connection Examples
- X.3 Parameter Customization Example
- Load an X.3 Profile Example
- Set PAD Parameters Example

PAD Mode Connection Examples

The following examples show two ways to make a call to a remote X.25 host over a serial line. The interface address of the remote host is 123456. In the first example, Router-A calls Router-B using the **pad 123456** EXEC command. The second example shows Router-A calling Router-B using the **call 123456** PAD signal command in X.28 mode. Both commands accomplish the same goal.

```
Router-A# pad 123456
Trying 123456...Open

Router-B> exit

[Connection to 123456 closed by foreign host]

Router-A# x28

* call 123456
COM

Router-B>
```

The following examples show two ways to clear a connection with a remote X.25 host. The first example shows Router-A disconnecting from Router-B using the **disconnect** command in EXEC mode. The second example shows Router-B disconnecting from Router-A using the **clr** command in X.28 mode.

```
Router-A# pad 123456
Trying 123456...Open

Router-B> <Enter the escape sequence (for example, press Shift-Ctrl-^-x).>

Router-A# disconnect
Closing connection to 123456 [confirm]
Router-A#

Router-A# x28

* call 123456
COM

Router-B> <Press Ctrl-p>
* clr

CLR CONF

*
```

X.3 Parameter Customization Example

The following example shows how to change a local X.3 PAD parameter from a remote X.25 host using X.29 messages, which is a secure way to enable a remote host to gain control of local PAD. The local device is Router-A. The remote host is Router-B. The parameters listed in the ParamsIn field are incoming parameters, which are sent by the remote PAD. The parameters listed in the ParamsOut field are parameters sent by the local PAD.

```
Router-A# pad 123456
Trying 123456...Open

Router-B> x3 2:0
Router-B>
```

```
Router-A# show x25 pad

tty0, connection 1 to host 123456

Total input: 12, control 3, bytes 35. Queued: 0 of 7 (0 bytes).
Total output: 10, control 3, bytes 64.
Flags: 1,   State: 3,   Last error: 1
 ParamsIn:  1:0, 2:0, 3:0, 4:0, 5:0, 6:0, 7:0,
    8:0, 9:0, 10:0, 11:0, 12:0, 13:0, 14:0, 15:0,
    16:0, 17:0, 18:0, 19:0, 20:0, 21:0, 22:0,
 ParamsOut:  1:1, 2:0, 3:2, 4:1, 5:1, 6:0, 7:21,
    8:0, 9:1, 10:0, 11:14, 12:1, 13:0, 14:0, 15:0,
    16:127, 17:21, 18:18, 19:0, 20:0, 21:0, 22:0,
Router-A#
```

Load an X.3 Profile Example

The following example modifies and loads an existing X.25 PAD parameter profile. It accesses the existing PAD profile ppp, changes its padding parameter (specified as 9) to a value of 2, and displays the new parameters using the **par** command in X.28 mode.

```
Router-A# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router-A(config)# x29 profile ppp 9:2
Router-A(config)# end
Router-A#
%SYS-5-CONFIG_I: Configured from console by console
Router-A# x28 profile ppp

* par
   PAR 1:1 2:1 3:126 4:0 5:1 6:2 7:2 8:0 9:2 10:0 11:14 12:1 13:0 14:0 15:0 16:127 17:24
   18:18 19:2 20:0 21:0 22:0
```

Note If the X.29 profile is set to **default**, the profile is applied to all incoming X.25 PAD calls, including the calls used for protocol translation.

Set PAD Parameters Example

The following example starts a PAD session:

```
Router> pad 123456789
Trying 123456789...Open
Router2>
```

The following example shows how to reset the outgoing connection default for local echo mode on a router. The **/set** switch sets the X.3 parameters defined by parameter number and value, separated by a colon.

```
Router> resume 3 /set 2:1
```

The following are examples of **show x25 vc** command output for PAD over Connection-Mode Network Service (CMNS), PAD to PAD over X.25, and PAD over XOT (X.25 over TCP) connections:

```
Router# show x25 vc

SVC 1,  State: D1,  Interface: Ethernet0
  Started 00:01:48, last input 00:01:48, output 00:01:48
```

```
  Line: 0   con 0    Location: console Host: 2193330
   connected to 2193330 PAD <--> CMNS Ethernet0 00e0.b0e3.0d62

  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 2  PR: 3  ACK: 3  Remote PR: 2  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 54/19 packets 2/3 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0

SVC 1024,  State: D1,  Interface: Serial1
  Started 00:00:07, last input 00:00:26, output 00:00:26

  Line: 0   con 0    Location: console Host: 2194443
  2191111 connected to 2194443 PAD <--> X25

  Window size input: 5, output: 5
  Packet size input: 128, output: 128
  PS: 0  PR: 0  ACK: 0  Remote PR: 0  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 0/0 packets 0/0 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0

SVC 1,  State: D1,  Interface: [172.21.9.7,1998/172.21.9.11,11000]
  Started 00:06:48, last input 00:06:43, output 00:06:43

  Line: 0   con 0    Location: console Host: 219444001
  219111 connected to 219444001 PAD <--> XOT 172.21.9.7,1998

  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 5  PR: 4  ACK: 4  Remote PR: 5  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes
```

The following example shows output for the **show x25 pad** command:

```
Router# show x25 pad

tty0 (console), connection 1 to host 2194440

Total input: 75, control 2, bytes 3168. Input Queued: 0 of 7 (0 bytes).
Total output: 50, control 2, bytes 52. Output Queued: 0 of 5.
Flags: 1,   State: 3,   Last error: 1
 ParamsIn:  1:0, 2:0, 3:0, 4:0, 5:0, 6:0, 7:0,
    8:0, 9:0, 10:0, 11:0, 12:0, 13:0, 14:0, 15:0,
    16:0, 17:0, 18:0, 19:0, 20:0, 21:0, 22:0,
 ParamsOut:  1:1, 2:0, 3:2, 4:1, 5:1, 6:0, 7:21,
    8:0, 9:0, 10:0, 11:14, 12:1, 13:0, 14:0, 15:0,
    16:127, 17:21, 18:18, 19:0, 20:0, 21:0, 22:0,

tty18, Incoming PAD connection
Total input: 2, control 2, bytes 54. Input Queued: 0 of 7 (0 bytes).
Total output: 1, control 2, bytes 9. Output Queued: 0 of 5.
Flags: 1,   State: 3,   Last error: 1
 ParamsIn:  1:1, 2:0, 3:2, 4:1, 5:0, 6:0, 7:21,
    8:0, 9:0, 10:0, 11:14, 12:0, 13:0, 14:0, 15:0,
    16:127, 17:21, 18:18, 19:0, 20:0, 21:0, 22:0,
 ParamsOut:  1:1, 2:1, 3:2, 4:1, 5:0, 6:0, 7:4,
    8:0, 9:0, 10:0, 11:14, 12:0, 13:0, 14:0, 15:0,
    16:127, 17:21, 18:18, 19:0, 20:0, 21:0, 22:0,
```

Cisco Universal X.28 PAD Emulation Mode Examples

This section contains the following examples of making PAD connections using the **x28** command:

Set Parameters Using X.28 PAD Emulation Mode Example

The following example configures parameter 9 from 0 to 1, which adds a byte after the carriage return. This setting is performed from a local terminal using the **set** *parameter-number*:*new-value* PAD command signal.

```
Router# x28

* par
   PAR 1:1 2:1 3:126 4:0 5:1 6:2 7:2 8:0 9:0 10:0 11:14 12:1 13:0 14:0 15:0 16:127 17:24
   18:18 19:2 20:0 21:0 22:0

* set 9:1

* par
   PAR 1:1 2:1 3:126 4:0 5:1 6:2 7:2 8:0 9:1 10:0 11:14 12:1 13:0 14:0 15:0 16:127 17:24
   18:18 19:2 20:0 21:0 22:0

*
```

NUI Data Relocation Example

The following example sends an authentication message to a remote X.25 host using the **x28 nuicud** command in Cisco X.28 mode followed by the **Ncisc-123456** command. The network identifier is N. The network user password is cisc. The destination address of the remote device is 123456. The ASCII representation of the user password appears in the CUD field, not in the data packet.

```
Router-A# debug x25 event
X.25 special event debugging is on
Router-A# x28 nuicud

* Ncisc-123456
COM

Router-B>
02:02:58: Serial1: X.25 O P1 Call (16) 8 lci 20
02:02:58:   From(3): 222 To(3): 123456
02:02:58:   Facilities: (0)
02:02:58:   Call User Data (8): 0x01000000xxxxxxxx (pad)
02:02:58: Serial1: X.25 I P2 Call Confirm (5) 8 lci 20
02:02:58:   From(0):  To(0):
02:02:58:   Facilities: (0)
```

X.25 Reverse Charge Example

The following example shows how to use the **x28 reverse** command to make the charges for all outgoing calls made from the local router be reversed to the destination device. To reverse the charges for only one outgoing call, use the **R-***address* command, which is the standard X.28 reverse charge facility command.

```
Router-A# x28 reverse

* exit

Router-A# x28

* R-123456
COM
```

X.25 Call Detail Display Example

Each time a call is made to a remote device, you can specify that detailed information be displayed about the call and the destination device by entering the **x28 verbose** command. The following example shows reverse charging configured and CUD represented as userdata:

```
Router# x28 verbose

* R-111*userdata

Called DTE Address : 3001
Facility Block     : R
Call User Data     :userdata
COM
```

Set PAD French Service Signals in X.28 Mode Example

The following example shows PAD French enhancement being set in X.28 EXEC mode:

```
Router # x28
* set 6:9
```

Set PAD French Service Signals with an X.29 Profile Example

The following example shows PAD French enhancement being set with an X.29 profile:

```
Router(config)# x29 profile Primary 6:9
```

Get Help Example

The following example shows how to use the **help** command to get short descriptions of the available parameters:

```
* help
The "help" PAD command signal consists of the following elements:
 <help PAD command signal> <help subject>
  where
 <help subject> is the identifier for the type of
                explanatory information requested
* help break
BREAK    Simulate async BREAK
```

PAD XOT Examples

The following sections provide PAD over XOT configuration examples:

Accept XOT to PAD Connections Example

The following example enables connections from XOT to a local PAD. Because XOT is a TCP connection, the connection is not tied to an X.25 interface. An X.25 address must be configured for the host name of the router that is accepting the call. In this case, the router answers and clears an incoming PAD call through address 1234.

```
Router(config)# service pad from-xot
Router(config)# x25 host Router-A 1234
```

Accept XOT to Protocol Translation Example

The following example accepts an incoming PAD call over XOT to address 12345. The router then translates the call and makes a TCP connection to the device named puli.

```
Router(config)# service pad from-xot
Router(config)# translate x25 12345 tcp puli
```

Initiate a PAD Call over an XOT Connection Example

The following example enables outgoing PAD to XOT connections from an asynchronous line or vty. A route pointing out over XOT must be configured on the routing table to make a PAD call. This route can also be used for switching.

```
Router(config)# service pad to-xot
Router(config)# x25 route 1111 xot 10.2.2.2.
```

Address Substitution for PAD Calls Example

X25 synchronous or PAD devices attached to a router in a remote location may need to ensure that outgoing PAD calls use an assigned X.121 address for the calling (source) address or an assigned X.121 address for the called (destination) address.

Normally, the called address is sent by default in the outgoing PAD call. For the source address, the PAD applies the address for the originating interface (even if it is NULL) or the X25 host address (for example, XOT) as the source address of the call. To override the default behavior and substitute the original X.121 source/destination address in the outgoing PAD calls, use the **x25 route** command with the **substitute-source** and **substitute-dest** keyword options.

Note Address substitution can be applied to all PAD connections, not just PAD over XOT.

Configuring Address Substitution

The following example performs address substitution for PAD calls over XOT:

```
Router(config)# x25 route ^1234 substitute-source 5678 xot 10.1.1.1
```

or

```
Router(config)# x25 route ^1234 substitute-dest 5678 interface serial 1
```

Verifying Address Substitution

To verify the source or destination address substitution on the outgoing PAD call, use the **debug x25 event** command and **show x25 vc** command.

For example, to substitute the destination address of 8888 to 5678 and replace the default source address of the outgoing PAD call to 1234, enter the following **x25 route** command:

```
Router(config)# x25 route 8888 substitute-source 1234 substitute-dest 5678 interface
serial 1
```

Placing a PAD call to destination 8888 will be substituted by 5678 and a source address of 1234:

```
Router# pad 8888

Trying 8888...Open
```

The following is output of the **x25 debug event** command:

```
Serial1: X.25 O R1 Call (13) 8 lci 1024
   From(4): 1234 To(4): 5678
   Facilities: (0)
   Call User Data (4): 0x01000000 (pad)
Serial1: X.25 I R1 Call Confirm (5) 8 lci 1024
   From(0):  To(0):
   Facilities: (0)
```

The following is output from the **show x25 vc** command:

```
Router# show x25 vc

SVC 1024,  State: D1,  Interface: Serial1
  Started 00:23:54, last input 00:00:13, output 00:00:13

  Line: 0   con 0    Location: console Host: 456
  1234 connected to 5678 PAD <--> X25

  Window size input: 2, output: 2
  Packet size input: 128, output: 128
  PS: 0  PR: 0  ACK: 0  Remote PR: 0  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 68/958 packets 16/27 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

PAD Subaddressing Examples

The following example shows how to configure subaddressing on virtual terminal lines 10 through 20 by appending the line number as a subaddress to the X.121 calling address:

```
Router(config)# line vty 10 20
Router(config-line)# x25 subaddress line
```

The following example shows how to configure subaddressing on the first five TTY lines by appending the value 9 as a subaddress to the X.121 calling address of the X.28 connection originating on these lines:

```
Router(config-line)# line 1 5
Router(config-line)# x25 subaddress 9
Router(config-line)# autocommand x28
```

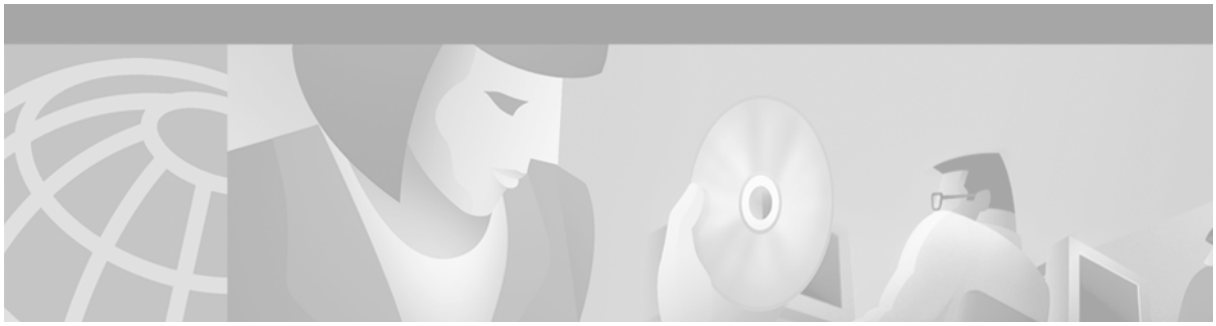
You can use the output from the **debug x25 event** and the **show line** commands to display information about PAD subaddressing. Once you have configured PAD subaddressing, the output from both of these commands changes to reflect the additional subaddress information.

The following example shows **debug x25 event** output, where the X.25 address is 12345 and the subaddress for TTY line 3 is 09:

```
Router# debug x25 event

Serial1: X.25 O P1 Call (14) 8 lci 1024
  From(7): 1234509 To(4): 6789
  Facilities: (0)
  Call User Data (4): 0x01000000 (pad)
Serial1: X.25 I P2 Call Confirm (5) 8 lci 1024
  From (0): to (0):
  Facilities: (0)
  PAD3: Call completed
```

The following example shows sample **show line** output for a router named enkidu, where line 18 has been configured for PAD subaddressing:

```
Router# show line 18

Tty  Typ     Tx/Rx     A Modem  Roty  AccO  AccI  Uses  Noise  Overruns
 18  VTY               -    -      -     -     -     1      0       0/0

Line 18, Location: "enkidu", Type: " "
Length: 48 lines, Width: 80 columns
Baud rate: (TX/RX) is 9600/9600
Status: Ready, Connected, Active, No Exit Banner
Capabilities: Line usable as async interface, PAD Sub-addressing used
Modem state: Ready
```



Configuring Protocol Translation and Virtual Asynchronous Devices

This chapter describes how to configure protocol translation and virtual asynchronous connections using Cisco IOS software. These tasks are described in the following sections, which also describe the process of tunneling and protocol translation, and the two-step and the one-step translation methods:

- Protocol Translation Overview
- Protocol Translation Configuration Task List
- Changing the Number of Supported Translation Sessions
- Configuring Tunneling of SLIP, PPP, or ARA
- Configuring X.29 Access Lists
- Creating an X.29 Profile Script
- Defining X.25 Host Names
- Protocol Translation and Processing PAD Calls
- Increasing or Decreasing the Number of Virtual Terminal Lines
- Enabling Asynchronous Functions on Virtual Terminal Lines
- Maintaining Virtual Interfaces
- Monitoring Protocol Translation Connections
- Troubleshooting Protocol Translation
- Virtual Template for Protocol Translation Examples
- Protocol Translation Application Examples
- Protocol Translation Session Examples

The X.3 packet assembler/disassembler (PAD) parameters are described in the "X.3 PAD Parameters" appendix later in this publication.

The protocol translation facility assumes that you understand how to use the configuration software. Before using this chapter, you should be familiar with configuring the protocols for which you want to translate: X.25, Telnet, local-area transport (LAT), TN3270, AppleTalk Remote Access (ARA), PPP, Serial Line Internet Protocol (SLIP), and XRemote.

Note Telnet is a remote terminal protocol that is part of the TCP/IP suite. The descriptions and examples in the following sections use the term TCP as a reference to Telnet functionality.

To identify the hardware platform or software image information associated with a feature, use the Feature Navigator on Cisco.com to search for information about the feature or refer to the software release notes for a specific release. For more information, see the "Identifying Supported Platforms" section in the "Using Cisco IOS Software" chapter.

For a complete description of the commands in this chapter, refer to the *Cisco IOS Terminal Services Command Reference*, Release 12.2. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

Protocol Translation Overview

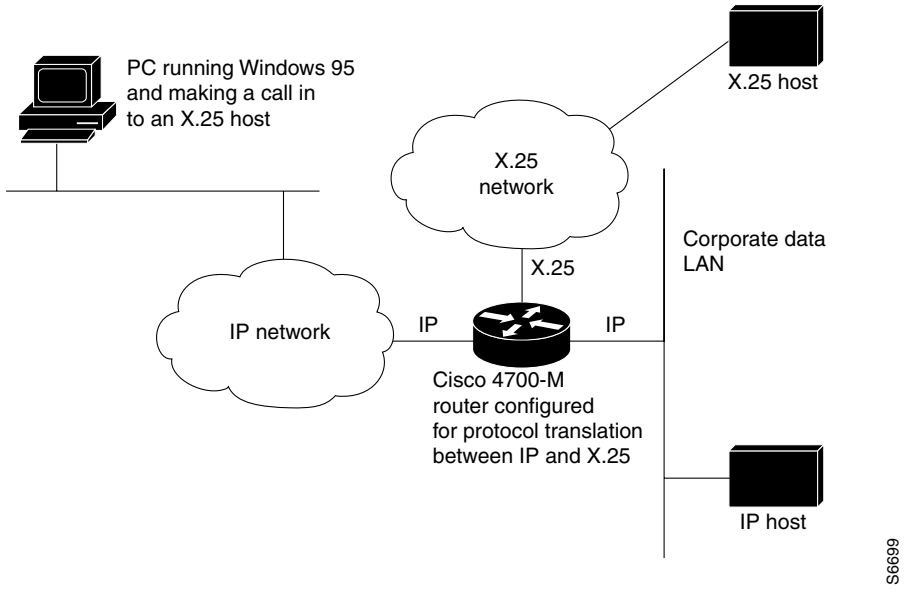
This section describes the additional tasks required to perform protocol translation from one host to another host or to a router. It includes the following sections:

Definition of Protocol Translation

The protocol translation feature provides transparent protocol translation between systems running different protocols. It enables terminal users on one network to access hosts on another network, despite differences in the native protocol stacks associated with the originating device and the targeted host.

Protocol translation is a resourceful facility for many business applications. For example, Figure 29 shows a remote PC dialing through an IP network and connecting to an X.25 host. The TCP packets on the PC undergo a TCP-to-X.25 protocol translation by the Cisco 4700-M router.

Figure 29 Protocol Translation Business Application

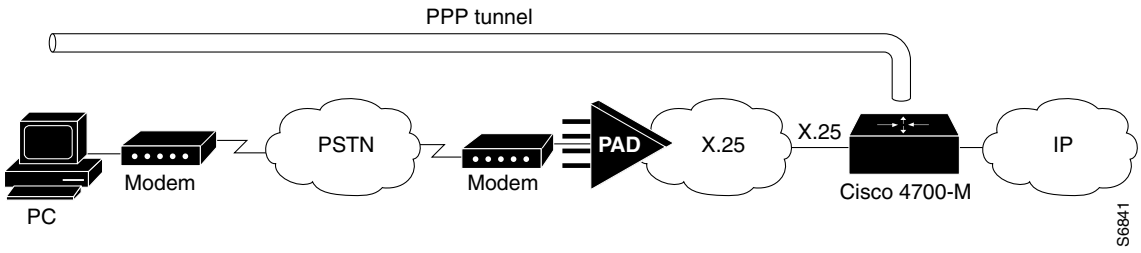


Definition of Tunneling

Unlike other protocols such as LAT, X.25, and TCP, which are actually translated when you use protocol translation, SLIP, PPP, and ARA are not translated to the destination protocol. Instead, they are carried inside a LAT, X.25, TCP, or Layer 2 Forwarding Protocol (L2F) tunnel specific to the device on the remote network. However, the protocol translation facility is used to enable tunneling of SLIP, PPP, or ARA.

Figure 30 shows a typical tunneling scenario.

Figure 30 Tunneling X.25 with PPP Across an IP Network



You can also tunnel PPP-IPX over X.25, TCP, or LAT to an Internetwork Packet Exchange (IPX) network when tunneling PPP on virtual terminal lines.

Deciding Whether to Use One-Step or Two-Step Protocol Translation

The Cisco IOS software supports virtual terminal connections in both directions between the following protocols. You can configure the router to translate automatically between them. This translation method is called *one-step translation*, and is more popular than the two-step method.

- X.25 and LAT
- X.25 and Telnet sessions using the TCP
- LAT and TCP/Telnet

On outgoing connections, you can also use the one-step protocol translation facility to tunnel SLIP or PPP to IP and IPX networks, or ARA to AppleTalk networks across X.25, LAT, or IP (on outgoing connections only).

Cisco IOS software supports limited connections in both directions between the following protocols. Connecting between these protocols requires that you first connect to a router, then to the host to which you want to connect. This translation method is called *two-step translation*, and is the less popular method.

- XRemote to SLIP/PPP and X.25 PAD environments (XRemote must use the two-step method)
- LAT, X.25, SLIP/PPP, and TCP (Telnet) to TN3270 (TN3270 must use the two-step method)

One-Step Protocol Translation

Use the one-step method when network users repeatedly log in to the same remote network hosts through a router. This connection is more efficient than the two-step method and enables the device to have more knowledge of the protocols in use because the router acts as a network connection rather than as a terminal. The one-step method provides transparent protocol conversion. When connecting to the remote network host, the user enters the connection command to the remote network host but does not need to specify protocol translation. The network administrator has already created a configuration that defines a connection and the protocols to be translated. The user performs only one step to connect with the host.

When you make a one-step connection to the router, the Cisco IOS software determines which host the connection is for and which protocol that host is using. It then establishes a new network connection using the protocol required by that host.

A disadvantage of the one-step protocol translation method is that the initiating computer or user does not know that two networking protocols are being used. This limitation means that parameters of the foreign network protocols cannot be changed after connections are established. The exception to this limitation is any set of parameters common to both networking protocols. Any parameter common to both can be changed from the first host to the final destination.

To configure the one-step method of protocol translation, set up the following protocols and connection options in the configuration file:

- The incoming connection—The configuration includes the protocol to be used—LAT, X.25, or TCP/IP (Telnet)—the address, and any options such as reverse charging or binary mode that are supported for the incoming connection.
- The outgoing connection—The outgoing connection is defined in the same way as the incoming connection, except that SLIP, PPP (including IP and IPX on PPP sessions), and ARA are also supported.

- The connection features global options—You can specify additional features for the connection to allow, for example, incoming call addresses to match access list conditions or limit the number of users that can make the connection.

Refer to the section "Protocol Translation Configuration Task List" later in this chapter for configuration tasks.

Two-Step Protocol Translation

Use two-step protocol translation for one-time connections or when you use the router as a general-purpose gateway between two types of networks (for example, X.25 public data network (PDN) and TCP/IP). As with the one-step method, we recommend that you configure virtual templates for this feature.

Note You must use the two-step method for translations of TN3270 and XRemote.

With the two-step connection process, you can modify the parameters of either network connection, even while a session is in process. This process is similar to connecting a group of terminal lines from a PAD to a group of terminal lines from a TCP server. The difference is that you do not encounter the wiring complexity, unreliability, management problems, and performance bottlenecks that occur when two devices are connected via asynchronous serial lines.

Refer to the section "Protocol Translation Configuration Task List" later in this chapter for configuration tasks.

Tunneling SLIP, PPP, and ARA

Unlike other protocols such as LAT, X.25, and TCP, which actually are translated when you use one-step protocol translation, SLIP, PPP, and ARA are not translated to the destination protocol. Instead, they are carried inside a LAT, X.25, or TCP tunnel specific to the device on the remote network. However, you use the protocol translation facility to enable tunneling of SLIP, PPP, or ARA.

You can also tunnel IPX-PPP over X.25, TCP, or LAT, to an IPX network when tunneling PPP on virtual terminal lines. Refer to the section "Configuring Tunneling of SLIP, PPP, or ARA" later in this chapter for configuration tasks.

One-Step Tunneling of SLIP, PPP, and ARA

To use one-step protocol translation to tunnel SLIP, PPP (or IPX-PPP), or ARA, you need not enter any preliminary commands. Simply use the **translate** command with the **slip** or **ppp** keyword for one-step SLIP or PPP connections or the **autocommand arap** command for one-step ARA connections. Because ARA does not use addressing, you must specify the **autocommand** keyword, then specify the string **arap** to tunnel ARA to an AppleTalk network.

If you are tunneling PPP, SLIP, or ARA across X.25, you must also set up your X.3 profile correctly using the **x29 profile** command, as described in the section "Configuring One-Step Tunneling of SLIP or PPP" later in this chapter.

Two-Step Tunneling of PPP and SLIP

To tunnel SLIP or PPP across an X.25 WAN to an IP network using the two-step protocol translation method, use the **vty-async** command, which enables you to run PPP and SLIP on virtual terminal lines. Normally, PPP and SLIP function only on physical asynchronous interfaces. The **vty-async** command enables you to run PPP and SLIP on virtual terminal lines, which permits you to tunnel from an incoming protocol to SLIP or PPP and then to an IP network (or IPX-PPP to an IPX network).

If you make a PAD connection to a router running protocol translation and then issue the **ppp** *definitions* command to connect across an X.25 network, you also must set up your X.3 profile using the **pad** [**/profile** *name*] command.

Two-Step Tunneling of ARA

To tunnel ARA using the two-step method, you configure ARA on one or more virtual terminal lines and then configure automatic protocol startup. When a user connects to the vty and receives an EXEC prompt, ARA starts up automatically on the outgoing vty.

Setting Up Virtual Templates for Protocol Translation

The Cisco IOS software simplifies the process of configuring protocol translation to tunnel PPP or SLIP across X.25, TCP, and LAT networks. It does so by providing virtual interface templates that you can configure independently and apply to any protocol translation session. You can configure virtual interface templates for one-step and two-step protocol translation.

A virtual interface template is an interface that exists just inside the router (it is not a physical interface). You can configure virtual interface templates just as you do regular asynchronous serial interfaces. You then apply these virtual interface templates for one-step and two-step protocol translation (the process is described in detail in the section "Protocol Translation Configuration Task List" in this chapter). When a user dials in through a vty and a tunnel connection is established, the router clones the attributes of the virtual interface template onto a *virtual access interface*. This virtual access interface is a temporary interface that supports the asynchronous protocol configuration specified in the virtual interface template. This virtual access interface is created dynamically and lasts only as long as the tunnel session is active.

Before virtual templates were implemented, you enabled asynchronous protocol functions on virtual terminal lines by creating virtual *asynchronous* interfaces rather than virtual *access* interfaces. (For one-step translation, you did so by specifying **ppp** or **slip** as outgoing options in the **translate** command. For two-step translation, you did so by specifying the **vty-async** command.) The differences between virtual asynchronous interfaces and virtual access interfaces are as follows:

- Virtual asynchronous interfaces are allocated permanently, whereas virtual access interfaces are created dynamically when a user calls in, and are closed down when the connection drops.
- Virtual asynchronous interfaces were unconfigurable and supported only a limited set of protocol translation functions. However, virtual access interfaces are fully configurable via the virtual interface template. All attributes of the virtual interface template are cloned onto the virtual access interface when a call comes in.

Virtual access interfaces replace virtual asynchronous interfaces for both one-step and two-step translation.

You can configure up to 25 virtual interface templates and have up to 300 virtual access interfaces per router (300 is the hardware limit on the router, based on the number of IDBs).

Note You can configure only a single virtual interface template (which applies to all virtual terminal asynchronous lines) when tunneling PPP or SLIP using two-step protocol translation.

Figure 31 shows a typical network diagram for a tunnel session from a PC across an X.25 network, through a router set up with a virtual interface template for protocol translation, and to a corporate intranet.

Figure 31 PPP Tunnel Session Across an X.25 Network

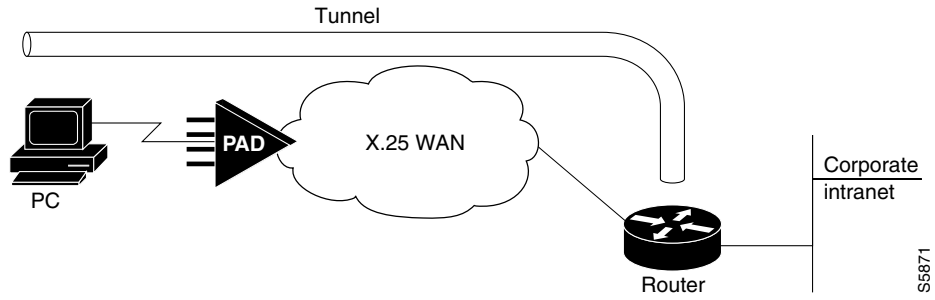
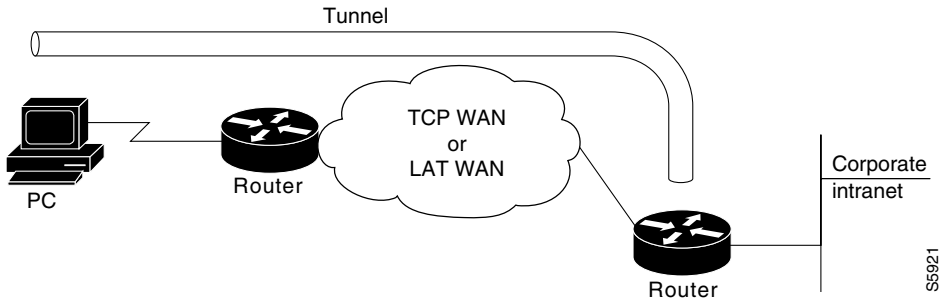


Figure 32 shows a typical network diagram for a tunnel session from a PC across a TCP or LAT WAN, through a router set up with a virtual interface template for protocol translation, and to a corporate intranet.

Figure 32 PPP Tunnel Session Across a TCP or LAT WAN



The virtual interface template service for protocol translation provides the following benefits:

- Allows customized configurations to be predefined in one location, then applied dynamically to any protocol translation session, whether one-step or two-step, for easier maintenance.
- Simplifies the **translate** command syntax by reducing the number of options required within each command.
- Makes virtual asynchronous interfaces configurable for both one-step and two-step protocol translation.

Virtual Templates and L2F

L2F tunneling technology is used in virtual private dialup networks (VPDNs). VPDN allows separate and autonomous protocol domains to share common access infrastructure including modems, access servers, and ISDN routers by the tunneling of link level frames.

L2F/VPDN over protocol translation virtual template interfaces allows services with multiple X.25 dial point of presences (POPs) to expand their current L2F services. This ability can be accomplished by terminating the PPP virtual-asynchronous connections over X.25 at the Cisco protocol translation/router and setting up the L2F tunnel to the home gateway. With this configuration, protocol-level packets are allowed to pass through the virtual tunnel between endpoints of a point-to-point connection.

Typical L2F tunneling use includes Internet service providers (ISPs) or other access service creating virtual tunnels to link to the remote sites of a customer or remote users with corporate home networks. In particular, a network access server at the POP for the ISP exchanges PPP messages with the remote users, and communicates by L2F requests and responses with the home gateway of the customer to set up tunnels.

Frames from the remote users are accepted by the POP, stripped of any linked framing or transparency bytes, encapsulated in L2F, and forwarded over the appropriate tunnel. The home gateway of the customer accepts these L2F frames, strips the L2F encapsulation, and processes the incoming frames for the appropriate interface.

Note This implementation of VPDN supports PPP dialup only.

For more information on VPDNs, refer to the chapters in the part "Virtual Private Networks" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2.

Protocol Translation Configuration Task List

To configure protocol translation, perform the tasks described in the following sections as needed:

- Configuring One-Step Protocol Translation (As Required)
- Configuring a Virtual Template for One-Step Protocol Translation (As Required)
- Configuring Two-Step Protocol Translation (As Required)
- Configuring a Virtual Template for Two-Step Protocol Translation (As Required)

Refer to the sections "Virtual Template for Protocol Translation Examples," "Protocol Translation Application Examples," and "Protocol Translation Session Examples" later in this chapter for examples of protocol translation sessions and configurations.

Configuring One-Step Protocol Translation

To create one-step protocol translation connection specifications, use the following command in global configuration mode:

Command	Purpose
`Router(config)# translate protocol incoming-address`	Creates the connection specifications for one-step protocol translation.

For incoming PAD connections, the router uses a default PAD profile to set the remote X.3 PAD parameters unless a profile script is defined in the **translate** command. To override the default PAD profile the router uses, you must create a PAD profile script using the **x29 profile** global configuration command. In the following example, *default* is the name of the default PAD profile script and *parameter:value* is the X.3 PAD parameter number and value separated by a colon.

```
x29 profile default parameter:value [parameter:value]
```

Note If the X.29 profile is named default, it is applied to all incoming X.25 PAD calls, including the calls used with protocol translation.

Configuring a Virtual Template for One-Step Protocol Translation

To configure a virtual interface template to enable tunneling of PPP or SLIP across an X.25, TCP, or LAT WAN, first create and configure a virtual interface template, then apply it as the single outgoing option to the **translate** command.

Virtual interface templates in general support all commands available on any serial interface, because virtual templates are used for purposes other than protocol translation. However, a virtual access interface—which clones the configuration of the corresponding virtual interface template when created for protocol translation—supports only asynchronous protocol commands.

To enable tunneling of PPP or SLIP across an X.25, TCP, or LAT WAN by using one-step protocol translation, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface virtual-template number`	Creates a virtual interface template, and enters interface configuration mode.
Step 2	`Router(config-if)# ip unnumbered ethernet 0`[1]	Assigns an IP address to the virtual interface template.
Step 3	`Router(config-if)# encapsulation {ppp | slip}`[2]	Enables encapsulation on the virtual interface template.
Step 4	`Router(config-if)# peer default ip address {ip-address | dhcp | pool [pool-name]}`	Assigns an IP address from a pool to the device connecting to the virtual access interface (such as the PC in Figure 31).
Step 5	`Router(config-if)# exit`	Exits to global configuration mode.
Step 6	`Router(config)# translate {lat | tcp | x25} incoming-address [in-options] virtual-template number [global-options]`	Assigns the virtual interface template to a protocol translation session.

1. You can also assign a specific IP address by using the **ip address** command, though assigning the IP address of the Ethernet 0 interface as shown is most common.
2. Virtual interface templates use PPP encapsulation by default, so you need not specify **encapsulation ppp**. However, to use SLIP encapsulation, you must explicitly specify **encapsulation slip**.

Rather than specify outgoing translation options in the **translate** command, configure these options as interface configuration commands under the virtual interface template, then apply the virtual interface template to the **translate** command. Table 7 maps outgoing **translate** command options to interface commands you can configure in the virtual interface template.

Table 7 Mapping Outgoing translate Command Options to Interface Commands

translate Command Options	Corresponding Interface Configuration Command
ip-pool	**peer default ip address** {**dhcp** | **pool** [*poolname*]}
header-compression	**ip tcp header compression** [**on** | **off** | **passive**]
routing	**ip routing** or **ipx routing**
mtu	**mtu**
keepalive	**keepalive**
authentication {**chap** | **pap**}	**ppp authentication** {**chap** | **pap**}
ppp use-tacacs	**ppp use-tacacs**
ipx loopback	**ipx ppp-client loopback** *number*

Configuring Two-Step Protocol Translation

To translate using the two-step method, use the following commands in EXEC mode. The first step is required only if you are tunneling SLIP or PPP using the two-step protocol translation facility.

	Command	Purpose

Step 1	`Router> connect`
	or
	`Router> lat`
	or
	`Router> pad`
	or
	`Router> telnet`
	or
	`Router> tunnel`
		Establishes an incoming connection to the router running protocol translation.

Step 2	`Router> connect`
	or
	`Router> lat`
	or
	`Router> pad`
	or
	`Router> telnet`
	or
	`Router> tunnel`
	or
	`Router> ppp`
	or
	`Router> slip`
		Establishes the outgoing connection from the router supporting protocol translation to another network host.

The Cisco IOS software supports the two-step method in both directions for protocols other than PPP and SLIP (for example, from Telnet to PAD, and vice versa).

Note PPP and SLIP are supported on outgoing connections only.

Configuring a Virtual Template for Two-Step Protocol Translation

If you are tunneling PPP or SLIP using two-step protocol translation with virtual interface templates, you still use the **vty-async** command, just as before implementation of virtual templates. However, virtual asynchronous interfaces are not created as they were before virtual interface templates. Virtual access interfaces are created dynamically when a tunnel connection is established.

To create and configure a virtual interface template and apply it to a two-step protocol translation session, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface virtual-template` *number*	Creates a virtual interface template, and enters interface configuration mode.
Step 2	`Router(config-if)# ip unnumbered ethernet 0`[1]	Assigns an IP address to the virtual interface template.
Step 3	`Router(config-if)# encapsulation {ppp | slip}`[2]	Enables encapsulation on the virtual interface template.
Step 4	`Router(config-if)# peer default ip address {dhcp | pool [`*pool-name*`]}`	Assigns an IP address from a pool to the device connecting to the virtual access interface (such as the PC in Figure 31).
Step 5	`Router(config-if)# exit`	Exits to global configuration mode.
Step 6	`Router(config)# vty-async`	Creates a virtual asynchronous interface.
Step 7	`Router(config)# vty-async virtual-template` *number*	Applies the virtual template to the virtual asynchronous interface.

1. You can also assign a specific IP address by using the **ip address** *address* command, though assigning the IP address of the Ethernet0 interface as shown is most common.
2. Virtual interface templates use PPP encapsulation by default, so you need not specify **encapsulation ppp**. However, to use SLIP encapsulation, you must explicitly specify **encapsulation slip**.

Other asynchronous configuration commands can be added to the virtual template configuration. We recommend that you include security on your virtual interface template. For example, you can enter the **ppp authentication chap** command.

Changing the Number of Supported Translation Sessions

There is a one-to-one relationship between protocol translation sessions and virtual terminal lines. For every session, you need a vty. Therefore, if you need to increase the number of protocol translation sessions, you need to increase the number of virtual terminal lines. That is, if your router has ten virtual terminal lines, you can have up to ten protocol translation sessions. The default number of virtual terminal lines is 5 (lines 0 through 4).

To increase the number of lines, and thus the maximum number of protocol translation sessions, use the following commands as needed, beginning in global configuration mode:

Command	Purpose
`Router(config)# line vty line-number`	Increases the number of virtual terminal lines, and thus the maximum number of protocol translation sessions.
`Router(config-line)# no line vty line-number`	Decreases the number of virtual terminal lines, and thus the maximum number of protocol translation sessions.

Protocol translation is a CPU-intensive task. Increasing the number of protocol translation sessions while routing is enabled can impact available memory. The amount of memory available depends on the platform type, the amount of DRAM available, the activity of each translation session, and the speed of the link. If you are using the maximum number of sessions and have problems with memory, you might need to decrease the number of protocol translation sessions.

Configuring Tunneling of SLIP, PPP, or ARA

To configure SLIP, PPP, or ARA tunneling, perform the tasks described in the following sections:

- Configuring One-Step Tunneling of SLIP or PPP (As Required)
- Configuring a Virtual Template for One-Step Protocol Translation (As Required)
- Configuring Two-Step Tunneling of SLIP or PPP (As Required)
- Enabling Dynamic Address Assignment for Outgoing PPP and SLIP on Virtual Terminal Lines (As Required)

You can also enable IPX over tunneled PPP sessions.

Configuring One-Step Tunneling of SLIP or PPP

To tunnel SLIP or PPP using the one-step protocol translation facility, use the following commands in global configuration mode:

Command	Purpose
`Router(config)# x29 profile name parameter:value [parameter:value]`	(Optional) If you are tunneling PPP over X.25, creates an X.3 profile so that the router will interoperate with the PAD.
`Router(config)# translate protocol incoming-address [in-options] protocol outgoing-address [out-options] [global-options]`	Creates the connection specifications for one-step protocol translation.

If you are configuring PPP over X.25 and do not know which X.3 profile parameters to use, try the following (these parameters do not function in all cases; they are simply a place from which to start):

1:0, 2:0, 3:2, 4:1, 5:0, 6:0, 7:21, 8:0, 9:0, 10:0, 11:14, 12:0, 13:0, 14:0, 15:0, 16:127, 17:24, 18:18, 19:0, 20:0, 21:0, 22:0

For more information about creating an X.29 profile script, refer to the section "Creating an X.29 Profile Script" later in this chapter. For an example of configuring PPP over X.25, see the section "Tunneling PPP over X.25 Example" at the end of this chapter.

To configure an outgoing session for IPX-PPP, use the **ipx loopback** *number* command for the outgoing session.

To tunnel SLIP or PPP across X.25, LAT, or Telnet using the one-step method, you need not enter any additional commands, as you do when you tunnel SLIP or PPP using the two-step method. The **translate** command enables asynchronous protocol features on one vty at a time.

PPP and SLIP, including IPX-PPP, can be tunneled on outgoing connections only.

Configuring One-Step Tunneling of ARA

To tunnel ARA using the one-step protocol translation facility, use the following commands beginning in global configuration mode. The first four steps are required; steps 5 through 11 are optional:

	Command	Purpose
Step 1	`Router(config)# appletalk routing`	Turns on AppleTalk routing.
Step 2	`Router(config)# translate` *protocol incoming-address* `[`*in-options*`] autocommand arap`	Uses the protocol translation facility to enable an ARA tunnel across a remote network.
Step 3	`Router(config)# line vty` *line-number* `[`*ending-line-number*`]`	Enters line configuration mode.
Step 4	`Router(config-line)# arap enable`	Enables ARA on one or more lines.
Step 5	`Router(config-line)# arap dedicated`	Sets one or more dedicated ARA lines.
Step 6	`Router(config-line)# arap timelimit [`*minutes*`]`	Sets the session time limit.
Step 7	`Router(config-line)# arap warningtime [`*minutes*`]`	Sets the disconnect warning time.
Step 8	`Router(config-line)# arap noguest`	Disallows guests.
Step 9	`Router(config-line)# arap require-manual-password`	Requires manual password entry.
Step 10	`Router(config-line)# arap zonelist` *zone-access-list-number*	Limits the zones the Macintosh user sees.
Step 11	`Router(config-line)# arap net-access-list` *net-access-list number*	Controls access to networks.

Configuring Two-Step Tunneling of SLIP or PPP

To tunnel SLIP or PPP using the two-step protocol translation facility, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# vty-async`	Enables tunneling of PPP and SLIP using two-step protocol translation.
Step 2	`Router(config)# exit`	Exits from global configuration mode into EXEC mode.

Step 3	`Router> connect`
	or
	`Router> lat`
	or
	`Router> pad`
	or
	`Router> telnet`
	or
	`Router> tunnel`
		Establishes an incoming connection to the router running protocol translation.

Step 4	`Router> connect`
	or
	`Router> slip`
	or
	`Router> ppp`
	or
	`Router> tunnel`
		Establish the outgoing connection from the router supporting protocol translation to another network host.

If you want to configure IPX over your PPP sessions on virtual terminal lines, refer to the chapter "Configuring Asynchronous SLIP and PPP" in the *Cisco IOS Dial Technologies Configuration Guide*, Release 12.2.

Enabling Dynamic Address Assignment for Outgoing PPP and SLIP on Virtual Terminal Lines

You can specify IP addresses dynamically from a Dynamic Host Configuration Protocol (DHCP) proxy client or a local IP address pool on outgoing PPP and SLIP sessions on virtual terminal lines.

Assigning IP Addresses Using DHCP

The DHCP client-proxy feature manages a pool of IP addresses available to PPP or SLIP dial-in clients that need not know an IP address to be able to access a system. This feature allows a finite number of IP addresses to be reused quickly and efficiently by many clients. Additional benefits include the ability to maintain sessions, such as Telnet, even when a modem line fails. When the client is autodialed back into the access server or router, the session can be resumed because the same IP address is reissued to the client by the access server or router.

A DHCP proxy client is a Cisco access server or router configured to arbitrate DHCP calls between a DHCP server and a DHCP client. For more information about DHCP proxy clients, refer to the *Cisco IOS IP Configuration Guide*, Release 12.2.

To assign IP addresses using DHCP, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ip address-pool dhcp-proxy-client`	Specifies that the router use the DHCP client-proxy.
Step 2	`Router(config)# translate` *protocol incoming-address* `[`*in-options*`] {slip | ppp} ip-pool`	Specifies DHCP pooling for the SLIP or PPP client on the outgoing session.

The name argument is the name of the DHCP proxy client specified with the **ip address-pool dhcp-proxy-client** command.

Assigning IP Addresses Using Local IP Address Pooling

To make temporary IP addresses available for outgoing PPP and SLIP clients on outgoing sessions, you must first specify that the Cisco IOS software use a local IP address pool on all asynchronous interfaces and create one or more local IP address pools. You then assign local pooling as part of the **translate** command. To assign IP addresses dynamically on a virtual asynchronous connection, use the following commands in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ip address-pool local`	Specifies that the router use a local IP address pool on all asynchronous interfaces.
Step 2	`Router(config)# ip local pool` *name begin-ip-address-range* `[`*end-ip-address-range*`]`	Creates one or more local IP address pools.
Step 3	`Router(config)# translate` *protocol incoming-address* `[`*in-options*`] {slip | ppp ip-pool [scope-name` *name*`]}`	Specifies local pooling for the SLIP or PPP client on the outgoing session.

The **scope-name** option takes the name of any local IP address pool that has been defined using the **ip local pool** command.

Configuring X.29 Access Lists

Cisco IOS software provides access lists to limit access to a router from certain X.25 hosts. Access lists take advantage of the message field defined by Recommendation X.29, which describes procedures for exchanging data between two PADs or between a PAD and a DTE device.

To define X.29 access lists, perform the tasks described in these sections:

- Creating an X.29 Access List (Required)
- Applying an Access List to a Virtual Line (Required)

Note When configuring protocol translation, you can specify an access list number with each **translate** command. In the case of translation sessions that result from incoming PAD connections, the corresponding X.29 access list is used.

Creating an X.29 Access List

To specify the access conditions, use the following command in global configuration mode:

Command	Purpose
`Router(config)# x29 access-list access-list-number {permit | deny} regular-expression`	Restricts incoming and outgoing connections between a particular vty (into a router) and the addresses in an access list.

An access list can contain any number of lines. The lists are processed in the order in which you type the entries. The first match causes the permit or deny condition. If an X.121 address does not match any of the entries in the access list, access will be denied.

Applying an Access List to a Virtual Line

To apply an access list to a virtual line, use the following command in line configuration mode:

Command	Purpose
`Router(config-line)# access-class number in`	Restricts incoming and outgoing connections between a particular vty (into a router) and the addresses in an access list.

The access list number is used for incoming TCP access and incoming PAD access. For TCP access, the access server or router using protocol translation uses the defined IP access lists. For incoming PAD connections, the same X.29 access list is used. If you want to apply access restrictions on only one of the protocols, you can create an access list that permits all addresses for the other protocol.

Note For an example of including an access list in a **translate** command, refer to the section "Tunneling PPP over X.25 Example" later in this chapter.

Creating an X.29 Profile Script

You can create an X.29 profile script for the **translate** command to use. An X.29 profile script uses X.3 PAD parameters. When an X.25 connection is established, the Cisco IOS software configured for protocol translation functions similar to an X.29 SET PARAMETER packet, which contains the parameters and values set by this command.

To create an X.29 profile script, use the following command in global configuration mode:

Command	Purpose
`Router(config)# x29 profile {default | name} parameter:value [parameter:value]`	Creates an X.29 profile script.

For incoming PAD connections, the router running protocol translation uses a default PAD profile to set the remote X.3 PAD parameters, unless a profile script is defined in the **translate** command. To override the default PAD profile the router uses, you must create a PAD profile script and name it default using the **x29 profile** {**default** | *name*} *parameter:value* [*parameter:value*] global configuration command, where the *name* argument is the word "default" and *parameter:value* is the X.3 PAD parameter number and value separated by a colon. For more information about X.3 PAD parameters, refer to the appendix "X.3 PAD Parameters" at the end of this publication.

Note When the X.29 profile is named default, it is applied to all incoming X.25 PAD calls, including the calls used with protocol translation.

You can also create an X.29 profile script when connecting to a PAD using the **pad** [**/profile** *name*] EXEC command, which is described in the *Cisco IOS Terminal Services Command Reference*, Release 12.2.

Defining X.25 Host Names

This section describes how to define symbolic host names, which means that instead of remembering a long numeric address for an X.25 host, you can refer to the X.25 host using a symbolic host name. To define a symbolic host name, use the following command in global configuration mode:

Command	Purpose
`Router(config)# x25 host name x.121-address [cud call-user-data]`	Defines a symbolic host name.

Protocol Translation and Processing PAD Calls

This section explains how Cisco routers initiate and accept PAD calls using protocol translation.

Background Definitions and Terms

X.29 encodes the PAD Call User Data (CUD) field in the Call packet to indicate that the call request signifies a PAD-to-DTE device interaction.The CUD field is 16 bytes long and can be up to 128 bytes long when the Select facility is applied. The first 4 bytes of the CUD field are the protocol identifier (PID).

When a PAD calls a host DTE device, X.29 ensures that the encoding of the PID field contains a standard PAD PID "0x01000000," which informs the host that a PAD is calling. The remainder of the CUD field contains the user data that could signify a login message or a password for the host.

The **x25 map pad** interface command specifies the other end of a connection and how to interact with that host. For incoming calls, the PAD checks for a matching SOURCE address in the map entry. For outgoing calls, the PAD checks for a matching DESTINATION address in the map entry.

The **x25 map pad** commands normally are used to configure PAD and protocol translation access. They are also used to override the configuration of the interface on a per-destination basis.

The following example configures an X.25 interface to restrict incoming PAD access to a single mapped host. This example requires that both incoming and outgoing PAD access use the Network User Identification (NUID) to authenticate the user.

```
interface serial 0
 x25 pad-access
 x25 smap pad 219104 nuid johndoe secret
```

Accepting a PAD Call

An incoming PAD call is accepted by a Cisco router if the destination address matches the following criteria:

- A translation entry.
- The interface address.
- An alias of an interface.
- The address of the interface with trailing zeros.
- An interface subaddress.
- A NULL address.
- Address/subaddress matches the address for the router set by the **x25 host** command.

Accepting Incoming PAD Protocol Translation Calls

When a Cisco router receives a call that requires protocol translation, the protocol translator searches the translation table for an entry with a regular expression in the X.121 address and CUD field that pattern matches the incoming X.121 address and the user data part of the CUD (the default PAD PID is not included).

If the PID is a nonstandard value (not equal to 0x01000000), the protocol translator searches the translation table for an entry with a regular expression in the X.121 and CUD field that matches the entire CUD (PID and user data).

For example, an incoming call to destination 417262510195 with a standard PAD PID of 0x01000000 and no user data will match the following translation entry:

```
translate x25 417262510195 tcp 172.31.186.54
```

An incoming call to destination 417262510195 with an unknown PID of 1234 and user data zayna will match the following translation entry:

```
translate x25 417262510195 cud 1234zayna tcp 172.31.186.54
```

An incoming call to destination 417262510195 with a standard PAD PID of 0x01000000 and user data zayna will match the following translation entry:

```
translate x25 417262510195 cud zayna tcp 172.31.186.54
```

Note You can specify the CUD field in the **translate** command in ASCII or octal. You cannot enter CUD values in hexadecimal in the **pad** or **translation** command. However, you can enter the octal equivalents of CUD hexadecimal values using the following command syntax:

```
pad x121-address /cud \307\021
```

or

```
translate x25 x121-address cud \307\021 tcp ip-address
```

In the following example, the regular expression CUD field allows an incoming call to destination 31200100994301 with a standard PAD PID of 0x01000000 and User Data 0xD0<*whatever*> to match the following translation entry:

```
translate X25 31200100994301 cud \320.* tcp 172.20.169.11 port 13301
```

Note The PID cannot be eliminated. The entire CUD field cannot be 0. The PAD uses the PID length to determine if a PID was entered. Therefore, using the characters *""* or *\000* will be interpreted as if no PID was given.

Processing Outgoing PAD Calls Initiated by Protocol Translation

Using the **use-map** option added to the **pad** EXEC command and to the global **translate** command, as an outgoing protocol option, allows the optional PID, CUD, and facilities to be applied on a per-PAD connection or protocol translation basis.

If you specify the **use-map** option on the PAD connection or on the **translate** command, the destination address and (optional) PID and CUD will be checked against a configured list of entries configured with the **x25 map pad** command. If a match is found, the PID, CUD, and facilities will be applied on the outgoing Call Request.

For example, entering the **use-map** option on the **pad** EXEC command returns the following:

```
interface serial 1
 encapsulation x25
 x25 address 2192222
 x25 win 7
 x25 wout 7
 x25 ips 256
 x25 ops 256
 x25 map pad 77630 packetsize 1024 1024 windowsize 2 2 reverse
```

Note that the interface in this example is configured for a window size of 7 and a packet size of 256.

The following example specifies the **use-map** option so that the outgoing PAD connection will override the interface facilities and apply a window size of 2, a packet size of 1024, and reverse charging on the outgoing PAD call:

```
pad 77630 /use-map
```

The following example specifies the **use-map** option so that a translation of the following outgoing PAD connection will cause the Call Request to be sent with a standard PAD PID and user data in hexadecimal format:

```
! On the interface the call goes out on:
interface Serial1
 x25 map pad 417262510197 pid 0x01000000<hex for your user data>
!
translate tcp 172.21.186.54 x25 417262510197 use-map
```

The following example specifies the **use-map** options so that this outgoing PAD connection will cause the Call Request to be sent with a nonstandard PAD PID of 0x0E and user data hello:

```
! On the interface the call goes out on:
interface Serial1
 x25 map pad 417262510198 pid 0x0E cud hello
!
translate tcp 172.21.186.54 x25 417262510198 use-map
```

Increasing or Decreasing the Number of Virtual Terminal Lines

Because each protocol translation session uses a vty, you need to increase the number of virtual terminal lines to increase the number of protocol translation sessions. That is, if your router has ten virtual terminal lines, you can have up to ten protocol translation sessions. The default number of virtual terminal lines is 5 (lines 0 through 4). To increase the number of lines, and thus the maximum number of protocol translation sessions, use the following commands as needed, beginning in global configuration mode:

Command	Purpose
`Router(config)# line vty line-number`	Increases the number of virtual terminal lines, and thus the maximum number of protocol translation sessions.
`Router(config-line)# no line vty line-number`	Decreases the number of virtual terminal lines, and thus the maximum number of protocol translation sessions.

Caution Protocol translation is a CPU-intensive task. Increasing the number of protocol translation sessions while routing is enabled can impact available memory. The amount of memory available depends on the platform type, the amount of DRAM available, the activity of each translation session, and the speed of the link. If you are using the maximum number of sessions and have problems with memory, you might need to decrease the number of protocol translation sessions.

The maximum number of protocol translation sessions for each platform can be increased to the number specified in Table 8. One virtual terminal is required for each protocol translation session.

Table 8 Maximum Number of Protocol Translation Sessions by Platform

Platform	Default Number of Virtual Terminal Lines	Total Number of Lines[1]	Maximum Virtual Terminal Lines with Translation Option
Cisco 1000 running Cisco IOS software	5	6	5
Cisco 2500 series (8 asynchronous ports)	5	200	180
Cisco 2500 series (16 asynchronous ports)	5	200	182
Cisco 2600 series	5	200	182
Cisco 3000 series	5	200	198

Table 8 Maximum Number of Protocol Translation Sessions by Platform (continued)

Platform	Default Number of Virtual Terminal Lines	Total Number of Lines[1]	Maximum Virtual Terminal Lines with Translation Option
Cisco 3640	5	1002	872
Cisco 3620	5	1002	936
Cisco 4000 series	5	200	198
Cisco 4500 series	5	1002	1000
Cisco 4700 series	5	1002	1000
Cisco AS5200	5	200	182
Cisco AS5300	5	1002	952
Cisco 7000 series	5	120	118
Cisco 7200 series	5	1002	1000
Cisco 7000 series with RSP	5	1002	1000

1. Maximum number of virtual terminal lines = (TTYs + AUX + CON lines). Maximum number of virtual terminal lines with protocol translation option = (TTYs + AUX + CON lines).

Enabling Asynchronous Functions on Virtual Terminal Lines

Using Cisco IOS software, you can configure asynchronous protocol features such as PPP and SLIP on virtual terminal lines. PPP and SLIP normally function only on asynchronous interfaces, not on virtual terminal lines. When you configure a vty to support asynchronous protocol features, you are creating *virtual asynchronous interfaces* on the virtual terminal lines. One practical benefit of virtual asynchronous interfaces is the ability to tunnel PPP and SLIP across X.25, TCP, or LAT networks on virtual terminal lines. You tunnel PPP and SLIP using the protocol translation facility.

To configure and use virtual asynchronous interfaces, perform the tasks described in the following sections:

- Creating Virtual Asynchronous Interfaces (Required)
- Enabling Protocol Translation of PPP and SLIP on Virtual Asynchronous Interfaces (Optional)
- Enabling IPX-PPP over X.25 to an IPX Network on Virtual Terminal Lines (Optional)
- Enabling Dynamic Routing on Virtual Asynchronous Interfaces (Optional)
- Enabling TCP/IP Header Compression on Virtual Asynchronous Interfaces (Optional)
- Enabling Keepalive Updates on Virtual Asynchronous Interfaces (Optional)
- Setting an MTU on Virtual Asynchronous Interfaces (Optional)
- Enabling PPP Authentication on Virtual Asynchronous Interfaces (Optional)

Note These tasks enable PPP and SLIP on a virtual asynchronous interface on a global basis on the router. To configure SLIP or PPP on a per-vty basis, use the **translate** command.

Creating Virtual Asynchronous Interfaces

To create a virtual asynchronous interface, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vty-async`	Configures all virtual terminal lines to support asynchronous protocol features.

Enabling Protocol Translation of PPP and SLIP on Virtual Asynchronous Interfaces

One practical benefit of enabling virtual asynchronous interfaces is the ability to tunnel PPP and SLIP over X.25, thus extending remote node capability into the X.25 area. You can also tunnel PPP and SLIP over Telnet or LAT on virtual terminal lines. You can tunnel PPP and SLIP over X.25, LAT, or Telnet, but you do so by using the protocol translation feature in the Cisco IOS software.

To tunnel incoming dialup SLIP or PPP connections over X.25, LAT, or TCP to an IP network, you can use one-step protocol translation or two-step protocol translation, as follows:

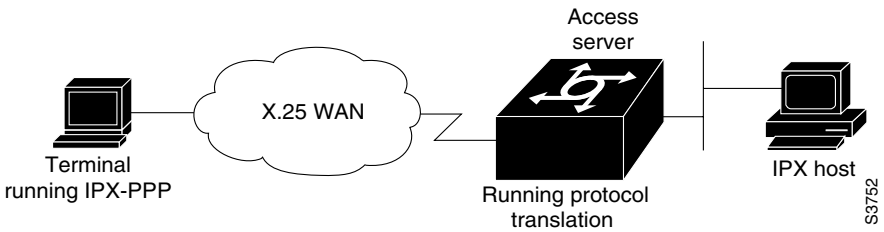
- If you are tunneling SLIP or PPP using the one-step method, you need not enter the **vty-async** command. Using the **translate** command with the **slip** or **ppp** keyword for one-step connections automatically enables asynchronous protocol functions on a per-vty basis.
- If you are tunneling SLIP or PPP using the two-step method, you must first enter the **vty-async** command on a global basis. Next, you perform a two-step connection process.

Enabling IPX-PPP over X.25 to an IPX Network on Virtual Terminal Lines

You can enable IPX-PPP on virtual terminals, which permits clients to log in to a virtual terminal on a router, invoke a PPP session at the EXEC prompt to a host, and run IPX to the host.

For example, in Figure 33 the client terminal on the X.25 network logs in to the vty on the access server, which is configured for IPX-PPP. When the user connects to the access server and the EXEC prompt appears, the user issues the PPP command to connect to the IPX host. The virtual terminal is configured to run IPX, so when the PPP session is established from the access server, the terminal can access the IPX host using an IPX application.

Figure 33 IPX-PPP on a Virtual Asynchronous Interface



To enable IPX to run over your PPP sessions on virtual terminal lines, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# ipx routing [node]`	Enables IPX routing.
Step 2	`Router(config)# interface loopback number`	Creates a loopback interface.
Step 3	`Router(config-if)# ipx network network`[1]	Enables a virtual IPX network on the loopback interface.
Step 4	`Router(config-if)# vty-async ipx ppp-client loopback number`	Enables IPX-PPP on virtual terminal lines by assigning the virtual terminal to the loopback interface configured for IPX.

1. Every loopback interface must have a *unique* IPX network number.

Enabling Dynamic Routing on Virtual Asynchronous Interfaces

To route IP packets using the Interior Gateway Routing Protocol (IGRP), RIP, and OSPF routing protocols on virtual asynchronous interfaces, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vty-async dynamic-routing`	Enables dynamic routing of IP packets on all virtual terminal lines.

When you make a connection, you must specify the **routing** keyword on the SLIP or PPP command line.

Note The **vty-async dynamic routing** command is similar to the **async dynamic routing** command, except that the **async dynamic routing** command is used for physical asynchronous interfaces, and the **vty-async dynamic-routing** command is used on virtual terminal lines configured for asynchronous protocol functionality.

Enabling TCP/IP Header Compression on Virtual Asynchronous Interfaces

You can compress the headers on TCP/IP packets on virtual asynchronous interfaces to reduce their size and increase performance. This feature only compresses the TCP header, so it has no effect on UDP packets or other protocol headers. The TCP header compression technique, described fully in RFC 1144, is supported on virtual asynchronous interfaces using PPP and SLIP encapsulation. You must enable compression on both ends of the connection.

You can specify outgoing packets to be compressed only if TCP incoming packets on the same vty are compressed. If you do not specify this option, the Cisco IOS software will compress all traffic. The default is no compression. This option is valid for SLIP.

To compress the headers of outgoing TCP packets on virtual asynchronous interfaces, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vty-async header-compression [passive]`	Enables header compression on IP packets on all virtual terminal lines.

Enabling Keepalive Updates on Virtual Asynchronous Interfaces

Keepalive updates are enabled on all virtual asynchronous interfaces by default. To change the keepalive timer or disable it on virtual asynchronous interfaces, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vty-async keepalive` *seconds*	Specifies the frequency with which the Cisco IOS software sends keepalive messages to the other end of an asynchronous serial link.

The default interval is 10 seconds. It is adjustable in 1-second increments from 0 to 32,767 seconds. To turn off keepalive updates, set the value to 0. A connection is declared down after three update intervals have passed without a keepalive packet being received.

Virtual terminal lines are very low bandwidth. When the keepalive timer is adjusted, large packets can delay the smaller keepalive packets long enough to cause the session to disconnect. You might need to experiment to determine the best value.

Setting an MTU on Virtual Asynchronous Interfaces

The maximum transmission unit (MTU) refers to the size of an IP packet. You might want to change to a smaller MTU size for IP packets sent on a virtual asynchronous interface for any of the following reasons:

- The SLIP or PPP application at the other end only supports packets up to a certain size.
- You want to ensure a shorter delay by using smaller packets.
- The host Telnet echoing takes longer than 0.2 seconds.

For example, at 9600 baud a 1500-byte packet takes about 1.5 seconds to transmit. This delay would indicate an MTU size of about 200, as derived from the following equations:

1.5 seconds / 0.2 seconds = 7.5

1500-byte packet / 7.5 = 200-byte packet

To specify the maximum IP packet size, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# vty-async mtu` *bytes*	Specifies the size of the largest IP packet that the virtual asynchronous interface can support.

The default MTU size is 1500 bytes. Possible values are 64 bytes to 1,000,000 bytes.

The TCP protocol running on the remote device can have a different MTU size than the MTU size configured on your router. Because the Cisco IOS software performs IP fragmentation of packets larger than the specified MTU, do not change the MTU size unless the SLIP or PPP implementation running on the host at the other end of the asynchronous line supports reassembly of IP fragments.

Enabling PPP Authentication on Virtual Asynchronous Interfaces

You can enable Challenge Handshake Authentication Protocol (CHAP) or Password Authentication Protocol (PAP) for authentication of PPP on virtual terminal lines set up for asynchronous protocol features.

Note Passwords cannot contain spaces or underscores. A user with a password containing spaces or underscores will not be able to log in to a TTY or vty.

Enabling CHAP

Access control using CHAP is available on all virtual asynchronous interfaces configured for PPP encapsulation. The authentication feature reduces the risk of security violations on your router.

When CHAP is enabled, a remote device (such as a PC, workstation, or router) attempting to connect to the local router is requested, or "challenged," to respond.

The challenge contains an ID, a random number, and either the host name of the local router or the name of the user on the remote device. This challenge is sent to the remote device.

The required response has two parts:

- An encrypted version of the ID, a password, and the random number (secreted information)
- Either the host name of the remote device or the name of the user on the remote device

When the local router receives the challenge response, it verifies the secreted information by looking up the name given in the response and performing the same encryption operation. The passwords must be identical on the remote device and the local router.

Because this response is sent, the secreted information is never sent, thus preventing other devices from stealing it and gaining illegal access to the system. Without the proper response, the remote device cannot connect to the local router.

CHAP transactions occur only when a link is established. The local router does not request a password during the rest of the session. (The local router can, however, respond to such requests from other devices during a session.)

To use CHAP on virtual asynchronous interfaces for PPP, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vty-async ppp authentication chap`	Enables CHAP on all virtual asynchronous interfaces.

CHAP is specified in RFC 1334. It is an additional authentication phase of the PPP Link Control Protocol (LCP).

Once you have enabled CHAP, the local router requires a response from the remote devices. If the remote device does not support CHAP, no traffic is passed to that device.

Enabling PAP

Access control using the PAP is available on all virtual asynchronous interfaces configured for PPP encapsulation. The authentication feature reduces the risk of security violations on your router.

To enable PAP, use the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# vty-async ppp authentication pap`	Enables PAP on all virtual asynchronous interfaces.

Enabling PPP Authentication via TACACS on Virtual Asynchronous Interfaces

Access control using TACACS is available on all virtual asynchronous interfaces configured for PPP encapsulation. The authentication feature reduces the risk of security violations on your router.

To enable TACACS with either CHAP or PAP, use the following command in global configuration mode:

Command	Purpose
`Router(config)# vty-async ppp use-tacacs`	Enables TACACS on all virtual asynchronous interfaces.

Maintaining Virtual Interfaces

To maintain virtual interfaces, perform the tasks described in the following sections:

- Monitoring and Maintaining a Virtual Access Interface
- Displaying a Virtual Asynchronous Interface
- Troubleshooting Virtual Asynchronous Interfaces

Monitoring and Maintaining a Virtual Access Interface

When a virtual interface template is applied to a protocol translation session, a virtual access interface is created dynamically, and is the only way a virtual access interface can be created. However, a virtual access interface can be cleared and displayed.

To display or clear a specific virtual access interface, use any the following commands in EXEC mode:

Command	Purpose
`Router> show users [all]`	Identifies the number associated with the virtual access interface, so you can display statistics about the interface or clear the interface.
`Router> show interfaces virtual-access number`	Displays the configuration of the virtual access interface.
`Router> clear interface virtual-access number`	Tears down the virtual access interface and frees the memory for other dial-in uses.

Displaying a Virtual Asynchronous Interface

To view information about the vty when the configuration of a virtual interface template is cloned to a vty configured as a virtual access interface for two-step protocol translation, use the following command in EXEC mode:

Command	Purpose
Router> **show line** [*line-number*]	Displays statistics about a vty.

Troubleshooting Virtual Asynchronous Interfaces

The following example shows **debug** command output for the router redmount. It also shows the output for a specific **vty-async** interface. The **vty-async** command configures all virtual terminal lines on a router to support asynchronous protocol features.

```
Router# show debug

  PPP:
    PPP protocol negotiation debugging is on
  Asynchronous interfaces:
    Async interface framing debugging is on
    Async interface state changes debugging is on
  ROUTER1#
  ROUTER1#
  Initializing ATCP
  VTY-Async3: Set up PPP encapsulation on TTY3
  VTY-Async3: Setup PPP framing on TTY3
  VTY-Async3: Async protocol mode started for 172.22.164.1
  %LINK-3-UPDOWN: Interface VTY-Async3, changed state to up
  ppp: sending CONFREQ, type = 2 (CI_ASYNCMAP), value = A0000
  ppp: sending CONFREQ, type = 5 (CI_MAGICNUMBER), value = 91B8C7
  ppp: sending CONFREQ, type = 2 (CI_ASYNCMAP), value = A0000
  ppp: sending CONFREQ, type = 5 (CI_MAGICNUMBER), value = 91B8C7
  ROUTER1# debug 0x2
  ppp: config ACK received, type = 2 (CI_ASYNCMAP), value = A0000
  ppp: config ACK received, type = 5 (CI_MAGICNUMBER), value = 91B8C7
  ppp: config ACK received, type = 7 (CI_PCOMPRESSION)
  ppp: config ACK received, type = 8 (CI_ACCOMPRESSION)
  PPP VTY-Async3: received config for type = 0x1 (MRU) value = 0x5DC acked
  PPP VTY-Async3: received config for type = 0x2 (ASYNCMAP) value = 0x0 acked
  PPP VTY-Async3: received config for type = 0x7 (PCOMPRESSION) acked
  PPP VTY-Async3: received config for type = 0x8 (ACCOMPRESSION) acked
  ipcp: sending CONFREQ, type = 3 (CI_ADDRESS), Address = 272.22.213.7
  ppp VTY-Async3: ipcp_reqci: rcvd COMPRESSTYPE (rejected) (REJ)
  ppp VTY-Async3: Negotiate IP address: her address 10.1.1.1 (NAK with address 172.22.164.1)
(NAK)
  ppp: ipcp_reqci: returning CONFREJ.
  PPP VTY-Async3: state = REQSENT fsm_rconfack(0x8021): rcvd id 0x1
  ipcp: config ACK received, type = 3 (CI_ADDRESS), Address = 172.21.213.7
  ppp VTY-Async3: Negotiate IP address: her address 10.1.1.1 (NAK with address 172.22.164.1)
(NAK)
  ppp: ipcp_reqci: returning CONFNAK.
  ppp VTY-Async3: Negotiate IP address: her address 172.22.164.1 (ACK)
  ppp: ipcp_reqci: returning CONFACK.
  %LINEPROTO-5-UPDOWN: Line protocol on Interface VTY-Async3, changed state to up

  Router# show interface vty-async 3

  VTY-Async3 is up, line protocol is up
    Hardware is Virtual Async Serial
```

```
Interface is unnumbered.  Using address of Ethernet0 (172.21.213.7)
MTU 1500 bytes, BW 9 Kbit, DLY 100000 usec, rely 255/255, load 1/255
Encapsulation PPP, loopback not set, keepalive set (10 sec)
DTR is pulsed for 0 seconds on reset
lcp state = OPEN
ncp ccp state = NOT NEGOTIATED   ncp ipcp state = OPEN
ncp osicp state = NOT NEGOTIATED   ncp ipxcp state = NOT NEGOTIATED
ncp xnscp state = NOT NEGOTIATED   ncp vinescp state = NOT NEGOTIATED
ncp deccp state = NOT NEGOTIATED   ncp bridgecp state = NOT NEGOTIATED
ncp atalkcp state = NOT NEGOTIATED   ncp lex state = NOT NEGOTIATED
ncp cdp state = NOT NEGOTIATED
Last input 0:00:01, output 0:00:02, output hang never
Last clearing of "show interface" counters never
Input queue: 1/75/0 (size/max/drops); Total output drops: 0
Output queue: 0/64/0 (size/threshold/drops)
   Conversations  0/1 (active/max active)
   Reserved Conversations 0/0 (allocated/max allocated)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   26 packets input, 1122 bytes, 0 no buffer
   Received 0 broadcasts, 0 runts, 0 giants
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
```

Monitoring Protocol Translation Connections

This section describes how to log significant virtual terminal-asynchronous authentication information, such as the X.121 calling address, CUD, and the IP address assigned to a virtual terminal asynchronous connection. Depending on how you configure the logging information to be displayed, you can direct this authentication information to the console, an internal buffer, or a UNIX syslog server. This authentication information can be used to associate an incoming PAD virtual terminal-asynchronous connection with an IP address.

Note By default, the Cisco IOS software displays all messages to the console terminal.

To monitor protocol translation connections, perform the tasks described in the following sections:

- Logging vty-Asynchronous Authentication Information to the Console Terminal
- Logging vty-Asynchronous Authentication Information to a Buffer
- Logging vty-Asynchronous Authentication Information to a UNIX Syslog Server

Logging vty-Asynchronous Authentication Information to the Console Terminal

To log significant vty-asynchronous authentication information to the console terminal, use the following command in global configuration mode:

Command	Purpose
`Router(config)# service pt-vty-logging`	Logs significant virtual terminal-asynchronous authentication information.

Logging vty-Asynchronous Authentication Information to a Buffer

To log significant vty-asynchronous authentication information to a buffer, use the following commands in global configuration mode as needed:

	Command	Purpose
Step 1	`Router(config)# service pt-vty-logging`	Logs significant virtual terminal-asynchronous authentication information.
Step 2	`Router(config)# logging buffered [size]`	Directs the authentication log information to a buffer.

Logging vty-Asynchronous Authentication Information to a UNIX Syslog Server

To log significant vty-asynchronous authentication information to a UNIX syslog server, use the following commands in global configuration mode as needed:

	Command	Purpose
Step 1	`Router(config)# service pt-vty-logging`	Logs significant vty-asynchronous authentication information.
Step 2	`Router(config)# logging host`	Directs the authentication log information to a UNIX syslog server.

Troubleshooting Protocol Translation

To troubleshoot your protocol translation sessions, use the following **show** and **debug** commands:

- **debug async**
- **debug pad**
- **show arap**
- **show async status**
- **show interfaces virtual-access**
- **show ip local pool**
- **show line**

Use these commands in EXEC mode. Refer to the Cisco IOS command references for explanations of command output.

Virtual Template for Protocol Translation Examples

The following sections show examples of configuring tunneling of PPP and SLIP using one-step and two-step protocol translation:

- One-Step Examples
- Two-Step Examples

One-Step Examples

The examples in the following sections show how to configure virtual templates and apply them in one-step protocol translation sessions:

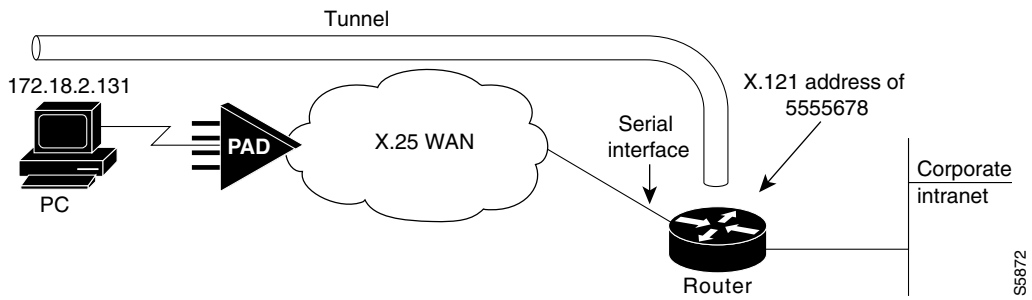
- Tunnel PPP Across X.25 Example
- Tunnel SLIP Across X.25 Example
- Tunnel PPP Across X.25 and Specifying CHAP and Access List Security Example
- Tunnel PPP with Header Compression On Example
- Tunnel IPX-PPP Across X.25 Example

Tunnel PPP Across X.25 Example

The following example shows a virtual interface template that specifies a peer IP address of 172.18.2.131, which is the IP address of the PC in Figure 34. The virtual interface template explicitly specifies PPP encapsulation. The translation is from X.25 to PPP, which enables tunneling of PPP across an X.25 network, as shown in Figure 34.

```
interface virtual-template 1
 ip unnumbered Ethernet0
 ! Static address of 172.18.2.131 for the PC dialing in to the corporate intranet.
 peer default ip address pool group1
 ! Where the pool name is defined as ip local pool group1 172.18.35.1 172.18.35.5.
 encapsulation ppp
! X.121 address of 5555678 is the number the PAD dials to connect through the router.
translate x25 5555678 virtual-template 1
```

Figure 34 Tunneling PPP Across an X.25 Network



Tunnel SLIP Across X.25 Example

The following example uses SLIP encapsulation instead of the PPP encapsulation on the virtual interface:

```
interface Virtual-Template5
 ip unnumbered Ethernet0
 encapsulation slip
 peer default ip address pool group1
 ! Where the pool name is defined as ip local pool group1 172.18.35.11 172.18.35.15.
!
translate x25 5555000 virtual-template 5
```

Tunnel PPP Across X.25 and Specifying CHAP and Access List Security Example

The following example uses PPP encapsulation on the virtual terminal interface, although it is not explicitly specified. It also uses CHAP authentication and an X.29 access list.

```
x29 access-list 1 permit ^5555
!
interface Virtual-Template1
 ip unnumbered Ethernet0
 peer default ip address pool group1
 ! Where the pool name is defined as ip local pool group1 172.18.35.21 172.18.35.25.
 ppp authentication chap
!
translate x25 5555667 virtual-template 1 access-class 1
```

Tunnel PPP with Header Compression On Example

The following example uses TCP header compression when tunneling PPP across X.25:

```
interface Virtual-Template1
 ip unnumbered Ethernet0
 ip tcp header-compression passive
 peer default ip address pool group1
 ! Where the pool name is defined as ip local pool group1 172.18.35.31 172.18.35.35.
!
translate x25 5555676 virtual-template 1
```

Tunnel IPX-PPP Across X.25 Example

The following example shows how to tunnel IPX-PPP across the X.25 network. It creates an internal IPX network number on a loopback interface, then assigns that loopback interface to the virtual interface template.

```
ipx routing 0000.0c07.b509
!
interface loopback0
 ipx network 544
 ipx sap-interval 2000
!
interface Virtual-Template1
 ip unnumbered Ethernet0
 ipx ppp-client Loopback0
 peer default ip address pool group1
 ! Where the pool name is defined as ip local pool group1 172.18.35.41 172.18.35.45.
!
translate x25 5555766 virtual-template 1
```

Two-Step Examples

The examples in the following sections show how to create and configure virtual interface templates and apply them in two-step protocol translation sessions:

- Two-Step Tunneling of PPP with Dynamic Routing and Header Compression Example
- Two-Step Tunneling of PPP with Dynamic Routing, TACACS, and CHAP Example

Two-Step Tunneling of PPP with Dynamic Routing and Header Compression Example

The following example uses the default PPP encapsulation on the virtual template. The example does not specify a peer default IP address because it is using two-step translation.

```
vty-async
vty-async virtual-template 1
vty-async dynamic-routing
vty-async header-compression
!
interface Virtual-Template1
 ip unnumbered Ethernet0
 no peer default ip address
```

After users connect to the router (in this example, named waffler), they invoke the **ppp** command to complete the two-step connection:

```
Router> ppp /routing /compressed 172.16.2.31
Entering PPP routing mode.
Async interface address is unnumbered (Ethernet0)
Your IP address is 172.16.2.31. MTU is 1500 bytes
```

Two-Step Tunneling of PPP with Dynamic Routing, TACACS, and CHAP Example

The virtual template interface in the following example uses the default encapsulation of PPP and applies CHAP authentication with TACACS+:

```
aaa authentication ppp default tacacs+
!
vty-async
vty-async dynamic-routing
vty-async virtual-template 1
!
interface Ethernet0
 ip address 10.11.12.2 255.255.255.0
!
interface Virtual-Template1
 ip unnumbered Ethernet0
 no peer default ip address
 ppp authentication chap
```

Protocol Translation Application Examples

This section provides protocol translation examples for the following scenarios:

- Basic Configuration Example
- Central Site Protocol Translation Example
- Decreasing the Number of Translation Sessions Example
- Increasing the Number of Translation Sessions Example
- LAT-to-LAT over an IP WAN Example
- LAT-to-LAT over Frame Relay or SMDS Example
- LAT-to-LAT Translation over a WAN Example
- LAT-to-LAT over an X.25 Translation Example
- LAT-to-TCP Translation over a WAN Example

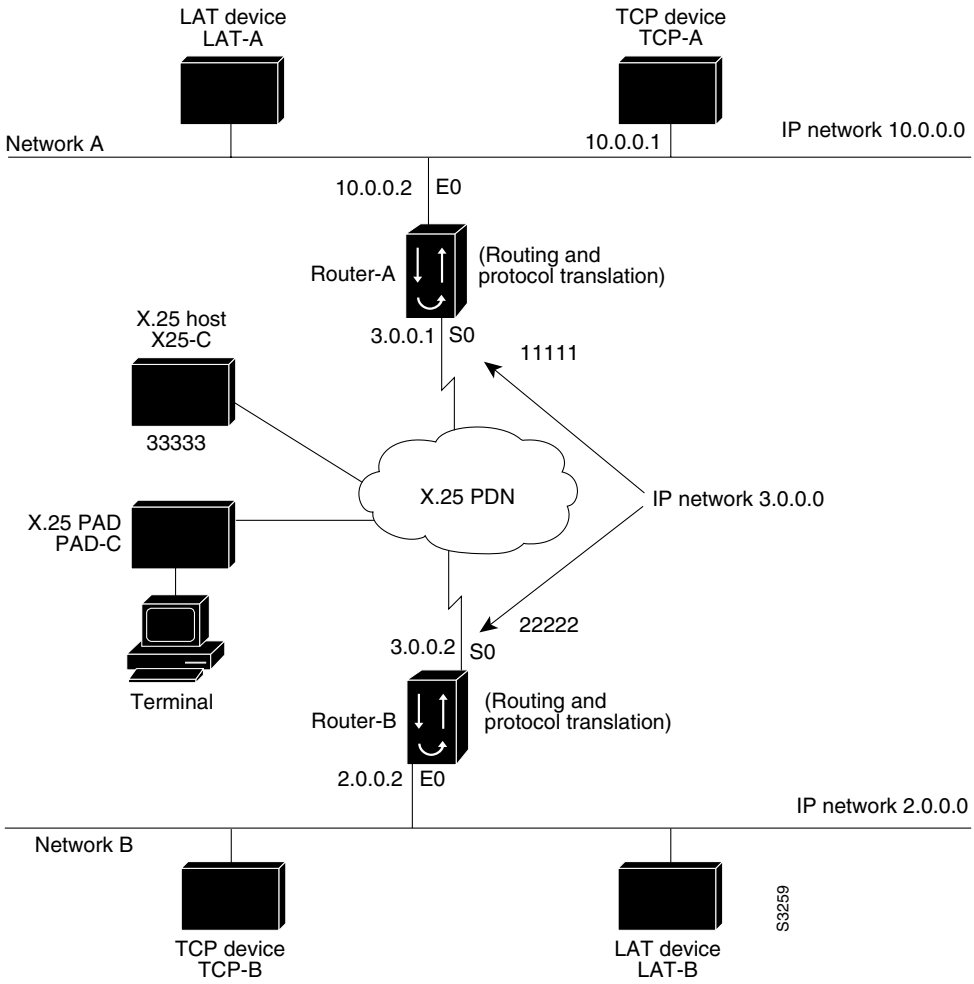
- LAT-to-TCP over X.25 Example
- LAT-to-X.25 Host Configuration Example
- Local LAT-to-TCP Translation Example
- Local LAT-to-TCP Configuration Example
- Standalone LAT-to-TCP Translation Example
- Tunneling SLIP Inside TCP Example
- Tunneling PPP over X.25 Example
- X.25 to L2F PPP Tunneling Example
- Assigning Addresses Dynamically for PPP Example
- Local IP Address Pool Example
- X.29 Access List Example
- X.3 Profile Example
- X.25 PAD-to-LAT Configuration Example
- X.25 PAD-to-TCP Configuration Example

Note In the application illustrations throughout the remainder of this chapter, source and destination device icons used to illustrate the flow of translated information are shown with black type in outlined shapes. Other elements in the environment are shown with reverse type on solid black shapes.

Basic Configuration Example

The following examples illustrate the basic global configuration commands and interface configuration commands for setting up Router-A (connected to Network A) and Router-B (connected to Network B), as illustrated in Figure 35. Refer to the chapter "Configuring Dial-In Terminal Services," for more information about LAT. For information on configuring X.25, refer to the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2.

Figure 35 Routers with Protocol Translation



Note The examples that follow focus on creating configurations that support one-step protocol translation. These connections can also be made using the two-step protocol translation method.

Configuration for Router-A

The following partial configuration for Router-A outlines a baseline configuration for Ethernet and serial interfaces on a router and configures support for IP, LAT, and X.25:

```
interface ethernet 0
 ip address 10.0.0.2 255.255.0.0
 !
 ! Enable LAT on interface.
 lat enabled
 !
interface serial 0
 encapsulation X.25
 x25 address 11111
 !
 ! The following parameters may depend on your network.
 x25 facility packetsize 512 512
 x25 facility windowsize 7 7
 !
```

```
 ! IP address and MAP command needed only if routing IP.
 ip address 10.3.0.1 255.255.0.0
 x25 map ip 10.3.0.2 22222 broadcast
 !
! Set up IP routing.
router igrp 100
 network 10.0.0.0
 network 10.3.0.0
 !
 ! Advertise as available for connections via LAT.
 ! Use this name (router-A) if connecting via 2-step method
 ! (for connecting directly to a specific router).
 lat service router-A enable
 !
 ! Set up some IP host names/addresses.
 ip host router-A 10.0.0.2 10.3.0.1
 ip host TCP-A 10.0.0.1
 ip host TCP-B 10.2.0.1
 ip host router-B 10.3.0.2 10.2.0.2
```

Configuration for Router-B

The following partial configuration for Router-B outlines a baseline configuration for Ethernet and serial interfaces on a router and configures support for IP, LAT, and X.25:

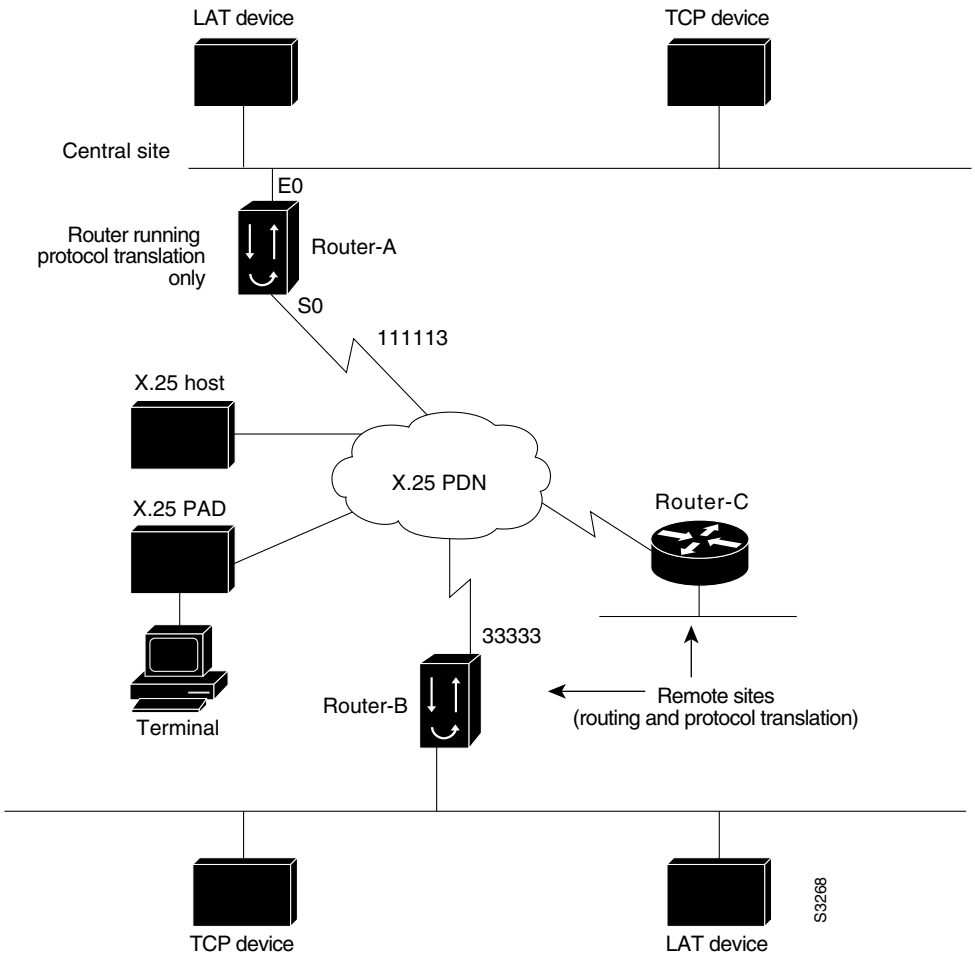
```
interface ethernet 0
 ip address 10.2.0.2 255.255.0.0
 !
 ! Enable LAT on interface.
 lat enabled
 !
interface serial 0
 encapsulation X.25
 x25 address 22222
 ! The following parameters may depend on your network.
 x25 facility packetsize 512 512
 x25 facility windowsize 7 7
 !
 ! IP address and MAP command needed only if routing IP.
 ip address 10.3.0.2 255.255.0.0
 x25 map ip 10.3.0.1 11111 broadcast
 !
 ! Set up IP routing.
router igrp 100
 network 10.2.0.0
 network 10.3.0.0
 !
 ! Advertise as available for connections via LAT.
 ! Use this name (router-B) if connecting via 2-step method
 ! (for connecting directly to a specific router).
 lat service router-B enable
 !
 ! Set up some IP host names/addresses.
 ip host router-A 10.3.0.1 10.0.0.2
 ip host TCP-A 10.0.0.1
 ip host TCP-B 10.2.0.1
 ip host router-B 10.2.0.2 10.3.0.2
```

Note You can specify IP host names used to identify specific hosts by explicitly using the **ip host** global configuration command or by using Domain Name System (DNS) facilities.

Central Site Protocol Translation Example

To support central site protocol translation, a router with an image that supports protocol translation is directly connected back-to-back to another router (see Figure 36). This second device acts as an X.25 switch by sending X.25 packets to Router-B while concurrently routing and bridging other protocols.

Figure 36 Central Site Protocol Translation Example



The following example shows how to configure a router to support translating protocols over an X.25 network among multiple sites. Router-C is configured to act as an X.25 switch to send X.25 packets to Router-A while concurrently routing and bridging other protocols.

The following example also shows how to use the **translate** global configuration command to translate LAT and TCP over X.25 WAN media. In this configuration, Router-A can translate LAT or TCP traffic into X.25 packets for transmission over an X.25 PDN network. Packets are then translated back to LAT or TCP on the other side of the WAN.

```
interface ethernet 0
 ip address 10.0.0.2 255.255.0.0
 !
 ! Enable LAT on interface if concurrently routing (8.3 feature).
 lat enable
 !
```

```
interface serial 0
 encapsulation X.25
 ! Note that this is subaddress 3 of 11111.
 x25 address 111113
 ! The following parameters may depend on your network.
 x25 facility packetsize 512 512
 x25 facility windowsize 7 7
 no ip address

 ! Translate Configuration for router-A.
 !
 no ip routing
 ! Note subaddress 03 of address 111113.
translate x25 11111303 tcp tcpdevice
translate lat TCP-B x25 3333301
translate lat lat-device tcp tcp-device
! etc...any translate commands needed by application.
```

Decreasing the Number of Translation Sessions Example

The following example sets the number of protocol translation sessions to 10, whether routing is turned on or off:

```
no line vty 10
```

Increasing the Number of Translation Sessions Example

The following example sets the number of protocol translation sessions to 120, whether routing is turned on or off:

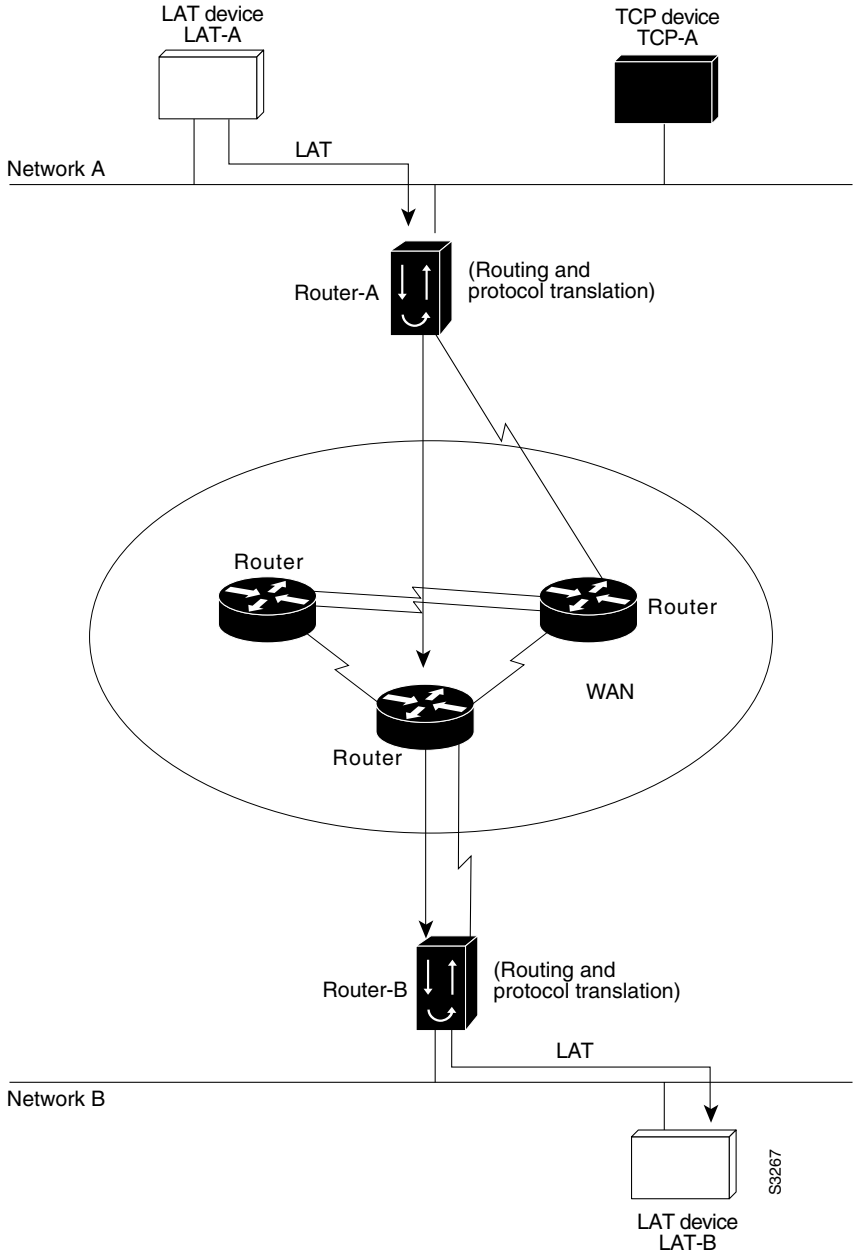
```
line vty 119
```

LAT-to-LAT over an IP WAN Example

The Cisco IOS software can be used to connect LAT devices over a WAN backbone that only allows routable protocols (see Figure 37). This configuration exists when LAT networks are either isolated or on their own internetwork.

With the protocol translation, LAT traffic can be translated to TCP and then routed on the WAN as TCP traffic. The LAT connections stay local between the LAT device and the router running the protocol translation option. Thus, connections are not susceptible to delays on the WAN. This capability reduces the amount of traffic on the WAN because only the data from specific LAT sessions is forwarded on the WAN rather than all the LAT protocol status information packets.

Figure 37 LAT-to-LAT over an IP WAN



The following example illustrates how to use the **translate** global configuration command to translate from LAT to LAT when an IP WAN is used. In this configuration, Router-B with the protocol translation option routes encapsulated packets translated from LAT to TCP over the WAN. Router-A translates packets back to LAT on the other side of the WAN. Example translation configurations for both Router-A and Router-B are shown, but these examples do not include configuration information for devices in the WAN.

The following examples are essentially the same configurations for protocol translation as those in the following Frame Relay example:

```
! Translate LAT to TCP/Telnet for Router-A, which is on Network A.
translate lat DISTANT-LAT tcp Router-A

! Translate TCP to LAT for Router-B, which is on Network B.
translate tcp Router-B lat LAT-B
```

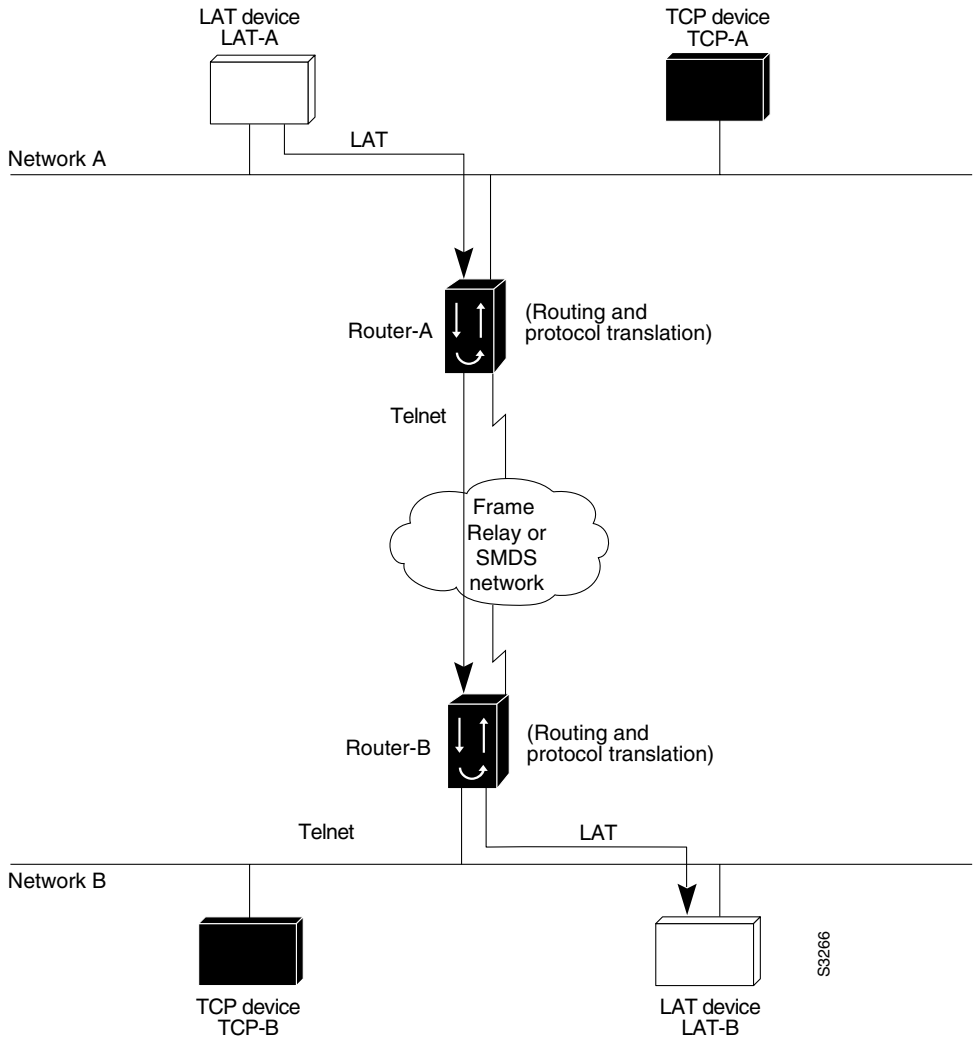
Note You can use the same name (for example, LAT-B) in the **translate** command for both Router-A and Router-B because each router operates independently. However, this symmetry is not required. The key is the common IP name in both **translate** commands.

LAT-to-LAT over Frame Relay or SMDS Example

To transport LAT traffic over a Frame Relay or an Switched Multimegabit Data Service (SMDS) network, LAT must first be translated to TCP. The TCP traffic is routed over the Frame Relay network and then translated back to LAT on Router-B on Network B (see Figure 38).

Note The interface configurations for a Frame Relay or an SMDS implementation differ from the specifications shown earlier in this chapter. For more information about configuring Frame Relay and SMDS, refer to the *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2.

Figure 38 LAT-to-LAT over Frame Relay or SMDS



The following example illustrates how to use the **translate** global configuration command to translate from LAT to LAT when the WAN uses Frame Relay or SMDS. In this configuration, the Cisco IOS software routes encapsulated packets translated from LAT to TCP over the Frame Relay or SMDS network. Packets are then translated back to LAT on the other side of the Frame Relay or SMDS network.

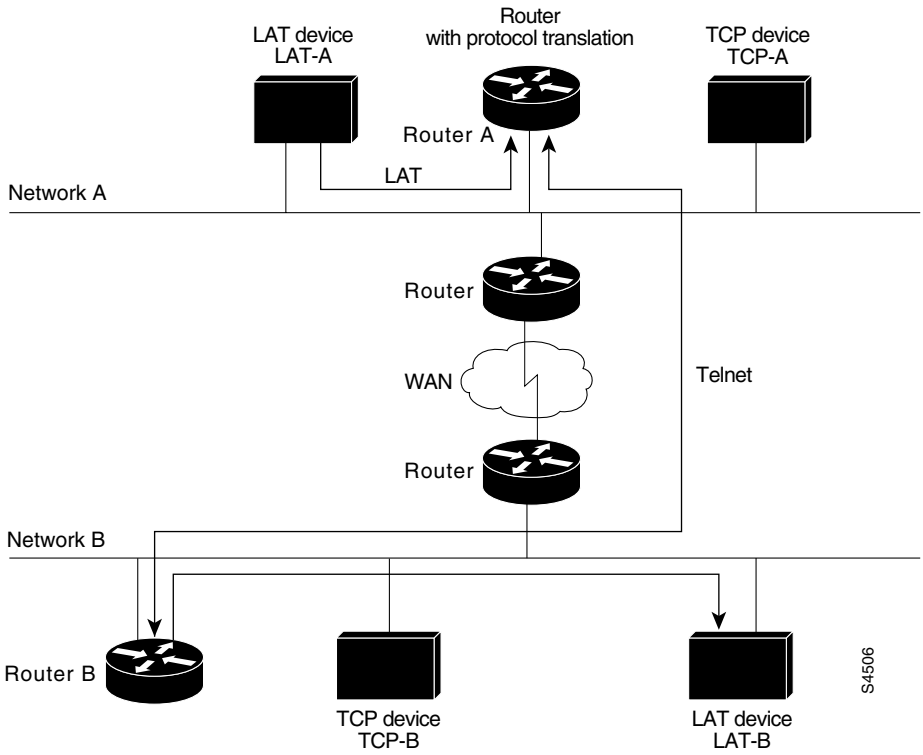
```
! Translate LAT to TCP/Telnet on router-A, which is on Network A.
translate lat DISTANT-LAT tcp router-A

! Translate TCP to LAT on router-B, which is on Network B.
translate tcp router-B lat LAT-B
```

Note You can use the same name (for example, LAT-B) in the **translate** command for both Router-A and Router-B because each router operates independently. However, this symmetry is not required. The key is the common IP name used in both **translate** commands.

LAT-to-LAT Translation over a WAN Example

In Figure 39, LAT can be transported to a remote LAT device by translating the packets to TCP format and using Telnet to send them across the WAN. The configuration files for the routers named Router-A and Router-B follow the figure. The logical name CS-B1 is the name given to device CS-B.

Figure 39 LAT-to-LAT Translation over a WAN



Configuration for Router-A

```
interface ethernet 0
 ip address 172.18.32.16 255.255.0.0
!
! Enable LAT on this interface.
 lat enabled
!
translate lat distant-LAT tcp TS-B1
```

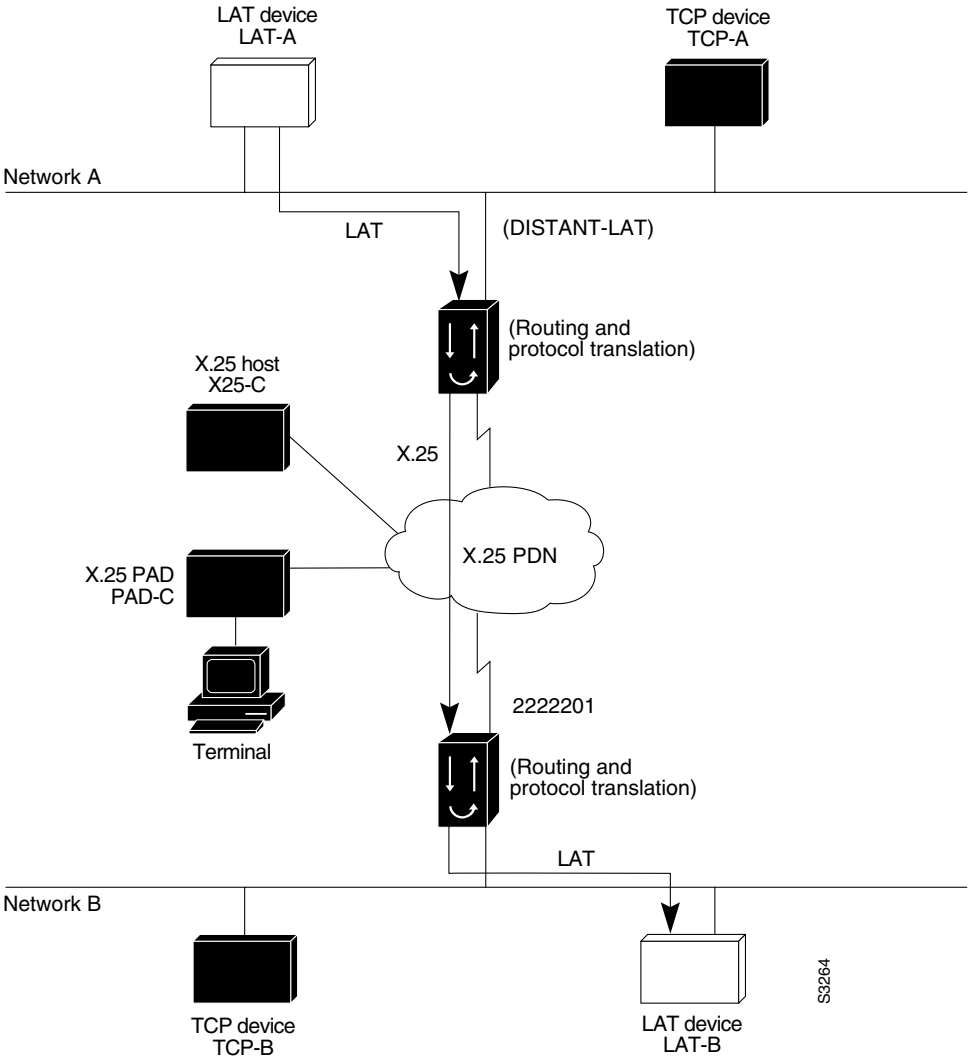
Configuration for Router-B

```
interface ethernet 0
 ip address 172.18.38.42 255.255.0.0
!
! Enable LAT on this interface.
 lat enabled
!
translate lat TS-B1 lat LAT-B
```

LAT-to-LAT over an X.25 Translation Example

Protocol translation provides transparent connectivity between LAT devices on different networks via an X.25 PDN. In Figure 40, which illustrates this application, the LAT device on Network A (LAT-A) first makes a virtual connection to the router named Router-A on Network A using the LAT protocol. Router-A then translates the LAT packets into X.25 packets and sends them through the X.25 network to Router-B on Network B. Router-B translates the X.25 packets back to LAT packets and establishes a virtual connection to the LAT device on Network B (LAT-B). These handoffs are handled transparently when the Cisco IOS software is configured for one-step protocol translation.

Figure 40 LAT-to-LAT via an X.25 PDN



The following example shows how to use the **translate** global configuration command to translate from LAT to X.25 and from X.25 back to LAT to allow connection service to a LAT device on Network B from a LAT device on Network A. This example requires two separate configurations, one for each LAT device.

```
! Translate LAT to X.25 on router-A, which is on Network A.
translate lat DISTANT-LAT x25 2222201
```

```
! Translate X.25 to LAT on router-B, which is on Network B.
translate x25 2222201 lat LAT-B
```

In the first **translate** command, DISTANT-LAT defines a LAT service name for Router-A. When a user on device LAT-A attempts to connect to LAT-B, the target specified in the **connect** command is DISTANT-LAT.

In the **translate** command for Router-B, the name of the LAT service on the target host (LAT-B) is LAT-B. Router-B translates the incoming X.25 packets from 2222201 to LAT and then transparently relays these packets to LAT-B.

The following example shows a connection request. When the user enters this command, a connection attempt from LAT-A on Network A to TCP-B on Network B is attempted.

```
Router> connect DISTANT-LAT
```

To configure Router-B to send information back from LAT-B to LAT-A, use commands symmetrical to the prior configuration (this path is not shown in Figure 40):

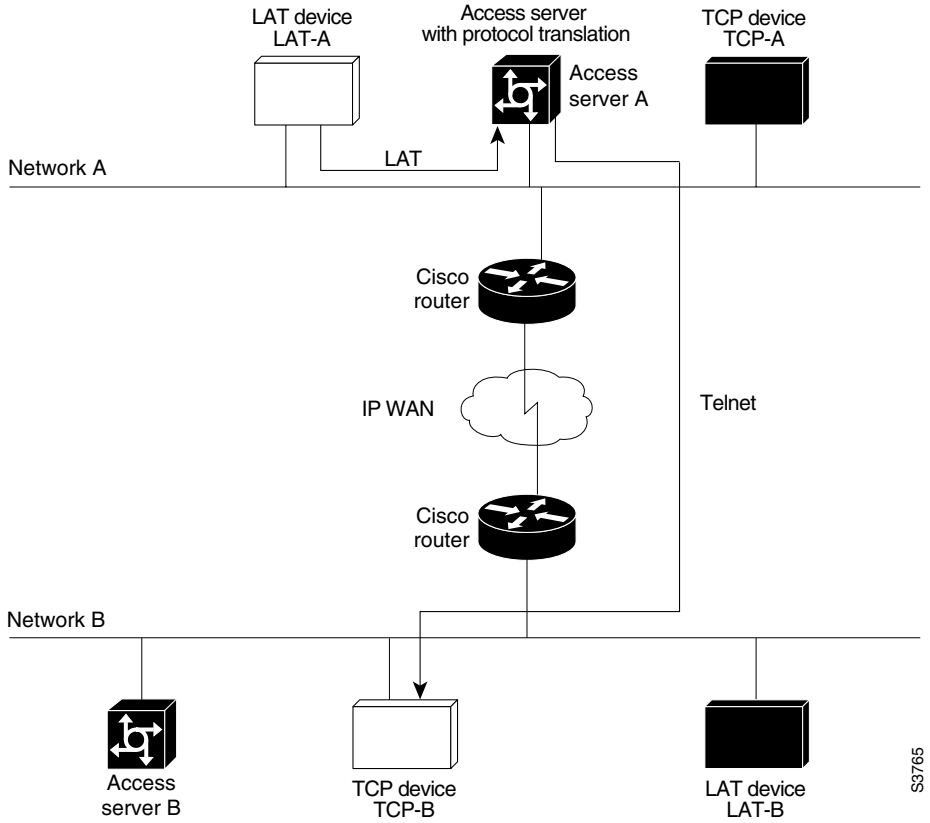
```
! Translate LAT to X.25 on router-B, which is on Network B.
translate lat FAR-LAT x25 1111103
! Translate X.25 to LAT on router-A, which is on Network A.
translate x25 1111103 lat LAT-A
```

Note You can use the same name (for example, LAT-B) in the **translate** command for both Router-A and Router-B because each router with the protocol translation option operates independently. However, this symmetry is not required. The key is the common X.121 address used in both **translate** commands. If you prefer to have unique service names, set the names in each router to be the same.

LAT-to-TCP Translation over a WAN Example

Figure 41 shows a configuration that allows translation of LAT to TCP and transmission across an IP-based WAN. The configuration file for the access server identified as A follows the figure. The logical LAT service name distant-TCP is the name given to device TCP-B.

Figure 41 LAT-to-TCP Translation over a WAN



Configuration for Access Server A

```
interface ethernet 0
 ip address 172.18.38.42 255.255.0.0
!
! Enable LAT on this interface.
 lat enabled
!
translate lat distant-TCP tcp TCP-B
```

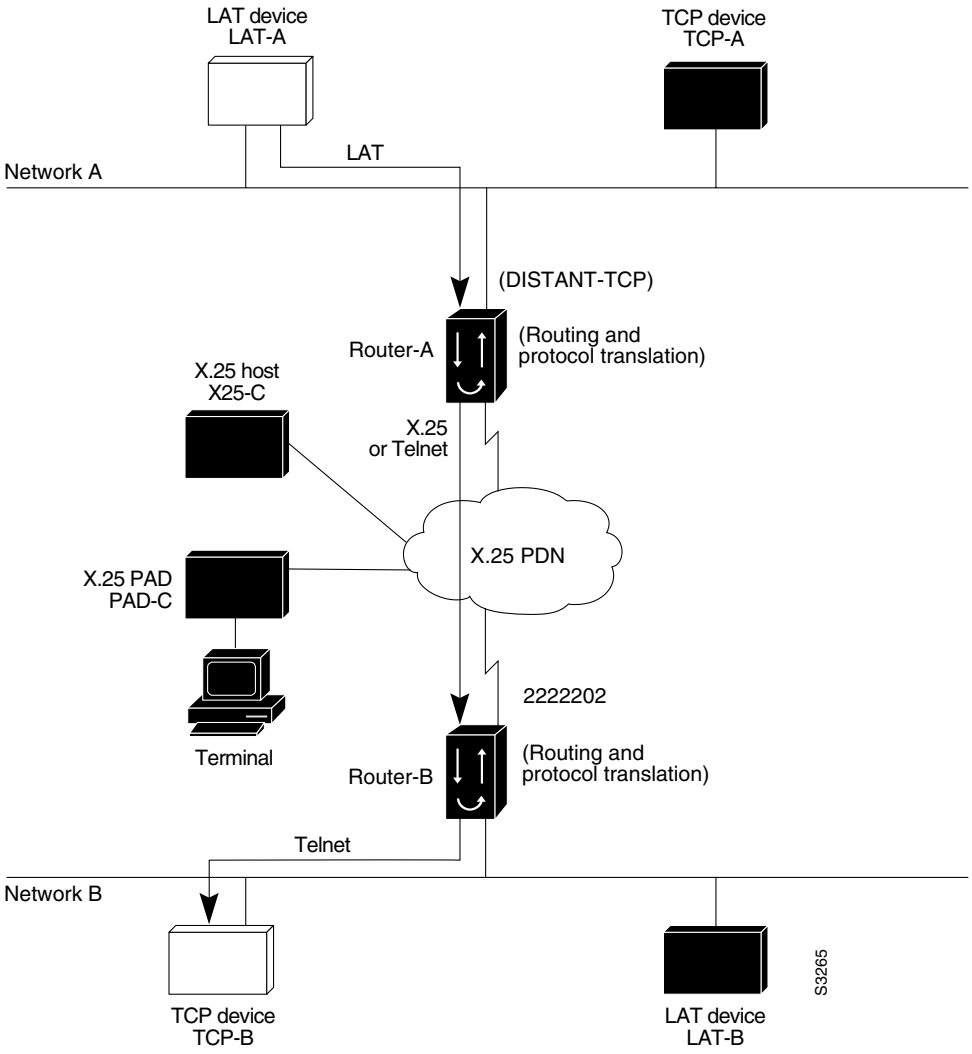
LAT-to-TCP over X.25 Example

You can use protocol translation to provide transparent connectivity between LAT and TCP devices on different networks via an X.25 PDN. In Figure 42, which illustrates this application, the LAT device on Network A is communicating with the TCP device on Network B. There are two ways to provide this connectivity: The LAT traffic from Network A can be translated into either X.25 packets, or TCP/IP packets can be sent out on the X.25 PDN.

If the traffic is translated from LAT directly into X.25 frames by Router-A, Router-B on Network B translates incoming packets intended for device TCP-B into TCP. If Router-A converts LAT to TCP, the TCP traffic is being encapsulated in X.25 and sent on the X.25 network. Router-B on Network B strips off the encapsulation and routes the TCP packet. In this case, protocol translation is not needed on Router-B.

If the traffic is translated to TCP by Router-A, the packets are encapsulated within X.25 frames. In general, translating the traffic directly to X.25 is more efficient in this application because no encapsulation is necessary. X.25 packets have only 5 bytes of header information, and TCP over X.25 has 45 bytes of header information.

Figure 42 LAT-to-TCP via X.25



The following example shows how to use the **translate** global configuration command to translate from LAT to X.25 (on Router-A) and from X.25 to TCP (on Router-B), thus allowing connection service to a TCP device on Network B (TCP-B) from a LAT device on Network A (LAT-A). You must configure Router-A and Router-B separately.

```
! Translate LAT to X.25 on router-A, which is on Network A.
translate lat DISTANT-TCP x25 2222202

! Translate X.25 to TCP on router-B, which is on Network B.
translate x25 2222202 tcp TCP-B
```

In the **translate** command for Router-A, DISTANT-TCP defines a LAT service name for Router-A. When a user on device LAT-A attempts to connect to LAT-B, the target specified in the **connect** command is DISTANT-TCP.

In the **translate** command for Router-B, the TCP service on the target host is TCP-B. Router-B translates the incoming X.25 packets from 2222202 to TCP packets and transparently relays these packets to TCP-B.

The following example shows a connection request. When the user enters this command, a connection attempt from LAT-A on Network A to LAT-B on Network B is attempted.

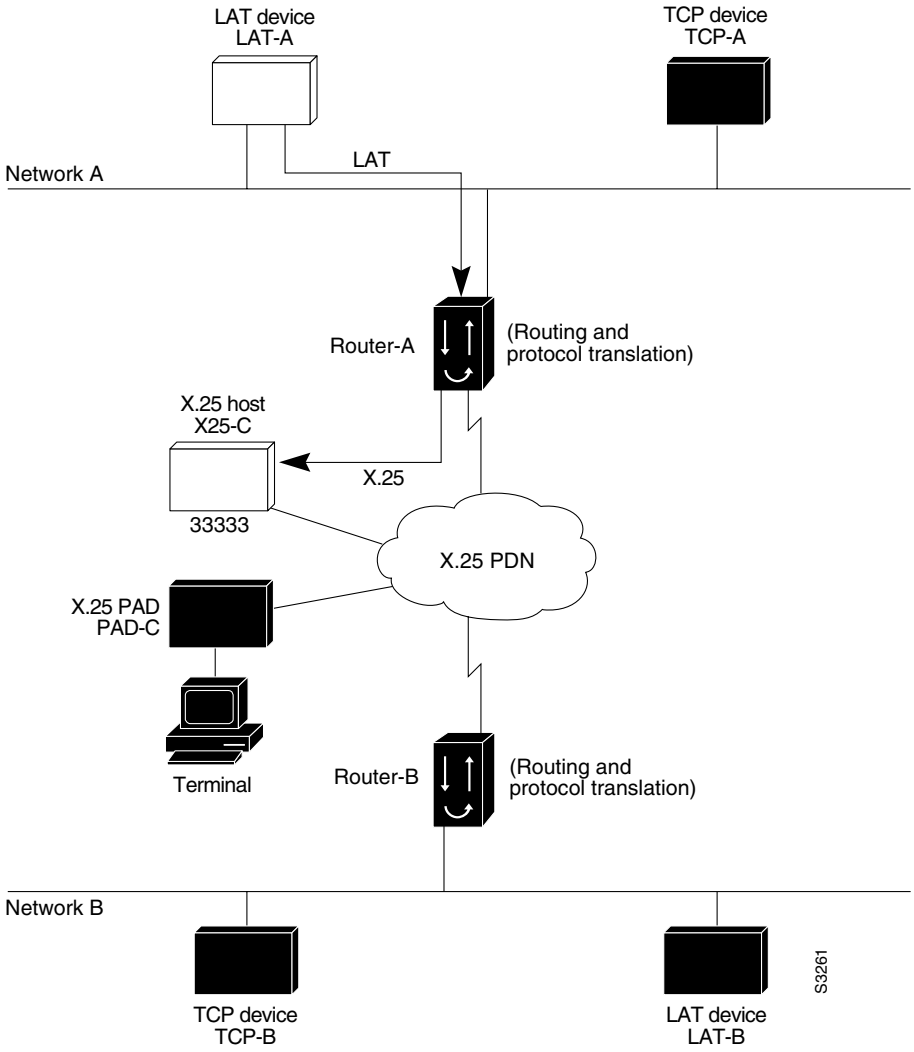
```
local> connect DISTANT-TCP
```

Note You can use the same name (for example, TCP-B) in the **translate** command for both Router-A and Router-B because each router operates independently. However, this symmetry is not required. The key is the common X.121 address used in both **translate** commands. If you prefer to have unique service names, set the names in each router to be the same.

LAT-to-X.25 Host Configuration Example

Figure 43 shows a protocol translation configuration that permits LAT devices to communicate with X.25 hosts through an X.25 PDN. In the application illustrated in Figure 43, LAT-A is a LAT device that is communicating with X25-C, an X.25 host. The LAT traffic from LAT-A is translated to X.25.

Figure 43 LAT-to-X.25 Host Translation



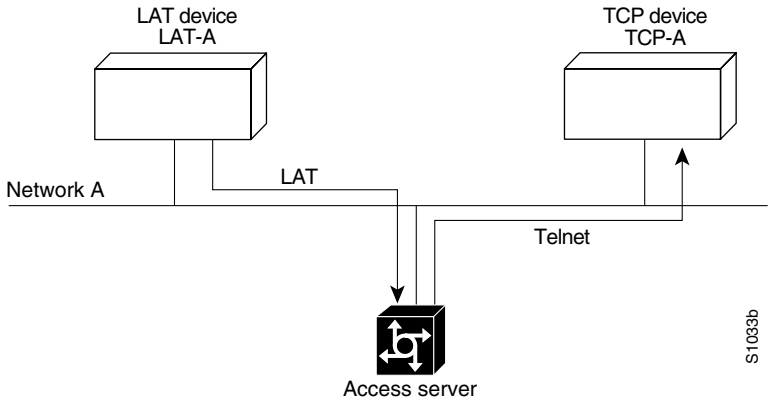
The following example shows how to use the **translate** global configuration command to translate from LAT to X.25. It is applied to Router-A. This example sets up reverse charging for connections, which causes the router with the protocol translation option to instruct the PDN to charge the destination for the connection. It is essentially a collect call. The reversal of charges must be prearranged with the PDN and destination location (on an administrative basis), or the call will not be accepted.

```
! Translate LAT to X.25 host, with reverse charging.
translate lat X25-C x25 33333 reverse
!
! Specify optional X.25 hostname.
x25 host X25-C 33333
```

Local LAT-to-TCP Translation Example

Figure 44 shows a simple LAT-to-TCP translation across an Ethernet network. Its Cisco IOS configuration file follows the figure. The name TCP-A is the logical name given to the device TCP-A.

Figure 44 Local LAT-to-TCP Translation



Configuration for the Access Server

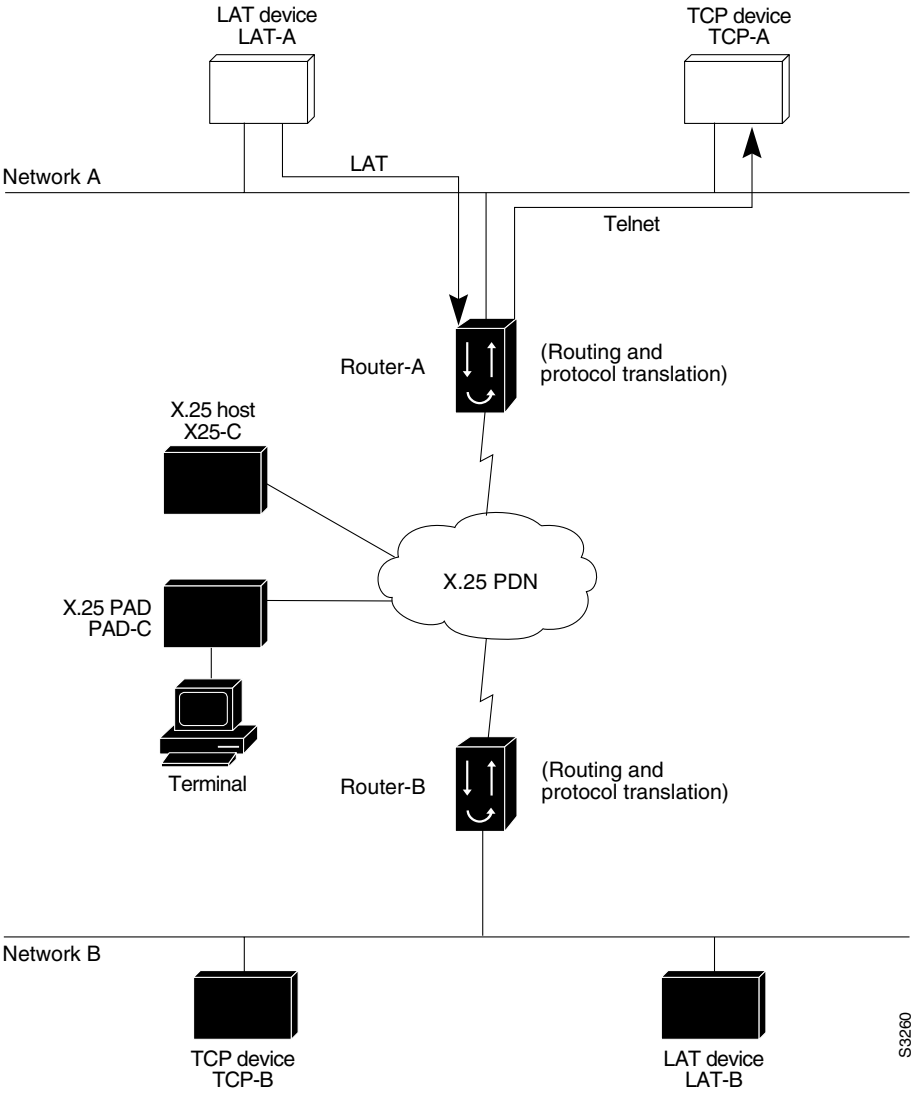
```
interface ethernet 0
 ip address 172.18.38.42 255.255.0.0
!
! Enable LAT on this interface.
 lat enabled
!
translate lat TCPA tcp TCP-A
```

Local LAT-to-TCP Configuration Example

The Cisco IOS software running protocol translation can translate between LAT and Telnet traffic to allow communication among resources in these protocol environments. In Figure 45, the LAT device on Network A (LAT-A) is shown connecting to a device running Telnet (TCP-A).

The commands in this example are only part of the complete configuration file for an individual device.

Figure 45 Local LAT-to-TCP Translation



The following example configures Router-A to translate from LAT to TCP:

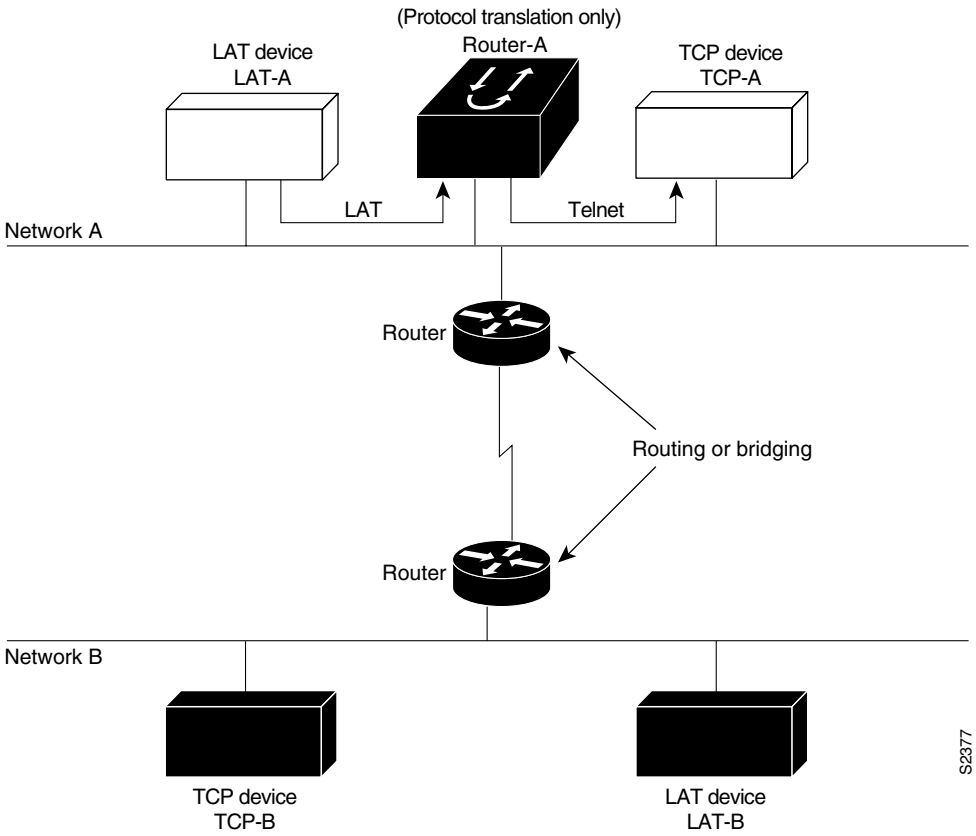
```
! Translate LAT connections to TCP for connectivity to TCP-A.
translate lat TCP-A tcp TCP-A
! Optional additional commands.
lat service TCP-A ident Protocol Translation to TCP-A
```

In the last command, the text string “Protocol Translation to TCP-A” is an identification string for the LAT service named TCP-A. This string is sent to other routers on the local network.

Standalone LAT-to-TCP Translation Example

If you need a large number of local LAT-to-TCP translation sessions, you can set up the router named Router-A to use only an Ethernet port, as the example following Figure 46 indicates. This application allows 100 concurrent translation sessions. In the applications shown in Figure 46, any other router that supports protocol translation can be used to interconnect network segments performing bridging or routing.

Figure 46 Router Functioning as a Standalone Protocol Translator



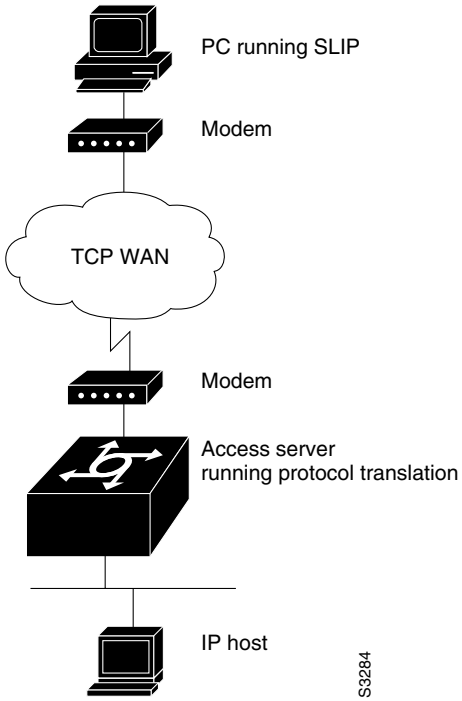
Configuration for Router-A

```
! Translation Configuration for Router-A only.
!
interface ethernet 0
 ip address 10.0.0.2 255.255.0.0
 !
 ! Enable LAT on this interface.
 lat enabled
 !
interface serial 0
 shutdown
 no ip routing
 default-gateway 10.0.0.100
!
translate lat TCP-A tcp TCP-A
translate lat TCP-B tcp TCP-B
translate tcp LAT-A lat lat-z
! etc...translate commands as required.
```

Tunneling SLIP Inside TCP Example

Protocol translation enables you to tunnel from TCP to SLIP to allow communication among resources in these protocol environments. In Figure 47, the PC running SLIP is connecting to a TCP/IP network and making a connection with the device IP host. The example following Figure 47 enables routing and turns on header compression.

Figure 47 Tunneling SLIP Inside TCP



The configuration tunnels SLIP inside of TCP packets from the SLIP client with IP address 10.2.0.5 to the router. It then establishes a protocol translation session to the IP host. Routing and header compression are enabled for the SLIP session.

```
translate tcp 10.0.0.1 slip 10.2.0.5 routing header-compression passive
```

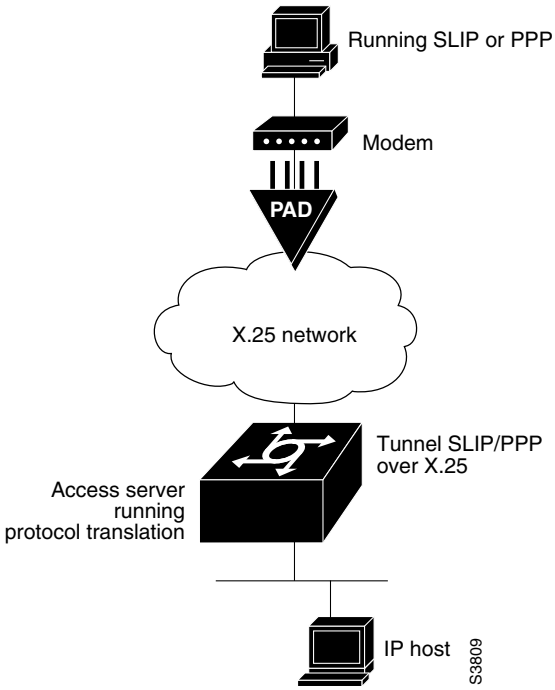
The device IP host on a different network attached to the router can be accessed by the SLIP client because routing has been enabled on the interface in the router where the SLIP session is established.

This example is incomplete. The commands in this example are only part of the complete configuration file for an individual router.

Tunneling PPP over X.25 Example

Cisco IOS software can tunnel PPP traffic across an X.25 WAN to allow communication among resources in these protocol environments. In Figure 48, the PC establishes a dialup PPP session through an X.25 network using CHAP authentication.

Figure 48 Tunneling PPP in X.25



The following configuration tunnels PPP over X.25 from the PPP client to the virtual asynchronous interface with IP address 10.0.0.4. Routing and CHAP authentication are enabled for the PPP session. The X.121 address of the X.25 host is 31370054065. An X.29 profile script named x25-ppp is created using the following X.3 PAD parameters:

1:0, 2:0, 3:2, 4:1, 5:0, 6:0, 7:21, 8:0, 9:0, 10:0, 11:14, 12:0, 13:0, 14:0, 15:0, 16:127, 17:24, 18:18, 19:0, 20:0, 21:0, 22:0

For more information about X.3 PAD parameters, refer to the appendix "X.3 PAD Parameters" at the end of this publication. If you were performing a two-step connection, you would specify these X.3 PAD parameters using the **pad** [**/profile** *name*] command.

With the router connected to the IP host, the PC running PPP can now communicate with the IP host.

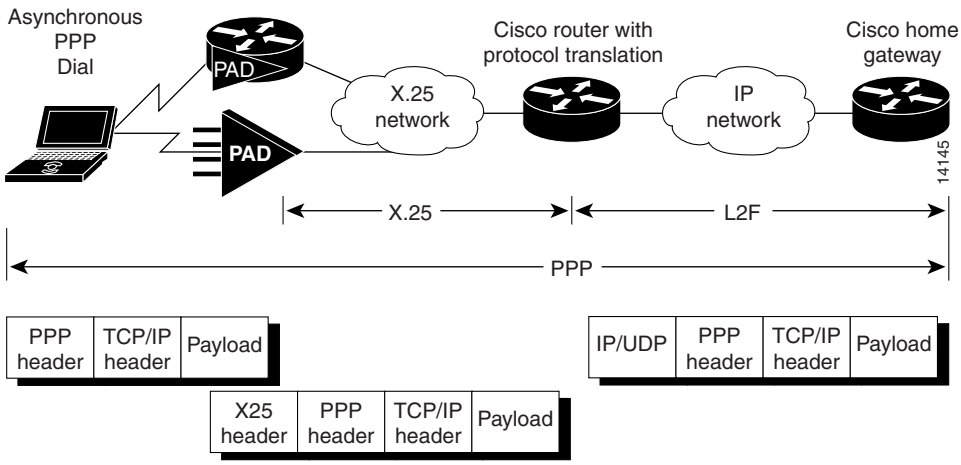
```
Router# configure terminal
Router(config)# X29 profile x25-ppp 1:0  2:0  3:2  4:1  5:0  6:0  7:21  8:0  9:0 10:0
11:14  12:0  13:0  14:0  15:0  16:127  17:24 18:18
Router(config)# translate x25 31370054065 profile x25-ppp ppp 10.0.0.4 routing
authentication chap
```

This example is incomplete. The commands in this example are only a part of the complete configuration file for an individual router.

X.25 to L2F PPP Tunneling Example

Protocol translation permits remote PPP users to connect to an X.25 PAD to communicate with IP network users via an L2F tunnel. (See Figure 49.)

Figure 49 L2F PPP Tunneling in X.25



The client application generates TCP/IP packets, which the PPP driver on the remote PC sends to the PAD. The PAD can either be an existing X.25/X.3/X.28/X.29-compliant PAD or a Cisco router with X.25 and PAD capability. The PAD receives the PPP/TCP/IP packets and sends them as X.25/PPP/TCP/IP packets to the X.25 network.

The Cisco router receives the packets and uses the protocol translation code to strip off the X.25 header. The router, using virtual templates, configures VPDN. VPDN invokes L2F tunneling and the virtual access interface via protocol translation, enables PPP to tunnel to the far home gateway and be terminated. At this point, the PC user can use Telnet, File Transfer Protocol (FTP), or similar file transfer utilities. The following is a partial example:

```
Router# virtual-temp 1
Router# encap ppp
Router# authentication chap
Router# trans x25 1234 virtual-temp 1
```

The following example shows a VPDN over a protocol translation virtual terminal-asynchronous connection over X.25 WAN. The client username is pc-user@cisco.com, the network access server is shadow (a Cisco router with the protocol translation option), and the home gateway is enkidu. The domain is cisco.com. The configuration for network access server shadow is as follows:

```
! VPDN NAS and Home Gateway passwords
username shadow password 7 013C142F520F
username enkidu-gw password 7 022916700202
vpdn enable
! VPDN outgoing to Home Gateway
vpdn outgoing cisco.com shadow ip 10.4.4.41
!
interface Virtual-Template1
 ip unnumbered Ethernet0
 no ip mroute-cache
 ppp authentication chap
!
interface Serial0
 description connects to enkidu s 0
 encapsulation x25 dce
 x25 address 2194440
 clockrate 2000000
!
translate x25 21944405 virtual-template 1
!
```

The configuration for home gateway enkidu-gw is as follows:

```
! VPDN NAS and Home Gateway passwords
 username shadow-nas password 7 143800200500
 username enkidu-gw password 7 132A05390208
 !
 ! The client user name and password
 username pc-user@cisco.com password 7 032B49200F0B
 !
 vpdn enable
 ! VPDN incoming from Shadow to this Home Gateway
 vpdn incoming shadow enkidu-gw virtual-template 1
 !
```

Assigning Addresses Dynamically for PPP Example

The following example shows how to configure the Cisco IOS software to assign an IP address dynamically to a PPP client using the one-step protocol translation facility:

```
! Enable DHCP proxy-client status on the router.
ip address-pool dhcp-proxy-client
! Specify rockjaw as the DHCP server on the network.
ip dhcp-server rockjaw
translate x25 5467835 ppp ip-pool keepalive 0
```

Local IP Address Pool Example

The following example shows how to select the IP pooling mechanism and how to create a pool of local IP addresses that are used when a client dials in on an asynchronous line. The address pool is named group1 and consists of interfaces 0 through 5.

```
! Tell the server to use a local pool.
ip address-pool local
! Define the range of ip addresses on the local pool.
ip local pool group1 172.18.35.1 192.168.35.5
translate x25 5467835 ppp ip-pool scope-name group1
```

X.29 Access List Example

The following example shows how to create an X.29 access list. Incoming permit conditions are set for all IP hosts and LAT nodes that have specific characters in their names. All X.25 connections to a printer are denied. Outgoing connections are restricted.

```
! Permit all IP hosts and LAT nodes beginning with "VMS".
! Deny X.25 connections to the printer on line 5.
!
access-list 1 permit 0.0.0.0 255.255.255.255
lat access-list 1 permit ^VMS.*
x29 access-list 1 deny .*
!
line vty 5
 access-class 1 in
 !
 ! Permit outgoing connections for other lines.
 !
 ! Permit IP access with the network 172.16.
 access-list 2 permit 172.16.0.0 0.0.255.255
 !
```

```
 ! Permit LAT access to the prasad/gopala complexes.
 lat access-list 2 permit ^prasad$
 lat access-list 2 permit ^gopala$
 !
 ! Permit X.25 connections to Infonet hosts only.
 x29 access-list 2 permit ^31370
 !
line vty 0 16
 access-class 2 out
 !
translate tcp 172.16.1.26 x25 5551234 access-class 2
```

X.3 Profile Example

The following profile script turns local edit mode on when the connection is made and establishes local echo and line termination upon receipt of a Return character. The name linemode is used with the **translate** command to effect use of this script.

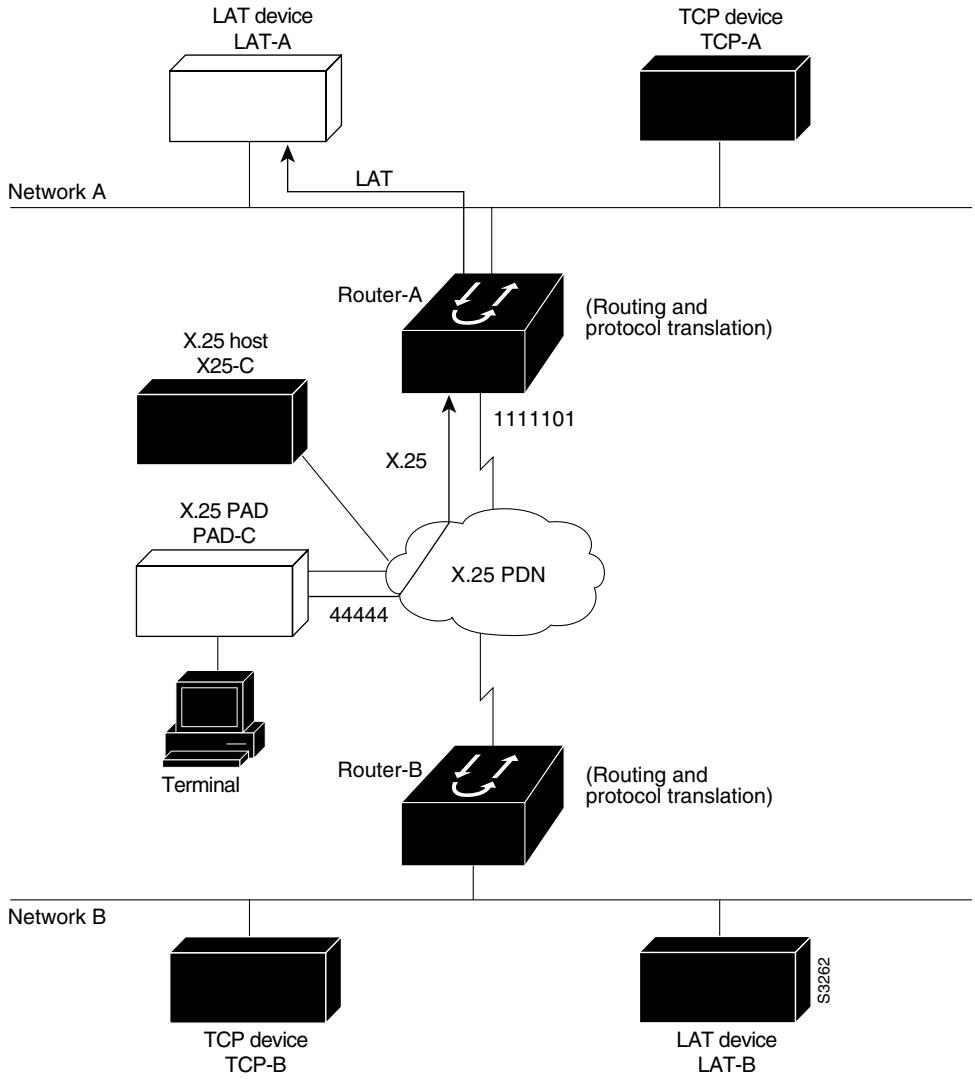
```
x29 profile linemode 2:1 3:2 15:1
translate tcp 172.16.1.26 x25 55551234 profile linemode
```

The X.3 PAD parameters are described in the "X.3 PAD Parameters" appendix at the end of this publication.

X.25 PAD-to-LAT Configuration Example

The following examples shows a protocol translation configuration that permits terminals connected to X.25 PADs to communicate with LAT devices on a remote LAN. (See Figure 50.) X.25 PAD terminals make a call using an X.121 address, which is translated to a LAT node. To the PAD terminal user, the connection appears to be a direct connection to a host on the X.25 PDN. The Cisco IOS software also supports X.29 access lists, which allow you to restrict LAN resources (LAT or TCP) available to the PAD user.

Figure 50 X.25 PAD-to-LAT Translation



The following example shows how to use the **translate** global configuration command to translate from an X.25 PAD to a LAT device on Network A. It is applied to Router-A. The configuration example includes an access list that limits remote LAT access through Router-A to connections from PAD-C.

```
! Define X25 access list to only allow pad-c.
x29 access-list 1 permit ^44444
x29 access-list 1 deny .*
!
! Set up translation.
translate x25 1111101 lat LAT-A access-class 1
```

This configuration example typifies the use of access lists in the Cisco IOS software. The first two lines define the scope of access-list 1. The first line specifies that access list 1 will permit all calls from X.121 address 44444. The caret symbol (^) specifies that the first number 4 is the beginning of the address number. Refer to the appendix "Regular Expressions" at the end of this publication for details concerning the use of special characters in defining X.121 addresses. The second line of the definition explicitly denies calls from any other number.

This access list is then applied to all incoming traffic on the serial port for Router-A (X.121 address 1111101) with the third configuration line in the example. However, it applies only to the **translate** command at the end of this example. This **translate** command specifies that incoming X.25 packets on the serial line (with address 1111101) are translated to LAT and sent to LAT-A if they pass the restrictions of the access list.

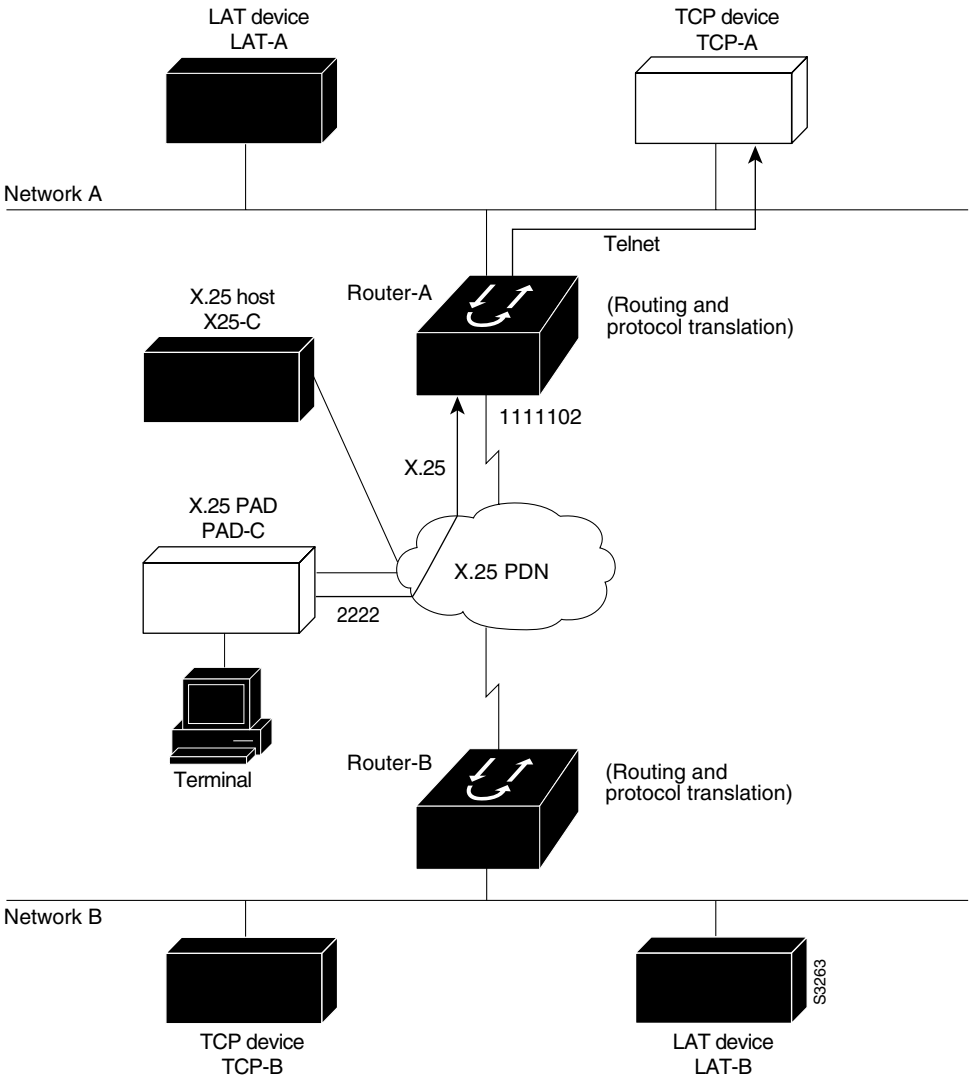
If you define multiple X.25 **translate** commands, each must contain a unique X.121 address. Also, the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) protocol that transfers packets must match the X.121 addresses. This requirement is specified in the protocol identification field of CUD. This field specifies whether a packet is routed, translated, or handled as a virtual terminal connection.

Note The X.121 address 1111101 used in this example can be a subaddress of the address 11111 originally assigned to this serial port on Router-A at the beginning of the configuration example section. However, making this assignment is not a requirement. The number to use in the **translate** command is negotiated (administratively) between your network management personnel and the PDN service provider. The X.121 address in the **translate** command represents the X.121 address of the calling device. That number may or may not be the number (or a subaddress of the number) administratively assigned to the router with the protocol translation option. You and the PDN must agree on a number to be used, because it is possible that the PDN can be configured to place calls that are intended for a destination on a given line that does not match the number assigned by you in the configuration file. Refer to the *1984 CCITT Red Book* specifications for more information concerning X.121 addresses.

X.25 PAD-to-TCP Configuration Example

Making a translated connection from an X.25 PAD to a TCP device is analogous to the preceding X.25 PAD-to-LAT example. (See Figure 51.) Instead of translating to LAT, the configuration for Router-A includes a statement to translate to TCP (Telnet). Note that a router with the protocol translation software option can include statements supporting both translations (X.25 PAD to LAT and X.25 PAD to TCP). Different users on the same PAD can communicate with X.25, LAT, or TCP devices.

Figure 51 X.25 PAD-to-TCP Translation



The following example shows how to use the **translate** global configuration command to translate from an X.25 PAD to a TCP device on Network A. It is applied to Router-A.

```
! Set up translation.
translate x25 2222 tcp TCP-A
```

Protocol Translation Session Examples

The examples in the following sections show how to make connections for protocol translation using the one-step and two-step methods:

- One-Step Method for TCP-to-X.25 Host Connections Example
- Using the Two-Step Method for TCP-to-PAD Connections Example
- Two-Step Protocol Translation for TCP-to-PAD Connections Example

One-Step Method for TCP-to-X.25 Host Connections Example

This sample session demonstrates one-step protocol translation featuring a UNIX workstation user making a connection to a remote X.25 host named host1 over an X.25 PDN. The router automatically converts the Telnet connection request to an X.25 connection request and sends the request as specified in the system configuration.

A connection is established when you enter the **telnet** EXEC command at the UNIX workstation system prompt, as follows:

```
unix% telnet host1
```

Note This example implicitly assumes that the name host1 is known to the UNIX host (obtained via DNS, IEN116, or a static table) and is mapped to the IP address used in a **translate** command.

The router accepts the Telnet connection and immediately forms an outgoing connection with remote host1 as defined in a **translate** command.

Next, host1 sets several X.3 parameters, including local echo. Because the Telnet connection is already set to local echo (at the UNIX host), no changes are made on the TCP connection.

The host1 connection prompts for a user name, then host1 sets the X.3 parameters to cause remote echo (the same process as setting X.3 PAD parameter 2:0), and prompts for a password. The Cisco IOS software converts this request to a Telnet option request on the UNIX host, which then stops the local echo mode.

At this point, the user is connected to the PAD application and the application will set the X.3 PAD parameters (although they can always be overridden by the user). When finished with the connection, the user escapes back to the host connection, then enters the appropriate command to close the connection.

The host named host1 immediately closes the X.25 connection. The Cisco IOS software then drops the TCP connection, leaving the user back at the UNIX system prompt.

Using the Two-Step Method for TCP-to-PAD Connections Example

To use the two-step method for making connections, perform the following steps:

Step 1 Connect directly from a terminal or workstation to a router.

For example, you might make the following connection requests at a UNIX workstation as a first step to logging in to the database named Information Place on an X.25 PDN:

```
unix% telnet orion
```

If the router named orion is accessible, it returns a login message and you enter your login name and password.

Step 2 Connect from the router to Information Place, which is on an X.25 host. You connect to an X.25 host using the **pad** EXEC command followed by the service address:

```
Router> pad 71330
```

Once the connection is established, the router immediately sets the PAD to single-character mode with local echoing, because these are the settings the router expects. The PAD responds with its login messages and a prompt for a password:

```
Trying 71330...Open
Welcome to the Information Place
Password:
```

Because the password should not echo on your terminal, the PAD requests remote echoing so that characters will be exchanged between the PAD and the router, but not echoed locally or displayed. After the password is verified, the PAD again requests local echoing from the router, which it does from then on.

To complete this sample session, you log out, which returns you to the router system EXEC prompt. From there, you enter the EXEC **quit** command, and the router drops the network connection to the PAD.

Two-Step Protocol Translation for TCP-to-PAD Connections Example

The following sample session shows a connection from a local UNIX host named host1 to a router named router1 as the first step in a two-step translation process:

```
host1% telnet Router1
```

The following sample session shows a connection from Router1 to a host named ibm3278 as the second step in a two-step translation process:

```
Router1> tn3270 ibm3278
ibm3278%
```

Next, connect directly from a terminal or workstation on a TCP/IP network to a router, and then to a database named Information Place on an X.25 packet data network. The database has a service address of 71330.

To complete the two-step translation connection, perform the following steps:

Step 1 Make the following connection requests at a UNIX workstation as a first step to logging in to the database Information Place:

```
unix% telnet router1
```

If the router named router1 is accessible, it returns a login message and you enter your login name and password.

Step 2 Connect from the router to the Information Place, which is on an X.25 host. You connect to an X.25 host using the **pad** EXEC command followed by the service address:

```
Router1> pad 71330
```

Once the connection is established, the router immediately sets the PAD to single-character mode with local echoing, because these are the settings that the router expects. The PAD responds with its login messages and a prompt for a password.

```
Trying 71330...Open
Welcome to the Information Place
Password:
```

Because the password should not echo on your terminal, the PAD requests remote echoing so that characters will be exchanged between the PAD and the router, but not echoed locally or displayed. After the password is verified, the PAD again requests local echoing from the router.

Step 3 Complete the session by logging out, which returns you to the router system EXEC prompt.

Step 4 Enter the **quit** EXEC command, and the router drops the network connection to the PAD.

Changing Parameters and Settings Dynamically Example

The following sample session shows how to make a dynamic change during a protocol translation session. In this sample, you will edit information on the remote host named Information Place. To change the X.3 PAD parameters that define the editing characters from the default Delete key setting to the Ctrl-D sequence, perform the following steps:

Step 1 Enter the escape sequence to return to the system EXEC prompt:

```
Ctrl ^ x
```

Step 2 Enter the **resume** command with the **/set** keyword and the desired X.3 parameters. X.3 parameter 16 sets the Delete function. ASCII character 4 is the Ctrl-D sequence.

```
Router> resume /set 16:4
```

The session resumes with the new settings, but the information is not displayed correctly. You may want to set the **/debug** switch to check that your parameter setting has not been changed by the host PAD.

Step 3 Enter the escape sequence to return to the system EXEC prompt, then enter the **resume** command with the **/debug** switch.

```
Router> resume /debug
```

The **/debug** switch provides helpful information about the connection.

You can also set a packet dispatch character or sequence using the **terminal dispatch-character** command. The following example shows how to set ESC (ASCII character 27) as a dispatch character:

```
Router> terminal dispatch-character 27
```

To return to the PAD connection, enter the **resume** command:

```
Router> resume
```

Monitoring Protocol Translation Connections Example

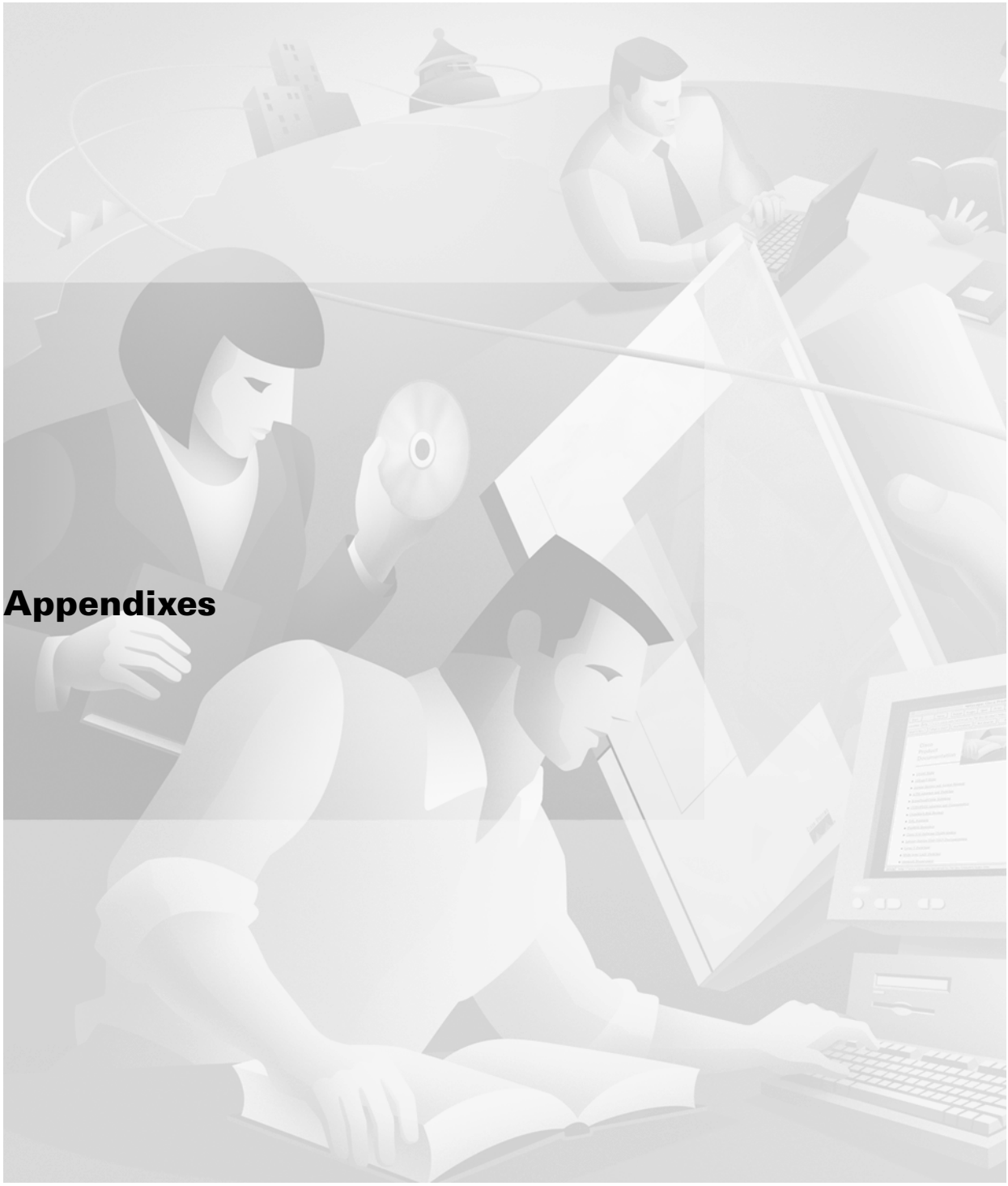
The following example shows how to log significant virtual terminal-asynchronous authentication information such as the X.121 calling address, CUD, and the IP address assigned to a virtual terminal-asynchronous connection to a UNIX syslog server named alice:

```
service pt-vty-logging
logging alice
```

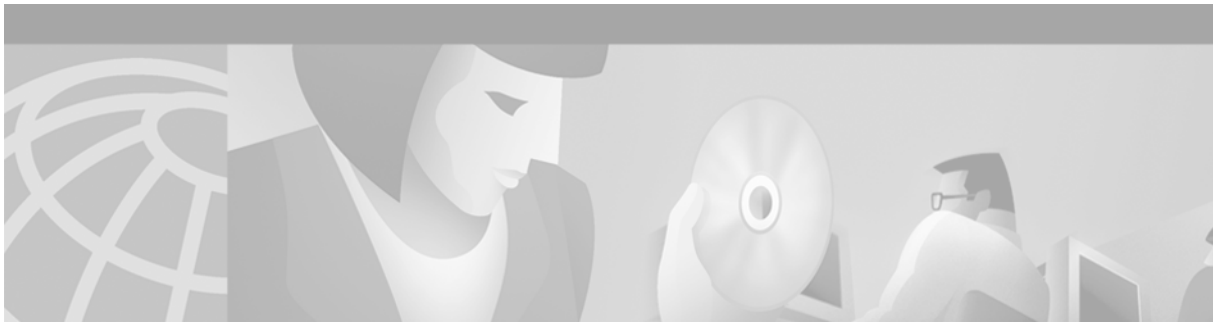
Two-Step Protocol Translation for Virtual Terminal Asynchronous Interfaces Example

The following example shows how to configure the **vty-async** command for PPP over X.25 using the router named redmount:

```
hostname redmount

ip address-pool local
x25 routing
vty-async                   <------ two-step translation
vty-async dynamic-routing   <------ optional
vty-async mtu 245           <------ optional

interface Ethernet0
 ip address 172.31.113.7 255.255.255.0
 no mop enabled

interface Serial0
 no ip address
 encapsulation x25
 x25 address 9876543210

router rip
 network 172.31.213.0
 network 172.22.164.0

ip domain-name cisco.com
ip name-server 172.31.213.2
ip name-server 172.31.213.4
ip local pool default 172.22.164.1 172.28.164.254
x25 route 9876543211 alias serial 0
x25 route 9876543212 alias serial 0

line con 0
 exec-timeout 0 0
line aux 0
 transport input all
line vty 0 1                <------ used for remote access to the router
 rotary 2
line vty 2 64               <------ used for ppp over x25
 rotary 1
 autocommand ppp default
```



Appendixes



X.3 PAD Parameters

A PAD is a packet assembler/disassembler, which is a device that collects data from a group of terminals and periodically outputs the data in packets (data organized in a special format). A PAD also does the reverse. That is, it can take data packets from a host and return them into a character stream that can be sent to the terminals, or start-stop mode DTE, as defined by the International Telecommunication Union (ITU). A PAD is defined by ITU-T Recommendations X.3, X.28, and X.29. (The ITU-T carries out the functions of the former Consultative Committee for International Telegraph and Telephone.)

ITU-T Recommendation X.3 specifies the parameters for terminal-handling functions such as data speed, flow control, character echoing, and other functions for a connection to an X.25 host. The X.3 parameters are similar in function to the Telnet options.

ITU-T Recommendation X.29 specifies a protocol for setting the X.3 parameters via a network connection. When a connection is established, the destination host can request that the PAD or terminal change its parameters using the X.29 protocol. A PAD can refuse the request, in which case a terminal user can change the parameter later. A PAD cannot tell the destination host to change its X.3 parameters, but it can communicate that its own parameters were changed.

Along with Recommendations X.3 and X.29, the ITU-T also provides Recommendation X.28 to specify the user interface for locally controlling a PAD.

Cisco IOS software offers two ways of connecting to a PAD: using the **pad** EXEC user interface command to initiate an outgoing connection to a PAD, and using the **x28** EXEC command to access the Cisco universal X.28 PAD user emulation mode.

In X.28 PAD user emulation mode, you can perform the same functions available from the Cisco **pad** EXEC user interface; however, X.28 PAD user emulation mode adds functionality such as the ability to exchange PAD signals across an X.25 network, and is useful for connecting to systems using software designed to interact with an X.28 PAD. X.28 PAD user emulation mode is also useful when a reverse connection requires packetization according to the X.29 parameters.

This appendix discusses the X.3 PAD parameters. The chapter "Configuring the Cisco PAD Facility for X.25 Connections" in this publication explains how to make PAD connections and how to switch between connections. Refer to the ITU-T X.3 and X.28 recommendations for additional information about the X.3 PAD parameters.

X.3 PAD Parameter Descriptions

Following are descriptions of X.3 parameters 1 through 22. Default values are noted in the descriptions. The default value for any parameter not so noted is zero for outgoing connections or not set for incoming PAD connections. For incoming PAD connections, the access server sends an X.29 SET PARAMETER packet to set the noted defaults.

Because the X.3 parameters describe the user terminal, which exists on only one side of the connection, the PAD protocols are not always symmetric.

Note Some of the commands described in this section require ASCII decimal values. Refer to the "ASCII Character Set and Hex Values" appendix in the *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.2, for a list of ASCII characters. Also note that the PAD EXEC user interface and X.28 PAD user emulation mode provide different support for the PAD parameters, and these differences are noted in the following descriptions.

Parameter 1: PAD Recall Using a Character

Parameter 1 determines whether the start-stop mode DTE is allowed to escape from data transfer mode to send PAD command signals.

Because the PAD EXEC mode uses a two-character escape sequence, and there is no way to set the escape character on a Telnet connection, this parameter is refused on translation sessions. The PAD EXEC user interface does not support this parameter; however, the Cisco X.28 standard user interface does support this parameter.

Minimum value: 0; maximum value: 126; X.28 PAD user emulation mode default: 1.

Parameter 2: Echo

Parameter 2 determines whether or not PAD is required to perform local echo of characters. This parameter can be negotiated end-to-end on translation sessions. On incoming PAD connections, software turns off local echo on the remote PAD to support the Cisco user interface. See Table 9 for local echo mode values and their descriptions.

Table 9 PAD Local Echo Mode Values

Value	Description
0	No local echo (incoming PAD connection default).
1	Local echo on (outgoing connection default).

Minimum value: 0; maximum value: 1; PAD EXEC mode and X.28 PAD user emulation mode defaults: 1.

Parameter 3: Selection of Data Forwarding Character

Parameter 3 sets up a packet forwarding mask; that is, it selects which character causes PAD to forward a packet either before expiration of the idle timer (see parameter 4) or when in local editing mode. See Table 10 for data forward character values and their descriptions.

Table 10 PAD Data Forward Character Values

Value	Description
0	None—full packet.
1	Forward packet upon receipt of an alphanumeric character.
2	Forward packet upon receipt of an ASCII CR (a Return is the outgoing connection default).
4	Forward packet upon receipt of an ASCII ESCAPE, BEL, ENQ, or ACK.
8	Forward packet upon receipt of an ASCII DEL, CAN, or DC2.
16	Forward packet upon receipt of an ASCII ETX or EOT.
32	Forward packet upon receipt of an ASCII HT, LT, VT, or FF.
64	All other characters in columns 0 and 1 of the ASCII chart not listed.

Because X.3 supports a wider variety of dispatch characters than Telnet does, parameter changes to or from the default cause a translation session to negotiate in or out of line mode on the Telnet connection.

A forwarding mask can also be statically set using the **terminal dispatch-character** terminal parameter-setting EXEC command. This command can set any character or characters as the forwarding mask, and overrides (when logical) any values set by parameter 3.

Minimum value: 0; maximum value: 255; PAD EXEC mode default: 2 (ASCII CR); X.28 PAD user emulation mode default: 126 (ASCII ~).

Parameter 4: Selection of Idle Timer Delay

Parameter 4 controls the amount of time the software waits for new data before sending a packet in the absence of a data forwarding character. See Table 11 for PAD idle timer values and their descriptions.

Table 11 PAD Idle Timer Values

Value	Description
0	No timer.
1–255	Delay value in twentieths of a second (default for both connection types is 1).

Minimum value: 0; maximum value: 255; PAD EXEC mode default: 1; X.28 PAD user emulation mode default: 0.

Parameter 5: Ancillary Device Control

Parameter 5 selects whether PAD can send flow control X-ON/X-OFF (ASCII DC1/DC3 transmission on and off) characters during data transfer to the start-stop mode DTE to control the terminal and data flow. Flow control is not directly supported on access servers because data must make network hops to travel to its final destination. However, depending on the type of incoming connection, setting this parameter can cause similar negotiations to be sent over the connection, thereby attempting to change the state of the flow control option at the device closest to the user.

See Table 12 for PAD flow control signal values and their descriptions.

Table 12 PAD Flow Control Signal Values

Value	Description
0	No use of X-ON/X-OFF.
1	Use of X-ON/X-OFF (data transfer).
2	Use of X-ON/X-OFF (data transfer and command).

Minimum value: 0; maximum value: 2; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 1.

Parameter 6: Control of PAD Service Signals

Parameter 6 controls PAD service signals and the prompt. By default, the Cisco X.28 standard user interface prompt is an asterisk (*), but the prompt can be changed. See Table 13 for PAD BREAK signal values and their descriptions.

Table 13 PAD BREAK Service Signal Values

Value	Description
0	No service signals are sent to the start-stop DTE.
1	Service signals other than the prompt PAD service signal are sent.
2	Editing PAD service signals are only sent in the format specified by parameter 19.
4	The prompt PAD service signal is sent in the standard format.
8 to 15	PAD service signals are only sent in network-dependent format. Value 8 specifies the prompt as x28>. Value 9 enables French extended mode support. Value 10 specifies the prompt be the same as the Cisco EXEC prompt.

The PAD EXEC user interface does not support this parameter; however, the Cisco X.28 standard user interface does support this parameter.

Minimum value: 0; maximum value: 255; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 2.

Parameter 7: Selection of Operation of PAD on Receipt of a BREAK Signal

Parameter 7 defines the action of the PAD after receiving a BREAK signal from the from the start-stop mode DTE. See Table 14 for PAD BREAK signal values and their descriptions.

Table 14 PAD BREAK Signal Values

Value	Description
0	Ignore the BREAK signal.
1	Send an interrupt packet to notify the remote host or another PAD that the BREAK signal has been generated.
2	Send a Reset packet to reset the virtual circuit.
4	Send an X.29 Indication of Break to the remote host, or to a PAD (outgoing connection default).
8	Escape from data transfer mode.
16	Discard output to the start-stop mode DTE by setting parameter 8 to a value of 1.
21	Combination of values 1, 4, and 16 (incoming connection default).

The PAD protocols allow you to send a special X.29 Indication of Break packet, send an Interrupt packet, perform a reset operation, act as if the recall character had been typed, or begin discarding output to the user. Combinations of these options are also allowed, as long as they are logical. Common options are to begin discarding output and send both an X.25 Interrupt packet and an X.29 Indication of Break packet; these options are supported. All other options are not supported and are silently ignored.

Minimum value: 0; maximum value: 31; PAD EXEC mode default: 4; X.28 PAD user emulation mode default: 2.

Parameter 8: Discard Output

Parameter 8 indicates to the PAD whether to discard received packets rather than disassemble and send them. This parameter works in conjunction with parameter 7. If value 16 is chosen for parameter 7, all output is discarded after reception of the BREAK signal. Setting parameter 8 to 0 restores normal data delivery to the terminal.

This parameter also can be set and unset manually using the PAD **resume** EXEC command.

See Table 15 for PAD discard output values and their descriptions.

Table 15 PAD Discard Output Values

Value	Description
0	Normal data delivery to the terminal (outgoing connection default).
1	Discard all output to the start-stop mode DTE. Set by parameter 7; see previous description.

Minimum value: 0; maximum value: 1; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 9: Padding After Return

Parameter 9 determines whether PAD can provide padding (insert filler characters) upon receipt of an ASCII CR (Return) control code from the start-stop mode DTE.

Minimum value: 0; maximum value: 255; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 10: Line Folding (Not Supported)

Neither the PAD EXEC user interface nor the X.28 PAD user emulation mode supports this parameter.

Parameter 11: DTE Speed

Parameter 11 is a read-only value that determines the binary speed of the start-stop mode DTE sent across the interface between PAD and the access server. See Table 16 for PAD speed values and their descriptions.

Table 16 PAD DTE Speed Values

Value	Description (in Bits per Second)
10	50
5	75
9	100
0	110
1	134.5
6	150
8	200
2	300
4	600
3	1200
7	1800
11	75/1200
12	2400
13	4800
14	9600
15	19200
16	48000
17	56000
18	64000

Minimum value: 0; maximum value: 18; PAD EXEC mode and X.28 PAD user emulation mode default: 14.

Parameter 12: Flow Control of the PAD by the Start-Stop Mode DTE

Parameter 12 determines whether the start-stop mode DTE can send ASCII X-ON/X-OFF characters to PAD during the data transfer mode. Flow control is not directly supported on access servers because data must make network hops to travel to its final destination. However, depending on the type of incoming connection, setting this parameter can cause similar negotiations to be sent over the connection, thereby attempting to change the state of the flow control option at the device closest to the user.

See Table 17 for PAD flow control values and their descriptions.

Table 17 PAD Flow Control Values

Value	Description
0	No use of X-ON/X-OFF.
1	Use of X-ON/X-OFF.

Minimum value: 0; maximum value: 1; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 1.

Parameter 13: Line Feed Insertion

Parameter 13 determines the procedure for inserting the line feed character upon receipt of an ASCII CR character. The PAD also responds to a value that results from the addition of any of the line feed signal values described in Table 18.

Table 18 PAD Line Feed Signal Values

Value	Description
0	Do not insert the line feed character (outgoing connection default).
1	Insert a line feed after sending an ASCII CR to the start-stop mode DTE.
2	Insert a line feed after echoing an ASCII CR to the start-stop mode DTE.
4	Insert a line feed after echoing an ASCII CR to the remote host.

Minimum value: 0; maximum value: 7; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 14: Line Feed Padding

Parameter 14 determines whether PAD can provide padding (insert filler characters) upon receipt of a line feed character from the start-stop mode DTE. This function is generally provided by the end-user operating system.

Minimum value: 0; maximum value: 255; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 15: Editing

Parameter 15 enables or disables a PAD editing function for the start-stop mode DTE in data transfer mode.

Enabling the editing function disables the idle timer (see parameter 4). The user at the start-stop mode DTE can make corrections and display the line buffer containing the characters to be sent when the data forwarding character (see parameter 3) is received. See Table 19 for PAD local editing function values and their descriptions.

Table 19 PAD Local Editing Functions

Value	Description
0	Disables editing capabilities in data transfer mode. Any characters entered become part of the data stream and are sent (default for both connection types).
1	Enables editing capabilities in the data transfer mode, which suspends the following PAD operations: • Full packet data forwarding until the edit buffer is full • Forwarding of data packets upon expiration of the idle timer

Parameters 16, 17, and 18 provide the editing functions.

Minimum value: 0; maximum value: 1; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 16: Character Delete

Parameter 16 allows you to select a character that will delete a character while in PAD editing mode. This character is valid only if parameter 15 is set to 1. Select one character from the ASCII character set to represent the delete character.

Minimum value: 0; maximum value: 127; PAD EXEC mode and X.28 PAD user emulation mode default: 127 (ASCII DEL).

Parameter 17: Line Delete

Parameter 17 allows you to select a character that will delete a line while in PAD editing mode. This character is valid only if parameter 15 is set to 1. Select one character from the ASCII character set to represent the line delete character.

Minimum value: 0; maximum value: 127; PAD EXEC mode default: 21 (ASCII NAK or Ctrl-U); X.28 PAD user emulation mode default: 24 (ASCII CAN or Ctrl-X).

Parameter 18: Line Display

Parameter 18 allows you to select a character that will display a line while in PAD editing mode. This character is valid only if parameter 15 is set to 1. Select one character from the ASCII character set to represent the delete character.

Minimum value: 0; maximum value: 127; PAD EXEC mode and X.28 PAD user emulation mode default: 18 (ASCII DC2 or Ctrl-R).

Parameter 19: Editing PAD Service Signals

Parameter 19 allows you to set editing PAD service signals.

The PAD EXEC user interface does not support this parameter; however, the X.28 PAD user emulation mode does support this parameter.

See Table 20 for editing PAD service signal values and their descriptions.

Table 20 Editing PAD Service Signal Values

Value	Description
0	No editing PAD service signals.
1	Editing PAD service signals for printing terminals.
2	Editing PAD service signals for display terminals.
8; 32–126	Editing PAD service signals using an ASCII character in the value range.

Minimum value: 0; maximum value: 126; PAD EXEC mode default: 0; X.28 PAD user emulation mode default: 2.

Parameter 20: Echo Mask

Parameter 20 allows you to set the start-stop mode DTE to echo all characters.

The PAD EXEC user interface does not support this parameter; however, the X.28 PAD user emulation mode does support this parameter.

See Table 21 for PAD echo mask values and their descriptions.

Table 21 PAD Echo Mask Values

Value	Description
0	No echo mask (all characters echoed).
1	No echo of ASCII character CR.
2	No echo of ASCII character LF.
4	No echo of ASCII characters VT, HT, FF.
8	No echo of ASCII characters BEL or BS.
16	No echo of ASCII characters ESCAPE or ENQ.
32	No echo of ASCII characters ACK, NAK, STX, SOH, EOT, ETB, or ETX.
64	No echo of characters as designated by parameters 16, 17, or 18.
128	No echo of all other characters not listed and of ASCII DEL.

Minimum value: 0; maximum value: 255; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 21: Parity Treatment

Parameter 21 controls the parity and character format used by the start-stop mode DTE. See Table 22 for the supported parity treatment values and their descriptions.

Table 22 Parity Treatment Values

Value	Description
0	No parity checking or generation (default). **Note** When the PAD transfers a data character or interprets a received character for a specific action different from the transfer of this data character to the remote DTE, it inspects only the first seven bits and will not take account of the eighth bit.
1	Check character parity against the parity configured on the asynchronous line, and drop character if invalid parity is set. **Note** The PAD treats the eighth bit of the characters received from the start-stop DTE as a parity bit and checks this bit against the type of parity used between the PAD and the start-stop mode DTE.
2	Generate parity. **Note** The PAD replaces the eighth bit of the characters to be sent to the start-stop mode DTE with the bit that corresponds to the type of parity used between the PAD and the start-stop mode DTE.
3	Check and generate parity (combination of 1 and 2). **Note** The PAD will both check the parity bit for characters received from the start-stop mode DTE and generate the parity bit for characters to be sent to the start-stop mode DTE, as described for values 1 and 2.
4	Pass parity transparently. **Note** The PAD transparently passes the eighth bit whenever it must transfer a data character or interpret a received character.

When the PAD generates characters such as service signals, determination of how the PAD sends them is made according to the following criteria:

- If parameter 21 is set to 0, the signals are sent with even parity.
- If parameter 21 is set to 1, 2 or 3, the signals are sent with the type of parity used between the PAD and the start-stop mode DTE.
- If parameter 21 is set to 4, the signals are sent with space parity.

Additionally, if parameter 21 is set to 0 and parity is determined by an alternate means—for example, it is detected with the service request signal—the PAD sends the service signals using the detected parity rather than the configured parity.

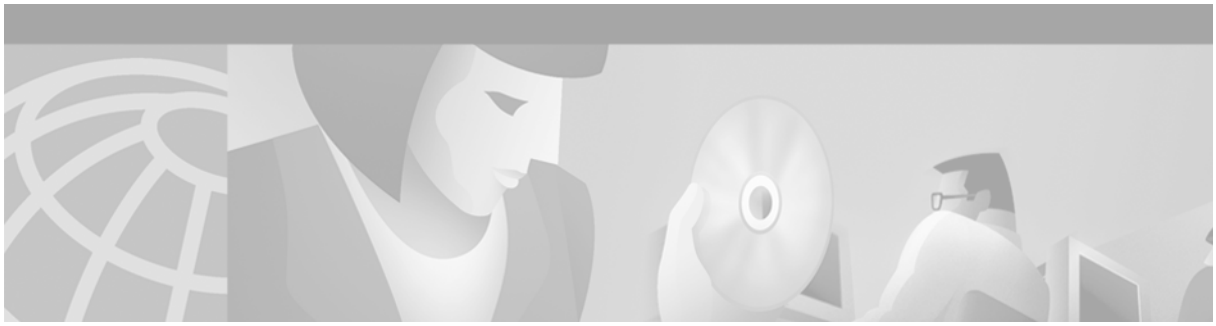
When the value of parameter 21 is set to 1 or 3 and PAD detects a parity error in the characters received from the start-stop mode DTE, the PAD will perform one of the following actions:

- If parameter 2 is set to 0 (no local echo), and parameter 6 is set to 0 (no service signals), PAD resets the virtual circuit.
- If parameter 2 is set to 1 (local echo) and parameter 6 is set to 0 (no service signals), PAD discards and does not echo the character in error, and sends the BEL character to the start-stop mode DTE.
- If parameter 2 is set to 1 (local echo) and parameter 6 is set to 1 or greater (service signals), PAD discards and does not echo the character in error, and sends the BEL character to the start-stop mode DTE; additionally, the PAD may also send the parity error PAD service signal.

Minimum value: 0; maximum value: 4; PAD EXEC mode and X.28 PAD user emulation mode default: 0.

Parameter 22: Page Wait (Not Supported)

Neither the PAD EXEC user interface nor the X.28 PAD user emulation mode supports this parameter.



Regular Expressions

This appendix explains regular expressions and how to use them in Cisco IOS software configurations. It also provides details for composing regular expressions. This appendix has the following sections:

General Concepts

A regular expression is a pattern to match against an input string. You specify the pattern that a string must match when you compose a regular expression. Matching a string to the specified pattern is called "pattern matching." Pattern matching either succeeds or fails.

For example, you can specify in an X.25 routing table that incoming packets with destination addresses beginning with 3107 are routed to serial interface 0. In this example, the pattern to match is the *3107* specified in the X.25 routing table. The string is the initial portion of the destination address of any incoming X.25 packet. When the destination address string matches *3107* pattern, then pattern matching succeeds and the Cisco IOS software routes the packet to serial interface 0. When the initial portion of the destination address does not match *3107*, then pattern matching fails and the software does not route the packet to serial interface 0.

If a regular expression can match two different parts of an input string, it will match the earliest part first.

Using Regular Expressions

Cisco configurations use several implementations of regular expressions. Generally, you use regular expressions to specify chat scripts for asynchronous lines in the dial-on-demand routing (DDR) feature.

On asynchronous lines, chat scripts send commands for modem dialing and logging in to remote systems. You use a regular expression in the **script dialer** command to specify the name of the chat script that the Cisco IOS software is to execute on a particular asynchronous line. You can also use regular expressions in the **dialer map** command to specify a "modem" script or "system" script to be used for a connection to one or multiple sites on an asynchronous interface.

Creating Regular Expressions

A regular expression can be a single-character pattern or a multiple-character pattern. That is, a regular expression can be a single character that matches the same single character in the input string or multiple characters that match the same multiple characters in the input string. This section describes creating both single-character patterns and multiple-character patterns. It also discusses creating more complex regular expressions using multipliers, alternation, anchoring, and parentheses.

Single-Character Patterns

The simplest regular expression is a single character that matches itself in the input string. For example, the single-character regular expression **3** matches a corresponding *3* in the input string. You can use any letter (A to Z, a to z) or number (0 to 9) as a single-character pattern. The following examples are single-character regular expression patterns:

A

k

5

You can use a keyboard character other than a letter or a number—such as an exclamation point (!) or a tilde (~)—as a single-character pattern, but certain keyboard characters have special meaning when used in regular expressions. Table 23 lists the keyboard characters with special meaning.

Table 23 Characters with Special Meaning

Character/Symbol		Special Meaning
asterisk	*	Matches 0 or more sequences of the pattern.
brackets	[]	Designates a range of single-character patterns.
caret	^	Matches the beginning of the input string.
dollar sign	$	Matches the end of the input string.
hyphen	-	Separates the end points of a range.
parentheses	()	(Border Gateway Protocol specific) Designates a group of characters as the name of a confederation.
period	.	Matches any single character, including white space.
plus sign	+	Matches 1 or more sequences of the pattern.
question mark	?	Matches 0 or 1 occurrences of the pattern.
underscore	_	Matches a comma (,), left brace ({), right brace (}), left parenthesis, right parenthesis, the beginning of the input string, the end of the input string, or a space.

To use these special characters as single-character patterns, remove the special meaning by preceding each character with a backslash (\). The following examples are single-character patterns matching a dollar sign, an underscore, and a plus sign, respectively:

\$

_

\+

You can specify a range of single-character patterns to match against a string. For example, you can create a regular expression that matches a string containing one of the following letters: *a*, *e*, *i*, *o*, and *u*. One and only one of these characters must exist in the string for pattern matching to succeed. To specify a range of single-character patterns, enclose the single-character patterns in square brackets ([ ]). The order of characters within the brackets is not important. For example, **[aeiou]** matches any one of the five vowels of the lowercase alphabet, while **[abcdABCD]** matches any one of the first four letters of the lowercase or uppercase alphabet.

You can simplify ranges by typing only the endpoints of the range separated by a hyphen (-). Simplify the previous range as follows:

[a-dA-D]

To add a hyphen as a single-character pattern in your range, include another hyphen and precede it with a backslash:

[a-dA-D\-]

You can also include a right square bracket (]) as a single-character pattern in your range. To do so, enter the following:

[a-dA-D\-\]]

The previous example matches any one of the first four letters of the lower- or uppercase alphabet, a hyphen, or a right square bracket.

You can reverse the matching of the range by including a caret (^) at the start of the range. The following example matches any letter *except* the ones listed:

[^a-dqsv]

The following example matches anything except a right square bracket (]) or the letter *d*:

[^\]d]

Multiple-Character Patterns

When creating regular expressions, you can also specify a pattern containing multiple characters. You create multiple-character regular expressions by joining letters, numbers, or keyboard characters that do not have special meaning. For example, **a4%** is a multiple-character regular expression. Precede keyboard characters that have special meaning with a backslash (\)when you want to remove their special meaning.

With multiple-character patterns, order is important. The regular expression **a4%** matches the character *a* followed by the number *4* followed by a % sign. If the input string does not have *a4%*, in that order, pattern matching fails. The multiple-character regular expression **a.** uses the special meaning of the period character (.) to match the letter *a* followed by any single character. With this example, the strings *ab*, *a!*, or *a2* are all valid matches for the regular expression.

You can remove the special meaning of the period character by preceding it with a backslash. In the expression **a\.** only the string *a.* matches the regular expression.

You can create a multiple-character regular expressions containing all letters, all digits, all special keyboard characters, or a combination of letters, digits, and other keyboard characters. The following examples are all valid regular expressions:

telebit

3107

v32bis

Multipliers

You can create more complex regular expressions that instruct the Cisco IOS software to match multiple occurrences of a specified regular expression. To do so, you use some special characters with your single- and multiple-character patterns. Table 24 lists the special characters that specify "multiples" of a regular expression.

Table 24 Special Characters Used as Multipliers

Character/Symbol		Special Meaning
asterisk	*	Matches 0 or more single- or multiple-character patterns.
plus sign	+	Matches 1 or more single- or multiple-character patterns.
question mark	?	Matches 0 or 1 occurrences of the single- or multiple-character pattern.

The following example matches any number of occurrences of the letter *a*, including none:

a*

The following pattern requires that at least one letter *a* be present in the string to be matched:

a+

The following pattern matches the string *bb* or *bab*:

ba?b

The following string matches any number of asterisks (*):

******

To use multipliers with multiple-character patterns, enclose the pattern in parentheses. In the following example, the pattern matches any number of the multiple-character string *ab*:

(ab)*

As a more complex example, the following pattern matches one or more instances of alphanumeric pairs (but not none; that is, an *empty string* is not a match):

([A-Za-z][0-9])+

The order for matches using multipliers (*, +, or ?) is longest construct first. Nested constructs are matched from outside to inside. Concatenated constructs are matched beginning at the left side of the construct. Thus, the regular expression matches *A9b3*, but not *9Ab3* because the letter appears first in the construct.

Alternation

Alternation allows you to specify alternative patterns to match against a string. You separate the alternative patterns with a vertical bar (|). Exactly one of the alternatives can match the input string. For example, the regular expression **codex|telebit** matches the string *codex* or the string *telebit*, but not both *codex* and *telebit*.

Anchoring

You can instruct the Cisco IOS software to match a regular expression pattern against the beginning or the end of the input string. That is, you can specify that the beginning or end of an input string contain a specific pattern. You "anchor" these regular expressions to a portion of the input string using the special characters shown in Table 25.

Table 25 Special Characters Used for Anchoring

Character/Symbol		Special Meaning
carat	^	Matches any single character, including white space.
dollar sign	$	Matches 0 or more sequences of the pattern.

Note another use for the ^ symbol. As an example, the following regular expression matches an input.

string only if the string starts with *abcd*:

^abcd

Whereas the following expression is a range that matches any single letter, as long as it is not the letters *a*, *b*, *c*, or *d*:

[^abcd]

With the following example, the regular expression matches an input string that ends with *.12*:

$\.12

Contrast these anchoring characters with the special character underscore (_). Underscore matches the beginning of a string (^), the end of a string ($), parentheses (( )), space ( ), braces ({ }), comma (,), or underscore (_). With the underscore character, you can specify that a pattern exist anywhere in the input string. For example, **_1300_** matches any string that has *1300* somewhere in the string. The string's *1300* can be preceded by or end with a space, brace, comma, or underscore. So, while *{1300_* matches the regular expression, *21300* and *13000* do not.

Using the underscore character, you can replace long regular expression lists. For example, you can replace the following list of regular expressions with simply **_1300_**:

^1300$

^1300(space)

(space)1300

{1300,

,1300,

{1300}

,1300,

(1300

Parentheses for Recall

As shown in the "Multipliers" section, you use parentheses with multiple-character regular expressions to multiply the occurrence of a pattern. You can also use parentheses around a single- or multiple-character pattern to instruct the Cisco IOS software to remember a pattern for use elsewhere in the regular expression.

To create a regular expression that recalls a previous pattern, you use parentheses to instruct memory of a specific pattern and a backslash (\) followed by an integer to reuse the remembered pattern. The integer specifies the occurrence of a parentheses in the regular expression pattern. If you have more than one remembered pattern in your regular expression, then \1 uses the first remembered pattern and \2 uses the second remembered pattern, and so on.

The following regular expression uses parentheses for recall:

a(.)bc(.)\1\2

This regular expression matches the letter *a* followed by any character (call it character #1) followed by *bc*, followed by any character (character #2), followed by character #1 again, followed by character #2 again. In this way, the regular expression can match *aZbcTZT*. The software identifies character #1 as *Z* and character #2 as*T,* and then uses *Z* and *T* again later in the regular expression.

The parentheses do not change the pattern; they only instruct the software to recall that part of the matched string. The regular expression **(a)b** still matches the input string *ab*, and **(^3107)** still matches a string beginning with *3107*, but now the Cisco IOS software can recall the *a* of the *ab* string and the starting *3107* of another string for use later.

Regular Expressions Examples

This section shows you practical examples of regular expressions. The examples correspond with the various ways you can use regular expressions in your configurations.

Chat Scripts Example

The following example uses regular expressions in the **chat-script** command to specify chat scripts for lines connected to Telebit and US Robotics modems. The regular expressions are **telebit.*** and **usr.***. When the chat script name (the string) matches the regular expression (the pattern specified in the command), then the Cisco IOS software uses that chat script for the specified lines. For lines 1 and 6, the Cisco IOS software uses the chat script named telebit followed by any number of occurrences (*) of any character (.). For lines 7 and 12, the software uses the chat script named usr followed by any number of occurrences (*) of any character (.).

```
! Some lines have Telebit modems.
line 1 6
chat-script telebit.*
! Some lines have US Robotics modems.
line 7 12
chat-script usr.*
```

X.25 Switching Feature Example

In the following X.25 switching feature example, the **x25 route** command causes all X.25 calls to addresses whose first four Data Network Identification Code (DNIC) digits are 1111 to be routed to serial interface 3. Note that the first four digits (^1111) are followed by a regular expression pattern that the Cisco IOS software is to remember for use later. The \1 in the rewrite pattern recalls the portion of the original address matched by the digits following the 1111, but changes the first four digits (1111) to 2222.

```
x25 route ^1111(.*) substitute-dest 2222\1 interface serial 3
```

DECnet Access List Example

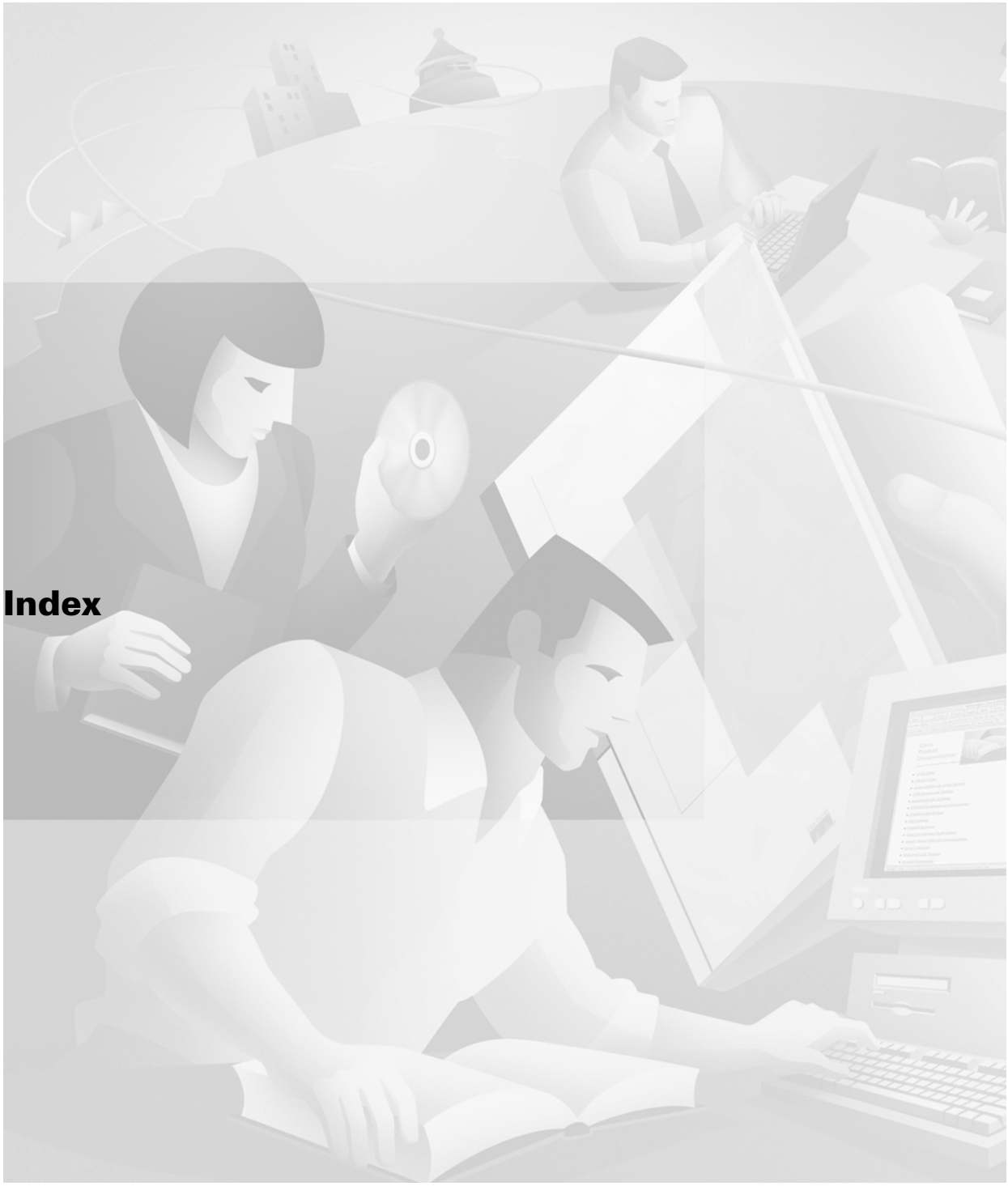
In the following DECnet example, the regular expression is **^SYSTEM$**. The access list permits access to all connect initiate packets that match the access identification of SYSTEM.

```
access-list 300 permit 0.0 63.1023 eq id ^SYSTEM$
```

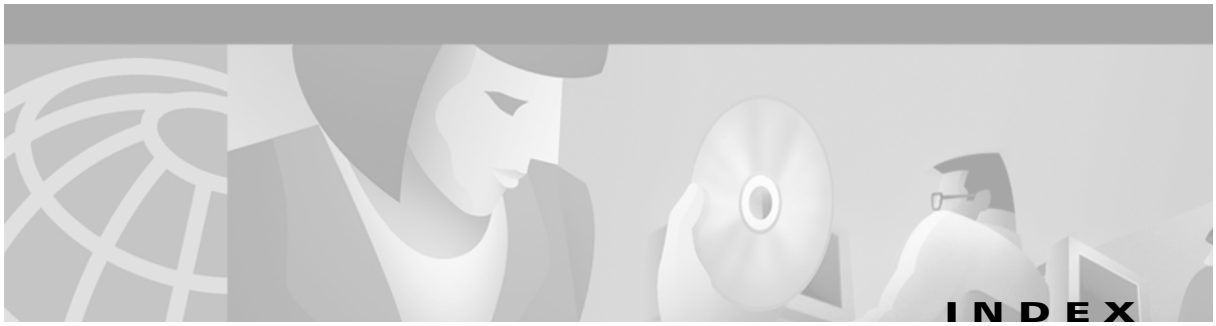
BGP IP Access Example

The following BGP example contains the regular expression **^123.***. The example specifies that the BGP neighbor with IP address 172.23.1.1 is not sent advertisements about any path through or from the adjacent autonomous system 123.

```
ip as-path access-list 1 deny ^123 .*

router bgp 109
network 172.18.0.0
neighbor 172.19.6.6 remote-as 123
neighbor 172.23.1.1 remote-as 47
neighbor 10.125.1.1 filter-list 1 out
```



Index



Symbols

A

B

C

D

E

F

G

H

I

K

L

M

N

P

Q

R

S

T

U

V

X