MODULE 2

Getting Started with Cisco IOS Software

CHAPTER 5

User Interface

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Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

- **Log in to a router in both user and privileged modes**
- **Use the context-sensitive help facility**
- **Use the command history and editing features**
- **Log out of the router**

2

This chapter discusses using the Cisco IOS software user interface to log in, log out, and enter commands for the router.

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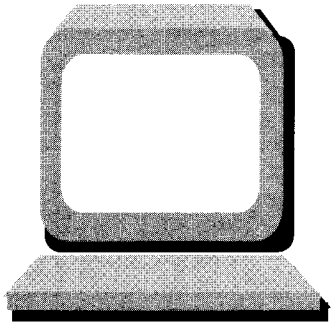
Overview of the User Interface



- **User Mode**
- **Privileged Mode**

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You configure Cisco routers from the user interface that runs on the router console or terminal. You can also configure Cisco routers using remote access. Cisco Internetwork Operating System (Cisco IOS) software provides a command interpreter called EXEC. EXEC interprets the commands you type and carries out the corresponding operations. You must log in to the router before you can enter an EXEC command.

For security purposes, the EXEC has two levels of access to commands: user mode and privileged mode.

- User mode—Typical tasks include those that check the router status.
- Privileged mode—Typical tasks include those that change the router configuration.

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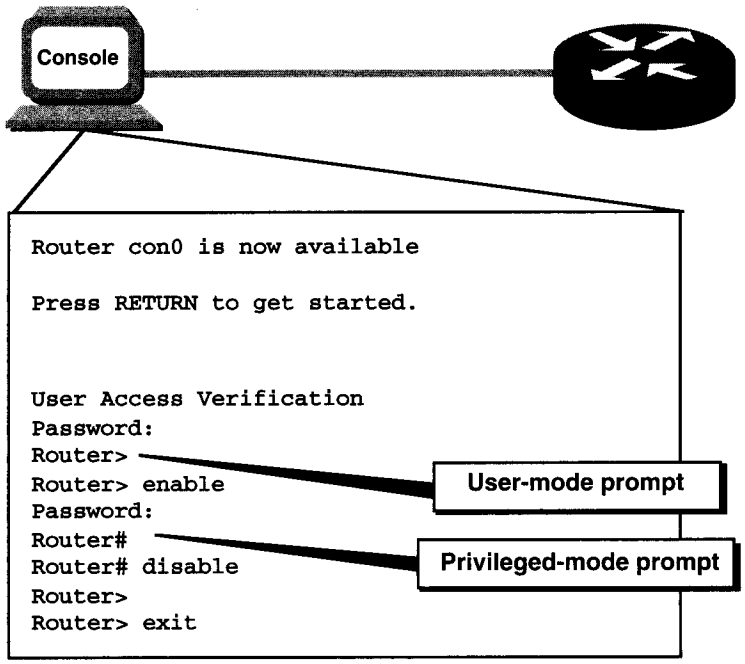
Logging in to the Router: Cisco IOS



4

When you first log in to the router, you will see a user-mode prompt. EXEC commands available at this user level are a subset of the EXEC commands available at the privileged level. For the most part, these commands allow you to display information without changing router configuration settings.

To access the full set of commands, you must first enable privileged mode; your EXEC prompt shows as a pound sign (#) while you are in this mode. From the privileged level, you can also access global configuration mode and the other specific configuration modes. These include interface, subinterface, line, router, route-map, and several additional configuration modes.

To log out of the router, type **exit**.

Screen output varies with your specific Cisco IOS software level and router configuration.

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User-Mode Command List

```
Router> ?
Exec commands:
  access-enable     Create a temporary Access-List entry
  atmsig            Execute Atm Signalling Commands
  cd                Change current device
  clear             Reset functions
  connect           Open a terminal connection
  dir               List files on given device
  disable           Turn off privileged commands
  disconnect        Disconnect an existing network connection
  enable            Turn on privileged commands
  exit              Exit from the EXEC
  help              Description of the interactive help system
  lat               Open a lat connection
  lock              Lock the terminal
  login             Log in as a particular user
  logout            Exit from the EXEC
  mrinfo            Request neighbor and version information from a
                    multicast router
-- More --
```

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Typing a question mark (?) at the user mode prompt or the privileged mode prompt displays a handy list of commonly used commands.

Notice the "-- More --" prompt at the bottom of the sample display. It indicates that multiple screens are available as output. More commands follow.

Note Here, or anywhere else in Cisco IOS software where the "More" prompt appears, you can resume output of the next available screen by pressing the space bar. To display the next line, press the Return key (or, on some keyboards, the Enter key). Press any other key to return to the prompt.

Screen output will vary with Cisco IOS software level and router configuration.

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User-Mode Command List (cont.)

```
mstat              Show statistics after multiple multicast
                   traceroutes
mtrace             Trace reverse multicast path from destination to
                   source
name-connection    Name an existing network connection
pad                Open a X.29 PAD connection
ping               Send echo messages
ppp                Start IETF Point-to-Point Protocol (PPP)
pwd                Display current device
resume             Resume an active network connection
rlogin             Open an rlogin connection
show               Show running system information
slip               Start Serial-line IP (SLIP)
systat             Display information about terminal lines
telnet             Open a telnet connection
terminal           Set terminal line parameters
tn3270             Open a tn3270 connection
traceroute         Trace route to destination
tunnel             Open a tunnel connection
where              List active connections
x3                 Set X.3 parameters on PAD
xremote            Enter XRemote mode                                  6
```

On the previous page, "-- More --" indicated additional commands. Pressing the space bar displays the remaining commands.

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Privileged-Mode Command List

```
Router>ena
Password:
Router# ?
Exec commands:
  access-enable     Create a temporary Access-List entry
  access-template   Create a temporary Access-List entry
  appn              Send a command to the APPN subsystem.
  atmsig            Execute Atm Signalling Commands
  bfe               For manual emergency modes setting
  calendar          Manage the hardware calendar
  cd                Change current device
  clear             Reset functions
  clock             Manage the system clock
  cmt               Start or stop FDDI Connection Management functions
  configure         Enter configuration mode
  connect           Open a terminal connection
  copy              Copy configuration or image data
  debug             Debugging functions (see also 'undebug')
  delete            Delete a file
  dir               List files on given device
 -- More --
```

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Type **enable** (or as shown, the abbreviation **ena**) to get into the privileged mode. You must also enter a password. Typing a question mark (?) at the user prompt or the privileged prompt displays a much larger list of EXEC commands.

The graphic shows some of these commands. These commands are continued on the next three pages of this manual.

Screen output varies with Cisco IOS software level and router configuration.

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Privileged-Mode Command List (cont.)

```
disable          Turn off privileged commands
disconnect       Disconnect an existing network connection
enable           Turn on privileged commands
erase            Erase flash or configuration memory
exit             Exit from the EXEC
format           Format a device
help             Description of the interactive help system
lat              Open a lat connection
lock             Lock the terminal
login            Log in as a particular user
logout           Exit from the EXEC
mbranch          Trace multicast route down tree branch
mrbranch         Trace reverse multicast route up tree branch
mrinfo           Request neighbor and version information from a
                 multicast router
mstat            Show statistics after multiple multicast traceroutes
mtrace           Trace reverse multicast path from destination to
                 source
name-connection  Name an existing network connection
ncia             Start/Stop NCIA Server
-- More --                                                        8
```

The privileged-mode commands continue on this screen.

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Privileged-Mode Command List (cont.)

```
no              Disable debugging functions
pad             Open a X.29 PAD connection
ping            Send echo messages
ppp             Start IETF Point-to-Point Protocol (PPP)
pwd             Display current device
reload          Halt and perform a cold restart
resume          Resume an active network connection
rlogin          Open an rlogin connection
rsh             Execute a remote command
sdlc            Send SDLC test frames
send            Send a message to other tty lines
setup           Run the SETUP command facility
show            Show running system information
slip            Start Serial-line IP (SLIP)
squeeze         Squeeze a device
start-chat      Start a chat-script on a line
systat          Display information about terminal lines
tarp            TARP (Target ID Resolution Protocol) commands
telnet          Open a telnet connection
-- More --
```

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The privileged-mode commands continue on this screen.

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Privileged-Mode Command List (cont.)

```
  terminal          Set terminal line parameters
  test              Test subsystems, memory, and interfaces
  tn3270            Open a tn3270 connection
  traceroute        Trace route to destination
  tunnel            Open a tunnel connection
  undebug           Disable debugging functions (see also 'debug')
  undelete          Undelete a file
  verify            Verify checksum of a Flash file
  where             List active connections
  which-route       Do OSI route table lookup and display results
  write             Write running configuration to memory, network, or
                    terminal
  x3                Set X.3 parameters on PAD
  xremote           Enter XRemote mode
Router#
```

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The list of privileged-mode commands end on this screen.

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Context-Sensitive Help

```
Router# clok
Translating "CLOK"
% Unknown command or computer name, or unable to find computer address

Router# cl?
clear   clock

Router# clock
% Incomplete command.

Router# clock ?
set     Set the time and date

Router# clock set
% Incomplete command.

Router# clock set ?
Current Time  (hh:mm:ss)
```

```
Router# clock set 19:56:00
% Incomplete command.

Router# clock set 19:56:00 ?
<1-31>       Day of the month
MONTH     Month of the year

Router# clock set 19:56:00 04 8
.                             ^
% Invalid input detected at the '^' marker

Router# clock set 19:56:00 04 August
% Incomplete command.

Router# clock set 19:56:00 04 August ?
<1993-2035>     Year
```

- **Symbolic translation**
- **Keyword completion**
- **Last command recall <Ctrl><P>**
- **Command prompting**
- **Syntax checking**

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In the graphic shown, suppose you want to set the router clock. If you do not know the command, use context-sensitive help to check the syntax for setting the clock. The help output shows that the **set** keyword is required. Next, check the syntax for entering the time.

Now enter the current time using hours, minutes, and seconds as shown.

The system indicates that you need to provide additional arguments to complete the command. Press Control-P (or up arrow) to repeat the previous command entry automatically. Then add a space and a question mark (?) to reveal the additional arguments.

Now you can complete the command entry.

The caret symbol (^) and help response indicate an error. To list the correct syntax, reenter the command up to the point where the error occurred, and then enter a question mark (?).

Enter the year using the correct syntax and press Return to execute the command.

Note that the user interface provides syntax checking in the form of an error location indicator (^). The caret symbol character appears at the point in the command string where you have entered an incorrect command, keyword, or argument. The error location indicator and interactive help system allow you to find and correct syntax errors easily.

Screen output varies with Cisco IOS software level and router configuration.

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Using Editing Commands

```
Router> $ value for our customers, employees, investors, and partners.
```

	Automatic scrolling of long lines.
<Ctrl><A>	**Move to the beginning of the command line.**
<Ctrl><E>	**Move to the end of the command line.**
<Esc><B>	**Move back one word.**
<Ctrl><F>	**Move forward one character.**
<Ctrl><B>	**Move back one character.**
<Esc><F>	**Move forward one word.**

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The user interface includes an enhanced editing mode that provides a set of editing key functions.

Although enhanced editing mode is automatically enabled with the current software release, you can disable it and revert to the editing mode of previous software releases. You might also want to disable enhanced editing if you have written scripts that do not interact well when enhanced editing is enabled.

Use the key sequences indicated in the graphic to move the cursor around on the command line for corrections or changes.

The editing command set provides a horizontal scrolling feature for commands that extend beyond a single line on the screen. When the cursor reaches the right margin, the command line shifts ten spaces to the left. You cannot see the first ten characters of the line, but you can scroll back and check the syntax at the beginning of the command.

To scroll back, press Control-B or the Left arrow key repeatedly until you are at the beginning of the command entry, or press Control-A to return directly to the beginning of the line.

In the example shown, the command entry extends beyond one line. When the cursor first reaches the end of the line, the line is shifted ten spaces to the left and redisplayed. The dollar sign ($) indicates that the line has been scrolled to the left. Each time the cursor reaches the end of the line, the line is again shifted ten spaces to the left.

Screen output varies with Cisco IOS software level and router configuration.

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Reviewing Command History

<Ctrl><P>	**or Up arrow**	**Last (previous) command recall**
<Ctrl><N >	**or Down arrow**	**More recent command recall**
Router> show history		**Show command buffer**
Router> terminal history size *number-of-lines*		**Set command buffer size**
Router> no terminal editing		**Disable advanced editing features**
Router> terminal editing		**Reenable advanced editing**
<Tab>		**Entry completion**

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The user interface provides a history or record of commands you have entered. This feature is particularly useful for recalling long or complex commands or entries. With the command history feature, you can complete the following tasks:

- Set the command history buffer size
- Recall commands
- Disable the command history feature

By default, command history is enabled and the system records ten command lines in its history buffer. To change the number of command lines the system will record during the current terminal session, use the **terminal history size** or **history size** command. The maximum number of commands is 256.

To recall commands in the history buffer beginning with the most recent command, press Control-P or the Up arrow key. Repeat the key sequence to recall successively older commands.

To return to more recent commands in the history buffer after recalling commands with Control-P or the Up arrow, press Control-N or the Down arrow key. Repeat the key sequence to recall successively more recent commands.

Once you enter the unique characters for a command, press the Tab key and the interface will finish the entry for you.

On most laptop computers you may also have additional select and copy facilities available. Copy a previous command string, then paste or insert it as your current command entry and press Return.

Ctrl-Z backs you out of configuration mode.

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Summary

Using the router

- Log in with user password
- Enter privileged mode with enable password
- Disable or quit

Advanced help features

- Command completion and prompting
- Syntax checking

Advanced editing features

- Automatic line scrolling
- Cursor controls
- History buffer with command recall
- Copy and paste using most laptop computers

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Lab: Using the User Interface

Objective: Log in to a router in both user and privileged modes.

Objective: Use the context-sensitive help facility.

Objective: Use the command history and editing features.

Objective: Log out of the router.

Step 1 Press **Return** to begin.

Enter user mode with the **cisco** password.

Step 2 Enter the help command (**?**) at the Router> prompt.

What is on the seventh line in the list?

Press **space bar**. *What does this do?*

Step 3 Enter privileged mode by using the **enable** command and the **san-fran** enable password.

Step 4 Enter the help command (**?**) at the Router# prompt.

What is on the eighth line in the list?

Press **Return** a few times. *What does this do?*

Enter **q**. *What does this do?*

Step 5 Enter the character string **sh?** at the Router# prompt.

Step 6 Enter the **sho** command at the Router# prompt and press the **tab** key. Then enter a space followed by the help command (**?**).

Step 7 Enter the **show running-config** command at the Router# prompt.

(Use **write term** with Cisco IOS Release 10.3 and earlier.)

This is the active configuration file.

When you see the "--More--" prompt, press **Return** a few times. When you see "--More--" again, press the **space bar**. *What does this do?*

Enter **q**. *What does this do?*

Step 8 Type an exclamation point (**!**) to indicate that you will be entering a comment. Enter a comment sentence. Refer to the editing commands and practice using the key combinations to move your cursor within the comment sentence.

Step 9 Press **Ctrl-P** (or press the Up arrow). *What does this do?*

If you are using a workstation as a console, use copy (or cut) and paste to reuse a previous command.

Step 10 Enter **exit** at the Router# prompt. *What does this do?*

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CHAPTER 6

Router Basics

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Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

Examine router elements

Remotely access a router

Test network connectivity

2

This chapter discusses general information you need to understand before configuring a router.

Sections:

- Configuration Components and Router Modes
- Examining Router Status
- Access to Other Routers
- Basic Testing
- Answers to Exercise

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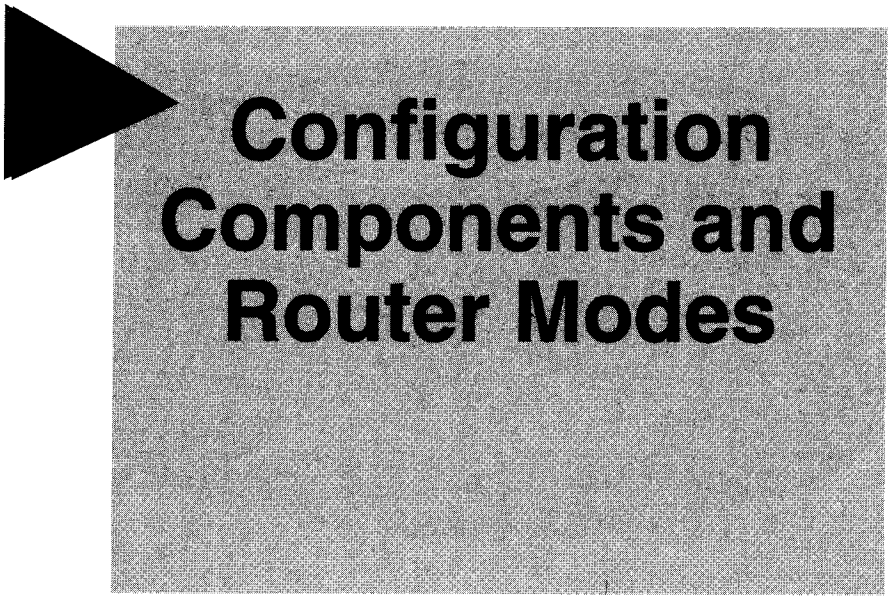

3

Configuration Components and Router Modes

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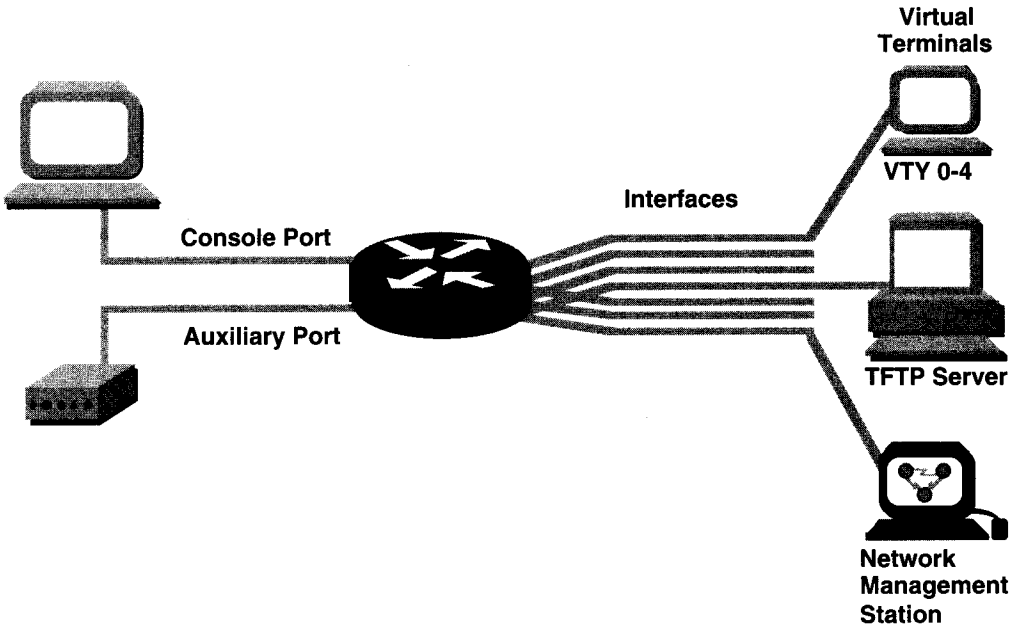
External Configuration Sources



- **Configuration information can come from many sources**

4

The router can be configured from many locations:

- Upon initial installation, it is configured from the console terminal, which is connected via the console port.
- It can be connected via modem using the auxiliary port.
- Once installed on the network, it can be configured from virtual terminals 0 through 4.

Files can also be downloaded from a TFTP server on the network.

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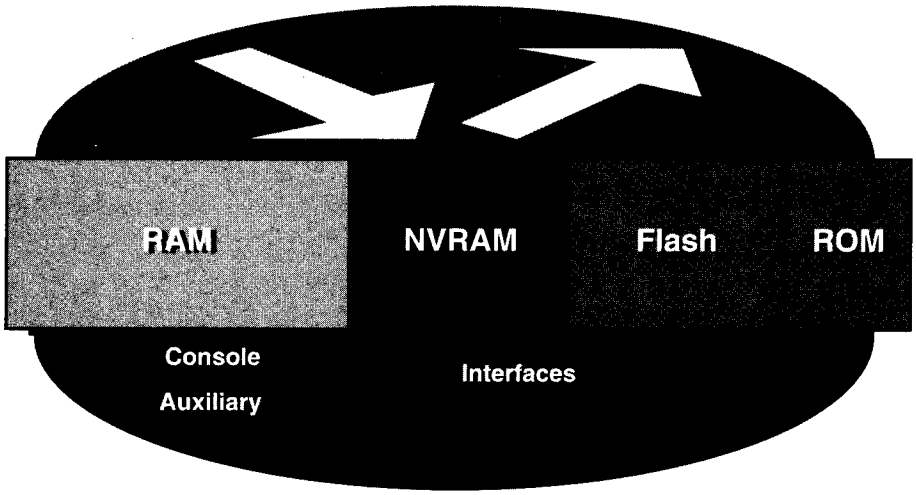
Internal Configuration Components



5

Internal configuration components are as follows:

- RAM/DRAM—Stores routing tables, ARP cache, fast-switching cache, packet buffering (shared RAM), and packet hold queues. RAM also provides temporary and/or running memory for the router's configuration file while the router is powered on. RAM content is lost when you power down or restart.
- NVRAM—Nonvolatile RAM stores the router's backup configuration file. NVRAM content is retained when you power down or restart.
- Flash—Erasable, reprogrammable ROM. Flash memory holds the operating system image and microcode. Having Flash memory allows you to update software without removing and replacing chips on the processor. Flash content is retained when you power down or restart. Multiple copies of IOS can be stored in flash memory.
- ROM—Contains power-on diagnostics, a bootstrap program, and operating system software. To perform software upgrades, remove and replace pluggable chips on the CPU.
- Interfaces—Network connections through which packets enter and exit the router. Interfaces are on the motherboard or on separate interface modules.

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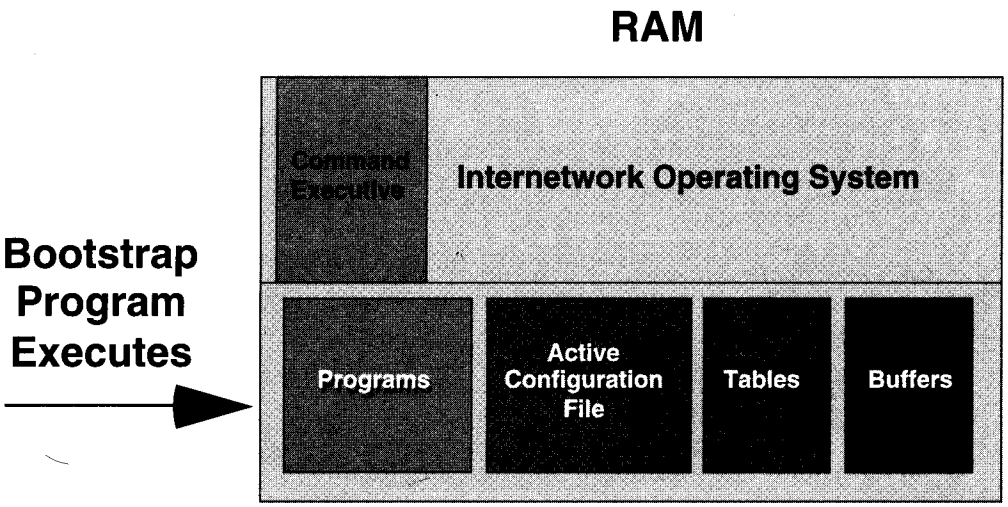
RAM for Working Storage



6

RAM is the working storage area for the router. When the router is turned on, a bootstrap program is executed from ROM. This program performs some tests, then loads the Cisco IOS software into memory. The command executive, or EXEC, is one part of the Cisco IOS software. EXEC receives and executes commands you enter for the router.

The router also stores an active configuration file and tables of networks maps and routing address lists. The configuration file contains ASCII characters and can be displayed on a remote or console terminal. A saved version of this file is stored in NVRAM. The saved file is accessed and loaded into main memory each time the router initializes. The configuration file contains global, process, and interface statements that directly affect the operation of the router and its interface ports.

The operating system image is already in binary executable form and cannot be displayed on the terminal screen. The image is usually executed from the main RAM and loaded from one of several input sources. The operating software is organized into "routines" that handle the tasks associated with different protocols, the movement of data, management of tables and buffers, routing updates, and the execution of user commands.

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Router Modes

User EXEC Mode

Limited examination of router. Remote access.

`Router>`

Global Configuration Mode

Simple configuration commands.

`Router(config)#`

Privileged EXEC Mode

Detailed examination of router. Debugging and testing. File manipulation. Remote access.

`Router#`

Other Configuration Modes

Complex and multiline configurations.

`Router(config - mode)#`

SETUP Mode

Prompted dialog used to establish an initial configuration.

RXBOOT Mode

Recovery from a catastrophe in the case of a lost password or the operating system being accidentally erased from Flash.

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Whether accessed from the console or by a Telnet session through an auxiliary port, the router can be placed in several modes. Each mode provides different functions:

- User EXEC mode—A "look-only" mode in which the user can view some information about the router, but cannot change anything.
- Privileged EXEC mode—Supports the debugging and testing commands, detailed examination of the router, manipulation of configuration files, and access to configuration modes.
- Setup mode—Presents an interactive prompted dialog at the console that helps the new user create a first-time basic configuration.
- Global configuration mode—Implements powerful one-line commands that perform simple configuration tasks.
- Other configuration modes—Provide more complicated multiple-line configurations.
- RXBOOT mode—A maintenance mode that can be used, among other things, to recover lost passwords.

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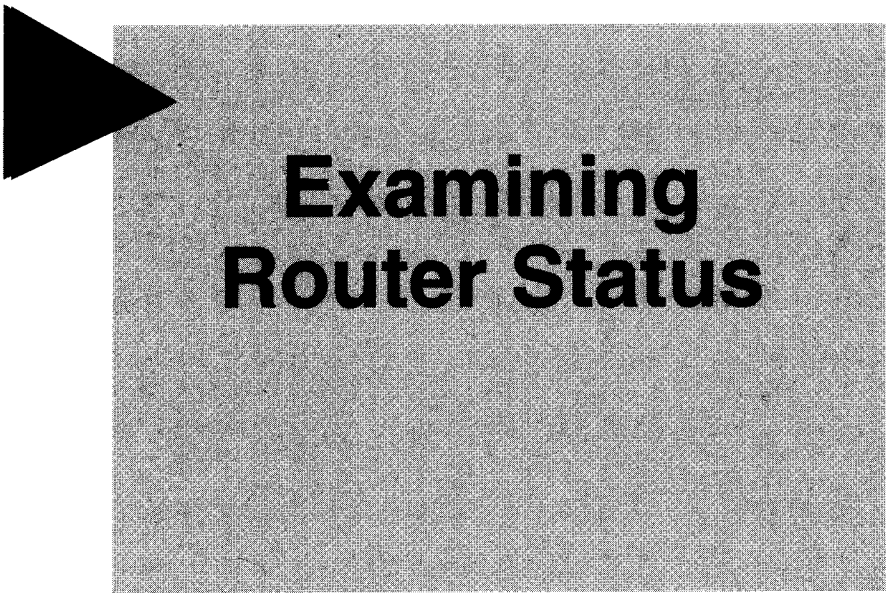

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Examining Router Status

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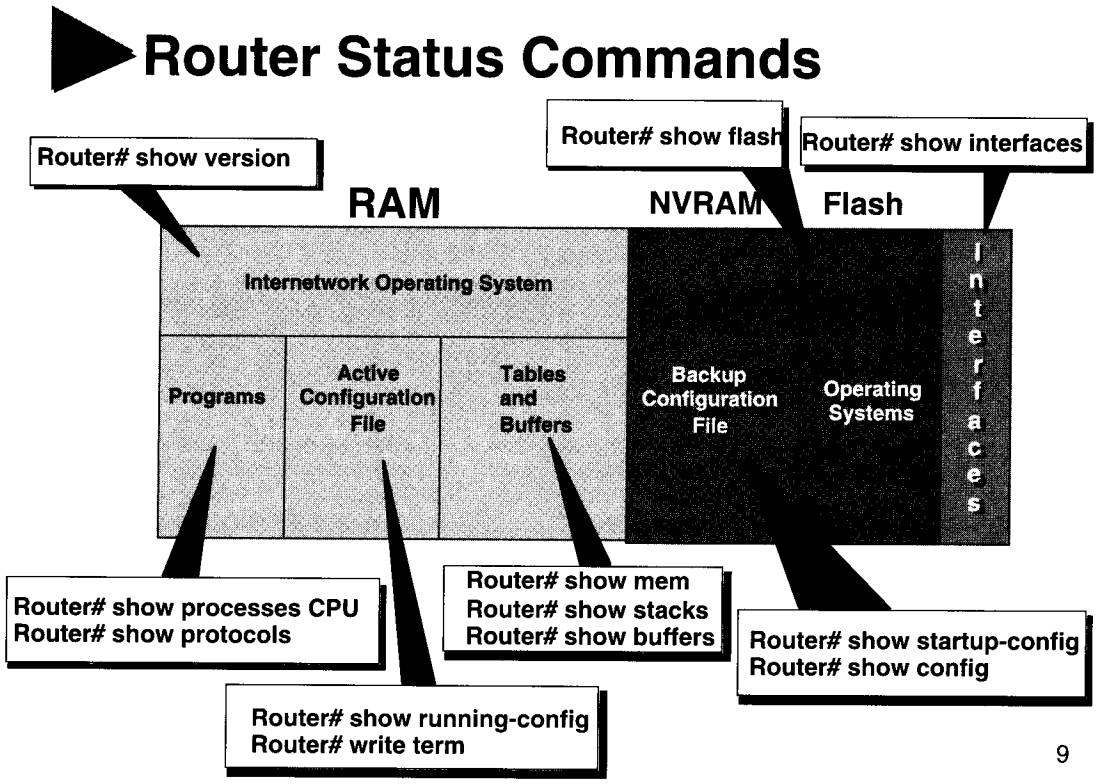

Router status commands are as follows:

- **show version**—Displays the configuration of the system hardware, the software version, the names and sources of configuration files, and the boot images.
- **show processes**—Displays information about the active processes.
- **show protocols**—Displays the configured protocols. This command shows the status of any configured Layer 3 (network) protocol.
- **show mem**—Shows statistics about the router's memory, including memory free pool statistics.
- **show stacks**—Monitors the stack use of processes and interrupt routines and displays the reason for the last system reboot.
- **show buffers**—Provides statistics for the buffer pools on the network server.
- **show flash**—Shows information about the Flash memory device.
- **show running-config** (**write term** on Cisco IOS Release 10.3 or earlier)—Displays the active configuration file.
- **show startup-config** (**show config** on Cisco IOS Release 10.3 or earlier)—Displays the backup configuration file.
- **show interfaces**—Displays statistics for all interfaces configured on the router.

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show running-config Command and *show startup-config* Command

```
Router# show running-config
Building configuration...

Current configuration:
!
version 11.2
!
     -- More --
```

```
Router# show startup-config
Using 1108 out of 130048 bytes
!
version 11.2
!
hostname router
     -- More --
```

- **Use *write terminal* with Release 10.3 and earlier**
- **Use *show config* with Release 10.3 and earlier**

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show running-config and **show startup-config** are among the most used Cisco IOS software EXEC commands because they allow an administrator to see the current running configuration on the router or the image size and startup configuration commands the router will use on the next restart.

Note The commands **write term** and **show config** used with Cisco IOS Release 10.3 and earlier have been replaced by new commands. The commands that have been replaced continue to perform their normal functions in the current release but are no longer documented. Support for these commands will cease in a future release.

You will know that you are looking at the active configuration file when you see the words "Current Configuration" at the top.

You will know that you are looking at the backup configuration file when you see a message at the top telling you how much nonvolatile memory has been used.

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show interface serial Command

```
Router# show interface serial 1
Serial1 is up, line protocol is up
  Hardware is MK5025
  Internet address is 183.8.64.129, subnet mask is 255.255.255.128
  MTU 1500 bytes, BW 56 Kbit, DLY 20000 usec, rely 255/255, load 9/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input 0:00:00, output 0:00:01, output hang never
  Last clearing of "show interface" counters never
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  Five minute input rate 1000 bits/sec, 0 packets/sec
  Five minute output rate 2000 bits/sec, 0 packets/sec
     331885 packets input, 62400237 bytes, 0 no buffer
     Received 230457 broadcasts, 0 runts, 0 giants
     3 input errors, 3 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     403591 packets output, 66717279 bytes, 0 underruns
     0 output errors, 0 collisions, 8 interface resets, 0 restarts
     45 carrier transitions
```

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The **show interface serial** command displays configurable parameters and real-time statistics related to serial interfaces.

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show version Command

```
Router# show version
Cisco Internetwork Operating System Software
IOS (tm) 4500 Software (C4500-J-M), Experimental Version 11.2(19960626:214907) ]
Copyright (c) 1986-1996 by cisco Systems, Inc.
Compiled Fri 28-Jun-96 16:32 by rbeach
Image text-base: 0x600088A0, data-base: 0x6076E000

ROM: System Bootstrap, Version 5.1(1) [daveu 1], RELEASE SOFTWARE (fc1)
ROM: 4500-XBOOT Bootstrap Software, Version 10.1(1), RELEASE SOFTWARE (fc1)

router uptime is 1 week, 3 days, 32 minutes
System restarted by reload
System image file is "c4500-j-mz", booted via tftp from 171.69.1.129

--More--
```

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The **show version** command displays information about the Cisco IOS software version that is currently running on the router.

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show protocols Command

```
Router# show protocols
Global values:
  Internet Protocol routing is enabled
  DECNET routing is enabled
  XNS routing is enabled
  CLNS routing is enabled (address 47.0005.80ff.f800.0000.ffff.0021.1830.0812.8002.00)
  Vines routing is enabled
  Appletalk routing is enabled
  Novell routing is enabled
 --More--
  Ethernet0 is up, line protocol is up
  Internet address is 183.8.128.2, subnet mask is 255.255.255.128
  Decnet cost is 5
  XNS address is 3010.aa00.0400.0284
  CLNS enabled
  Vines metric is 32
  AppleTalk address is 3012.93, zone ld-e0
  Novell address is 3010.aa00.0400.0284
 --More--
```

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Use the **show protocols** EXEC command to display the protocols configured on the router.

This command shows the global and interface-specific status of any configured Level 3 protocols (for example, IP, DECnet, IPX, and AppleTalk).

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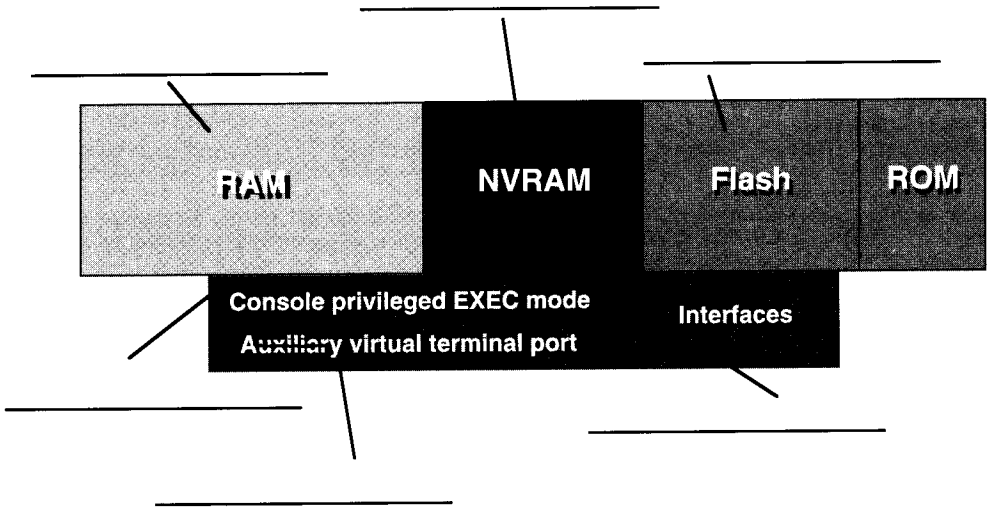
Exercise: Router Commands



14

Exercise: Router Commands

Objective: Examine router elements.

Instructions: On each line in the graphic, write a command that would access that router element.

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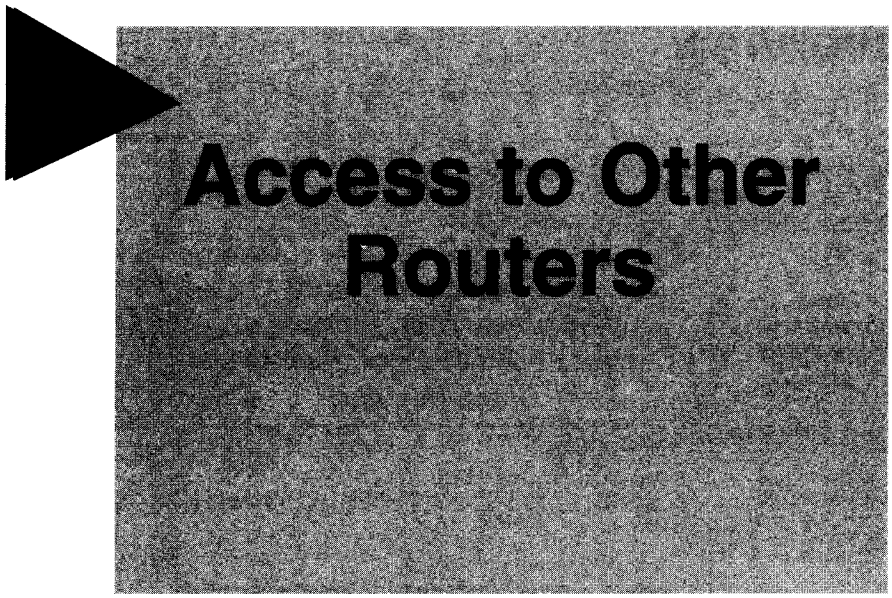

15

Access to Other Routers

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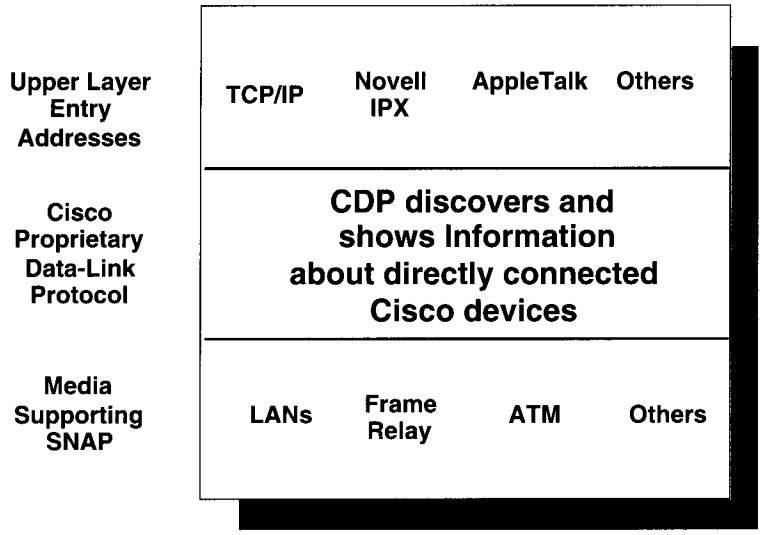
Cisco Discovery Protocol (CDP) Overview



• Media and protocol interactions

16

Cisco Discovery Protocol (CDP) provides a single proprietary command that enables network administrators to access a summary of the multiple protocols and addresses configured on other directly connected routers.

CDP runs over a data link layer connecting lower physical media and upper-network-layer protocols. Because CDP operates at this level, two or more CDP devices that support different network-layer protocols can learn about each other.

Physical media supporting the Subnetwork Access Protocol (SNAP) connect CDP devices. These can include all LANs, Frame Relay and SMDS WANs, and ATM networks.

When a Cisco device running Cisco IOS Release 10.3 and later boots up, CDP starts up by default. CDP can then automatically discover neighboring Cisco devices running CDP, regardless of which protocol suite or suites are running.

Discovered devices extend beyond those having TCP/IP. CDP will discover directly connected Cisco devices regardless of which protocol suite they run.

Once CDP discovers a device, it can display any of the various upper-layer protocol address entries used on the discovered device's port—IPX, AppleTalk Datagram Delivery Protocol (DDP), DECnet CLNS, and others.

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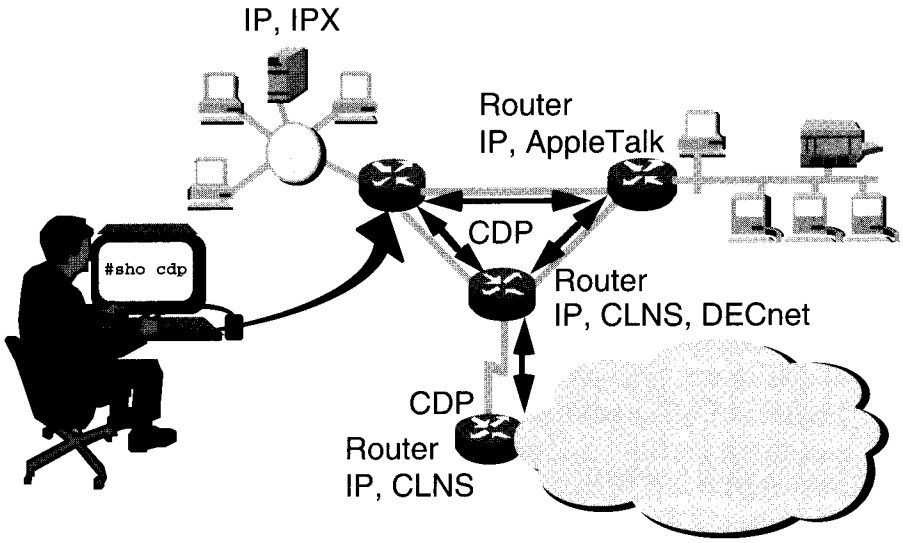
Show CDP Neighbor Entries



- **Single command summarizes protocols and addresses on target (for example, neighboring Cisco router)**

17

The graphic displays an example of how CDP delivers its benefits to a system manager.

Each router running CDP exchanges information about any protocol entries it knows with its neighbors. The administrator can display the results of this CDP information exchange on a console connected to a router configured to run CDP on its interfaces.

The network manager uses a **show** command to display information about the networks directly connected to the router. Frames formed by CDP provide information about each CDP neighbor device. Values include the following:

- Device identifiers—For example, the router's configured host name and domain name (if any).
- Address list—At least one protocol for SNMP, up to one address for each protocol supported.
- Port identifier—An ASCII character string such as Ethernet 0.
- Capabilities list—If, for example, the device acts as a source route bridge as well as a router.
- Version—Information such as that provided by the local command **show version**.
- Platform—The device's hardware platform: for example, Cisco 7000.

Notice that the lowest router in the graphic is not directly connected to the router of the administrator's console. To obtain CDP information about this device, the administrator would need to Telnet to a router directly connected to this target.

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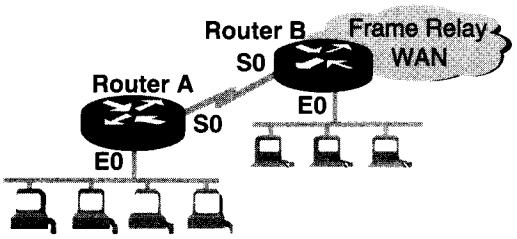
CDP Configuration Example




```
routerA (config-if)# cdp enable
```

- Enable CDP on each interface

```
routerA#show cdp interface
Serial0 is up, line protocol is up, encapsulation is Frame Relay
  Sending CDP packets every 60 seconds
  Holdtime is 180 seconds
Ethernet0 is up, line protocol is up, encapsulation is ARPA
  Sending CDP packets every 60 seconds
  Holdtime is 180 seconds
```

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CDP begins automatically upon a device's system startup. The CDP function normally starts by default when a Cisco product boots up with Cisco IOS Release 10.3 or later.

Although CDP runs by default, you must explicitly enable it on the device's interface using the command **cdp enable**. For example, the graphic shows the **cdp enable** command that you use on the E0 and S0 interfaces on the router named routerA.

This command begins CDP's dynamic discovery function on the device's interfaces. Advertisement and discovery using CDP involves data-link frame exchanges. Only directly connected neighbors exchange CDP frames.

A router caches any information it receives from its CDP neighbors. If a subsequent CDP frame indicates that any of the information about a neighbor has changed, the router discards the older information in favor of the newer information.

Use the command **show cdp interface** to display the values of the CDP timers, the interface status, and the encapsulation used by CDP for its advertisement and discovery frame transmission.

Default values for timers set the frequency between CDP updates and for aging CDP entries. These timers are set automatically at 60 seconds and 180 seconds, respectively. If the device receives a more recent update or if this holdtime value expires, the device must discard the CDP entry.

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Showing CDP Entries for a Device

```
routerA#sho cdp entry routerB
-------------------------------------
Device ID: routerB
Entry address(es):
  IP address: 198.92.68.18
  CLNS address: 490001.1111.1111.1111.00
  Appletalk address: 10.1
Platform: AGS,  Capabilities: Router Trans-Bridge
Interface: Ethernet0,  Port ID (outgoing port): Ethernet0
Holdtime : 155 sec

Version :
IOS (tm) GS Software (GS3),  11.2(13337) [asastry 161]
Copyright (c) 1986-1996 by cisco Systems, Inc.
Compiled Tue 14-May-96 1:04
```

19

Use the command **show cdp entry {device name}** to display a single cached CDP entry.

Notice that output from this command includes all the Layer 3 addresses present in the neighbor router B—an administrator can see the IP, CLNS, and DECnet network addresses of the targeted CDP neighbor with the single command entry on router A.

The holdtime value indicates how long ago the CDP frame arrived with this information. The command includes abbreviated version information about router B.

CDP was designed and implemented as a very simple, low-overhead protocol. A CDP frame can be as small as 80 octets, mostly made up of the ASCII strings that represent information like that shown.

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Showing CDP Neighbors

```
routerA#show cdp neighbors
Capability Codes: R - Router, T - Trans Bridge,
                  B - Source Route Bridge,
                  S - Switch, H - Host, I - IGMP

Device ID     Local Intrfce  Holdtme  Capability Platform  Port ID
routerB.cisco.com  Eth 0      151      R T      AGS      Eth 0
routerB.cisco.com  Ser 0      165      R T      AGS      Ser 3

routerA#show cdp neighbors detail
------------------------
Device ID: routerB.cisco.com
Entry address(es):
  IP address: 198.92.68.18
  CLNS address: 490001.1111.1111.1111.00
  Appletalk address: 10.1
Platform: AGS,  Capabilities: Router Trans-Bridge
Interface: Ethernet0,  Port ID (outgoing port): Ethernet0
Holdtime : 143 sec
```

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Use the command **show cdp neighbors** to display the CDP updates received on the local router. Notice that for each local port, the display shows the following:

- Neighbor device ID
- Local port type and number
- Decremental holdtime value in seconds
- Neighbor's device capability code
- Hardware platform of the neighbor
- Neighbor's remote port type and number

To display this information as well as information like that from **show cdp entry,** the administrator uses the optional **show cdp neighbors detail.**

Note In this example, a neighbor's device name contains a domain name. Therefore, the Device ID column for the router B displays a domain-name entry in the form *company.com*. To check the device as a single target, include the domain by entering the command variation **show cdp entry routerB.cisco.com**.

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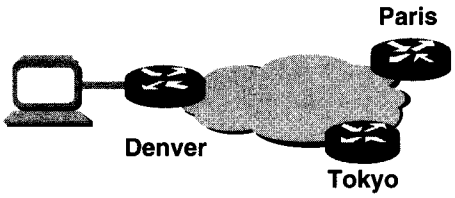
telnet Operations



Initiate a session

```
Denver> telnet paris
```

End a session

```
Paris> exit
```

Suspend a session

```
Paris> <Cntl><Shift><6>
<x> Denver>
```

Escape sequence

Resume a session

```
Denver> <Return>
```

Disconnect a session

```
Denver> disconnect paris
```

Display sessions

```
Denver# show sessions
Conn   Host    Address          Idle   Conn Name
  1    Paris   131.108.100.152   0     Paris
  2    Tokyo   127.102.57.63     0     Tokyo *
```

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Another way to learn about a remote router is to connect to it. Telnet, a virtual terminal protocol that is part of the TCP/IP protocol suite, allows connections to hosts. You can set a connection between the router and a connected device. A router can have up to five simultaneous incoming Telnet sessions.

With our implementation of TCP/IP, you do not need to enter the command **connect** or **telnet** to establish a Telnet connection. If you prefer, you can just enter the learned host name.

To end a Telnet session, use the EXEC command **exit** or **logout**.

These are alternate commands for the operations listed on the graphic:

- Initiate a session
  - — Denver> connect paris
  - — Denver> paris
  - — Denver> 131.108.100.152
- Resume a session (enter session number or name)
  - — Denver> 1

    Paris>
- End a session
  - — Paris> exit

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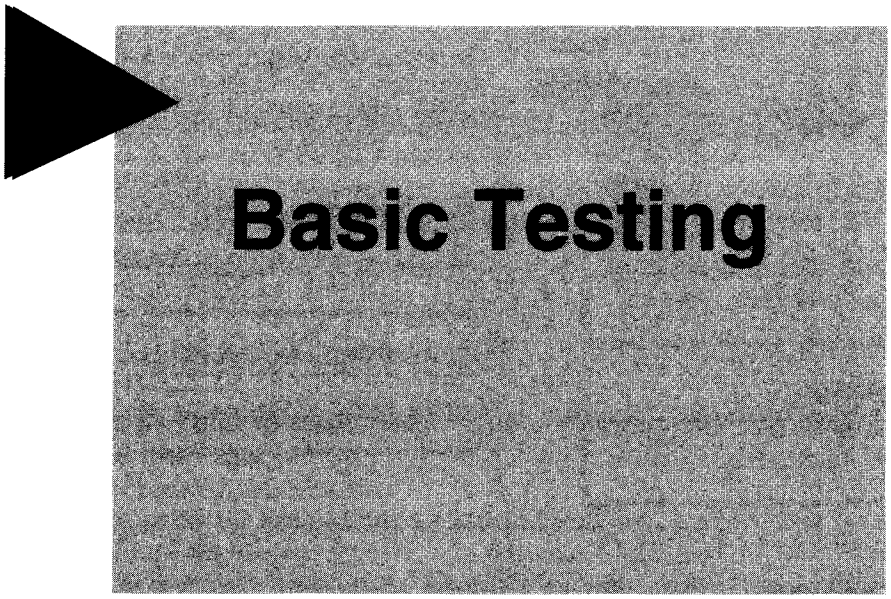

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Basic Testing

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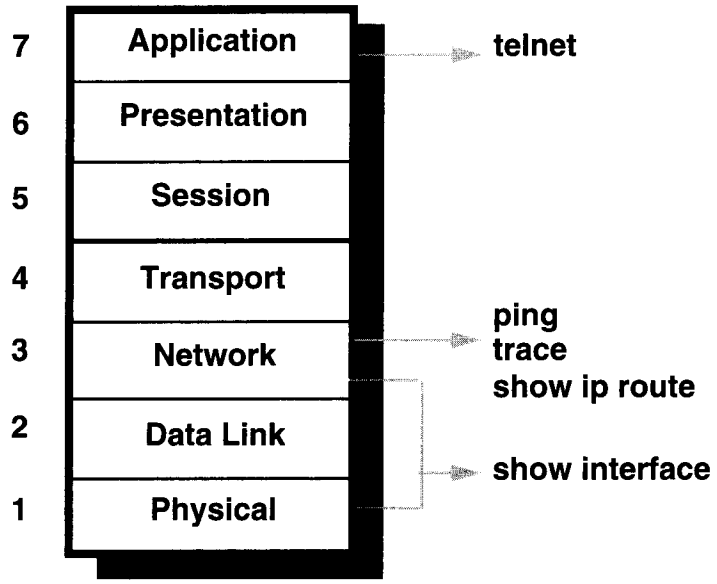
Testing Overview



23

Basic testing of an internetwork should proceed in sequence from one ISO/OSI layer to the next. Each test presented in this section focuses on network operations at a specific layer of the OSI model.

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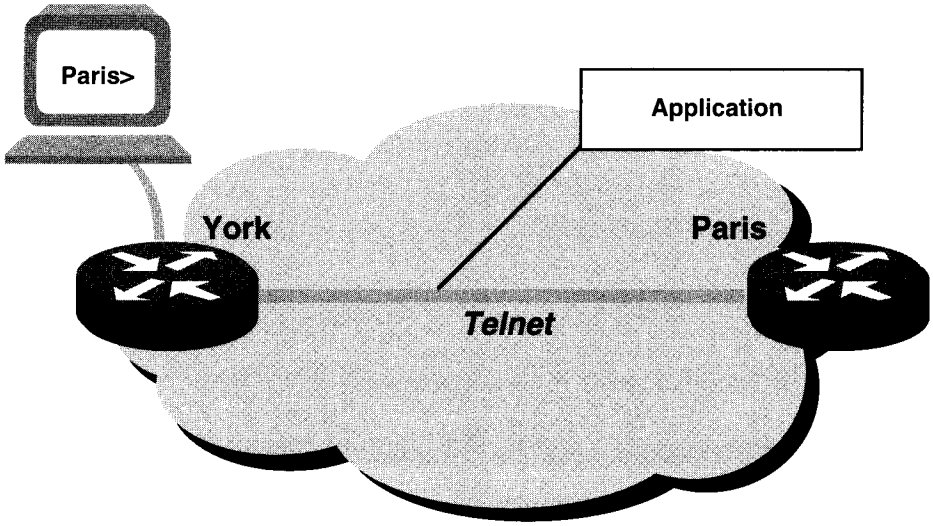
Test Application Layer Using *telnet*

- **Can the remote router be accessed?**



24

Begin testing by initially focusing on upper-layer applications.

As you learned earlier, the Telnet application provides a virtual terminal so that administrators can use Telnet operations to connect with other hosts running TCP/IP. Test to determine whether the remote router can be accessed. For example, your success running Telnet to connect from the router York to another router Paris provides a basic test of the internetwork connecting the two.

If we can remotely access another router through Telnet, then at least we know that one TCP/IP application can reach the remote router. A successful Telnet connection indicates that the upper-layer application (and the services of lower layers, as well) functions properly.

If we can Telnet to one router but not to another router, it is likely that the Telnet failure is caused by specific addressing, naming, or access permission problems. These problems can exist on our router or on the router that failed as a Telnet target.

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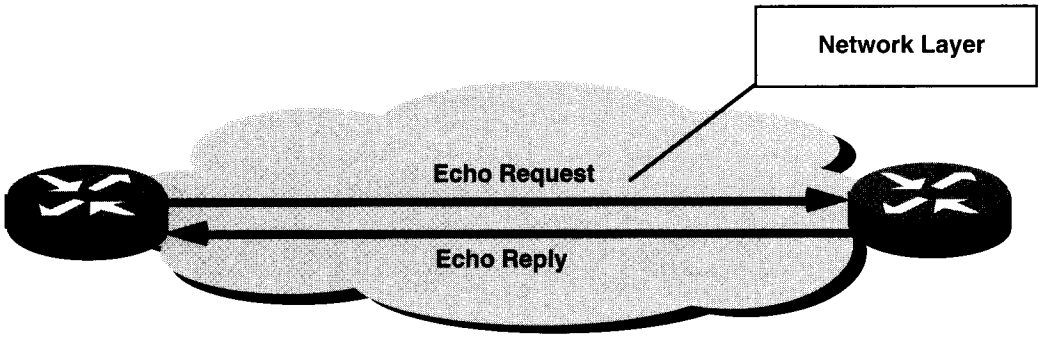
Testing with the *ping* Command

- **Are protocol packets being routed?**




```
Router> ping 172.16.1.5
Type escape sequence to abort.
Sending 5, 100 byte ICMP Echos to 172.16.1.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent, round-trip min/avg/max = 1/3/4 ms
Router>
```

25

As an aid to diagnosing basic network connectivity, many network protocols support an echo protocol, which is a test to determine whether protocol packets are being routed.

The **ping** command sends a special datagram to the destination host and then waits for a reply datagram from that host. Results from this echo protocol can help evaluate the path-to-host reliability, delays over the path, and whether the host can be reached or is functioning.

In the graphic, the ping target 172.16.1.5 responded successfully to all five datagrams sent. The exclamation points (!) indicate each successful echo. If you instead receive one or more periods (.) on your display, the application on your router timed out waiting for a given datagram echo from the ping target.

The **ping** user EXEC command can be used to diagnose basic network connectivity on AppleTalk, CLNS, IP, Novell IPX, Apollo, VINES, DECnet, or XNS networks.

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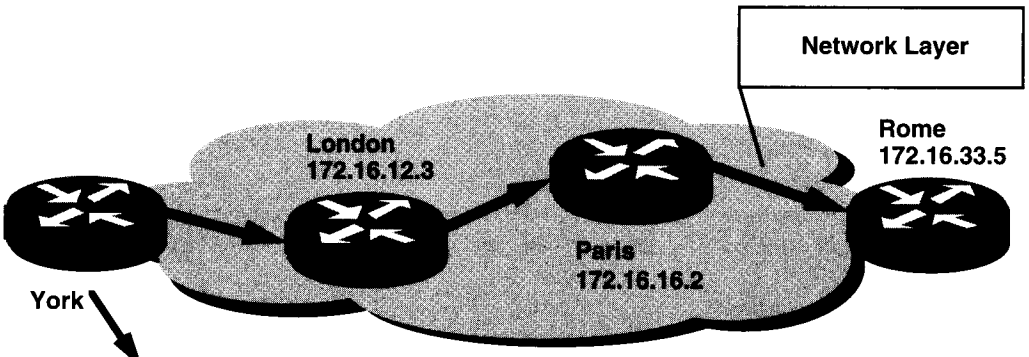
Testing with the *trace* Command

- **What path are packets taking?**




```
York# trace ROME
Type escape to abort.
Tracing the route to ROME (172.16.33.5)
     1 LONDON (172.16.12.3) 1000 msec 8 msec 4 msec
     2 PARIS (172.16.16.2) 8 msec 8 msec 8 msec
     3 ROME (172.16.33.5) 8 msec 8 msec 4 msec

York#
```

26

The **trace** command is the ideal tool for finding where data is being sent in your network. The **trace** command uses the same technology as the **ping** command, except that instead of testing end-to-end connectivity, **trace** tests each step along the way.

This operation can be performed at either the user or privileged EXEC levels. Protocols that support trace functions are IP, AppleTalk, VINES, and CLNS.

The **trace** command takes advantage of the error messages generated by routers when a datagram exceeds its Time To Live (TTL) value. The **trace** command starts by sending probe datagrams with a TTL value of 1. This value causes the first router to discard the probe datagram and send back an error message.

The **trace** command sends several probes at each TTL level and displays the round-trip time for each. The benefit of the **trace** command is that it tells us which router in the path is the last one to be reached. This is called fault isolation.

In this example, we are tracing the path from York to Rome. Along the way the path must go through London and Paris. If one of these routers had been unreachable, we would have seen three asterisks (*) instead of the name of the router. The **trace** command would continue attempting to reach the next step until we escape using the Control-Shift-6 X escape sequence.

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Using the *show ip route* Command

• Does an entry exist in the routing table?

Network Layer

```
Paris# show ip route

Codes:  I - IGRP derived, R - RIP derived, O - OSPF derived
        C - connected, S - static, E - EGP derived, B - BGP derived
        i - IS-IS derived, D - EIGRP derived
        * - candidate default route, IA - OSPF inter area route
        E1 - OSPF external type 1 route, E2 - OSPF external type 2 route
        L1 - IS-IS level-1 route, L2 - IS-IS level-2 route
        EX - EIGRP external route

Gateway of last resort is not set

I    144.253.0.0 [100/1300] via 133.3.32.2 0:00:22 Ethernet1
     131.108.0.0 is subnetted (mask is 255.255.255.0), 3 subnets
I       131.108.33.0 [100/180771] via 131.108.16.2, 0:01:29, Ethernet1
C       131.108.12.0 is directly connected, Ethernet0
C       131.108.16.0 is directly connected, Ethernet1
I    218.100.103.0 [100/1200] via 133.3.32.2, 0:00:22, Ethernet1
```

27

The router offers us some powerful tools at this point in our search. We can actually look at the routing table—the directions that the router uses to determine how it will direct traffic across the network.

The next basic test also focuses on the network layer. Use the **show ip route** command to determine whether a routing table entry exists for the target network.

The highlight shows that Rome (131.108.33.0) is reachable to Paris (131.108.16.2) via the Enternet0 interface.

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Is the Link Operational?

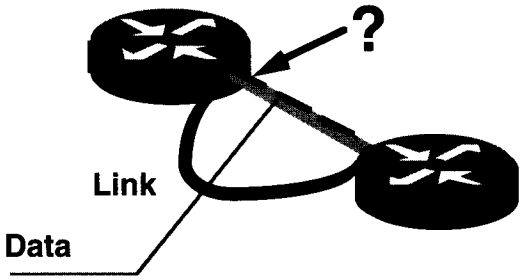
Hardware (Physical Layer)

- Cable
- Connectors
- Interface

Data Link Layer

- Keepalive Messages
- Control Information
- User Information

- Is the Carrier Detect signal present?



- Are keepalive messages being received?

28

The interface has two pieces: physical (hardware) and logical (software).

- The hardware must make the actual connection between the devices.
- The software is the messages that are passed between adjacent devices. This information is data being passed between two connected, or linked, devices.

When you test the physical and data link, you ask two questions:

- Is there a Carrier Detect signal?
- Are the keepalive messages being received?

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Interpreting *show interface serial*

```
Router# show int s 1

Serial1 is up, line protocol is up

  Hardware is cxBus Serial
  Description: 56Kb Line San Jose - MP
  :: :: :: :: :: :: :: :: :: ::
```

Carrier Detect **Keepalives**

Operational.....	**Serial1 is up, line protocol is up**
Connection Problem...	**Serial1 is up, line protocol is down**
Interface Problem.....	**Serial1 is down, line protocol is down**
Disabled	**Serial1 is administratively down, line protocol is down**

29

One of the most important elements of the **show interface serial** command output is display of the line and data-link protocol status. The graphic indicates the key summary line to check and the status meanings.

The line status in this example is triggered by a Carrier Detect signal, and refers to the physical-layer facility.

However, the line protocol, triggered by keepalive frames, refers to the data-link framing.

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Clearing *show interface* Counters

```
Router# clear counters
```

```
Router# show int s 1

Serial1 is up, line protocol is up

  Hardware is cxBus Serial
  Description: 56Kb Line San Jose - MP
  Internet address is 150.136.190.203, subnet mask is 255.255.255.
  MTU 1500 bytes, BW 56 Kbit, DLY 20000 usec, rely 255/255, load /255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input 0:00:07, output 0:00:00, output hang never
  Last clearing of "show interface" counters 2w4d
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  Five minute input rate 0 bits/sec, 0 packets/sec
  Five minute output rate 0 bits/sec, 0 packets/sec
     16263 packets input, 1347238 bytes, 0 no buffer
     Received 13983 broadcasts, 0 runts, 0 giants
     2 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 2 abort
     0 input packets with dribble condition detected
     22146 packets output, 2383680 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets, 0 restarts
     1 carrier transitions
```

30

The router tracks statistics that provide information about the interface. Use the **show interfaces** command to display the statistics.

The statistics reflect router operation since the last time the counters were cleared, as shown in the top highlighted line. In this example, that was two weeks and four days ago. The bottom set of highlights shows the critical counters.

Use the **clear counters** command to reset the counters to zero. By starting from zero, you get a more clear picture of the current status of the network.

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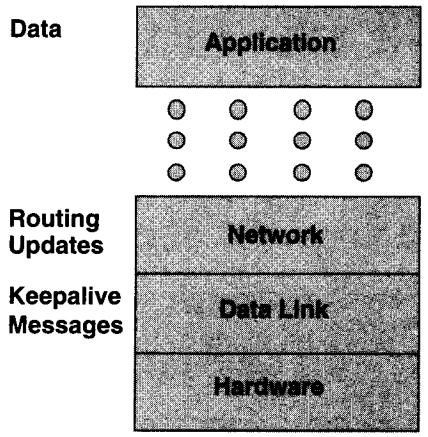
Check Real-Time Traffic with *debug*

• What protocol messages are being sent?




```
Router# debug broadcast
broadcast debugging is on

Ethernet0: Broadcast ARPA, src 0000.00c0.6fa4, dst ffff.ffff.ffff
type 0x0800, data 4500002800000000FF11EA7B, len 60
Serial3: Broadcast HDLC, size 64, type 0x800, flags 0x8F00
```

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The router includes hardware and software to aid in tracking down problems on it or on other hosts in the network. The **debug** privileged EXEC command starts the console display of the network events specified in the command parameter.

Use the **terminal monitor** command to forward debug output to your Telnet session terminal.

In this example, data-link broadcasts received by the router are displayed.

Use the **undebug all** command to turn debugging off when you no longer need it.

Caution Debugging is really intended for solving problems. Be very careful with this tool on a live network. Substantial debugging on a busy network will slow down the network significantly. Do not leave debugging turned on; use it to diagnose a problem, and then turn it off.

Processor Intensive

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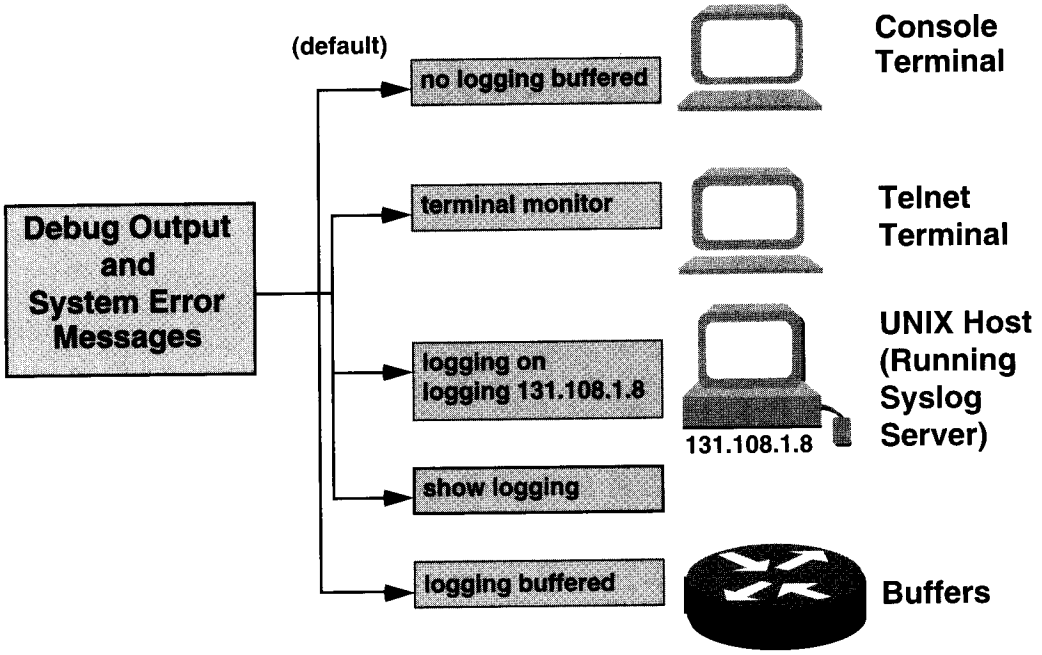
Logging Messages



32

By default, the router sends output from system error messages and the **debug** EXEC command to the console terminal. Messages can be redirected to a UNIX host or to an internal buffer.

The **terminal monitor** command provides you the ability to redirect these messages to a terminal.

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Summary

The router is made up of configurable components

The router has modes for examining, maintaining, and changing the components

Show commands are used for examination

Use CDP to show entries about neighbors

Access other routers with Telnet

Test network connectivity layer by layer

Testing commands include *ping*, *trace*, and *debug*

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Lab: Remote Configuration

Objective: Remotely access a router.

Objective: Test network connectivity.

Step 1 Press **Return** to begin.

Enter user mode with the password: **cisco**

Step 2 Enter privileged mode by using the **enable** command and the enable password: **san-fran**

Step 3 Enter the **show cdp neighbors** command at the Router# prompt.

Check for any entries about the device identifiers, addresses, port identifiers, capabilities list, version, and platform of your router neighbors. Use this information to complete the following table.

Device identifier	Address	Port identifier	Capabilities	Version	Platform

Step 4 Select one of the other routers in the room and enter its name. (The examples use the router named Paris. Substitute the router you chose for Paris in the following commands.)

Example: Router# **Tokyo**

Enter user mode by entering the VTY password: **cisco**

Enter privileged mode.

Example: Paris> **enable**

Example: Password: **san-fran**

Step 5 Enter the **show protocols** command at the Router# prompt.

A protocol is a language used by networking equipment to communicate with other devices on the network.

Is the Internet Protocol (IP) active on this router? Are any other protocols active?

[ ] Novell IPX *[ ] VINES* *[ ] DECnet* *[ ] XNS*

[ ] AppleTalk *[ ] ISO/CLNS* *[ ] Apollo* *[ ] IP*

Are any of the interfaces "Administratively down"?

Notice that each protocol must not only be active on the router, but also must be configured on each interface where it is to be used.

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Step 6 Enter the **show running-config** command at the Router# prompt.

(Use **write term** with Cisco IOS Release 10.3 and earlier.)

Locate the command in the active configuration file for any active routing protocols.

Step 7 Notice the **ip address** command below it.

Step 8 Enter the **show startup-config** command at the Router# prompt.

(Use **show config** with Cisco IOS Release 10.3 and earlier.)

How much NVRAM is used by the backup configuration file?

Step 9 Enter the **show ip protocols** command at the Router# prompt.

The **show protocol-name protocols** command provides more detailed information about active protocols.

What routing protocol is IP using?

Is IP using more than one routing protocol?

A routing protocol is a language used to communicate between routers. The routers share information about the location of objects in the network and use this to create directories called routing tables.

Step 10 Enter the **show ip route** command at the Router# prompt.

This is the routing table that IP is using to direct traffic through the network.

Is the network 131.108.0.0. listed in your IP routing table?

If the router receives data destined for this network, what interface must it use in order to reach that destination?

Step 11 Enter the **show interfaces** command at the Router# prompt.

Locate the first Ethernet or Token Ring interface.

What is the burnt-in address (bia)? _____

Step 12 Enter the **show ip interface** command at the Router# prompt.

The **show protocol-name interface** command provides more detailed information about active protocols.

Find the first Ethernet or Token Ring interface with an IP internetwork address.

*What interface is this?*_____

What is this address? _____

How was this address determined?

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Step 13 Use the escape sequence to return to your router.

Paris# **Shift-Ctrl-6 X**

Router#

Step 14 Initiate two more sessions between your router and other routers. (The router names Tokyo and Dallas are examples here. Use router names from your classroom configuration instead of these example names.)

Example: Router# Tokyo

Example: Tokyo# Shift-Ctrl-6 X

Example: Router# Dallas

Example: Dallas# Shift-Ctrl-6 X*Example:* Router#

Step 15 Enter the **show sessions** command at the Router# prompt.

This command enables you to determine how many Telnet sessions are active.

Step 16 Resume the last initiated session by pressing **Return.**

Use the escape sequence to return to your router.

Resume the second initiated session by entering: Router# **2**

Step 17 Enter the following in the remote router session:

Paris# **send 0**

(Enter any message you want.)

Ctrl-Z

Return

What happened?

End this session by entering: **exit**

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Step 18 Resume the first initiated session by entering: Router# **1**

Use the escape sequence to return to your router.

Disconnect this session from your router by entering the **disconn 1** command at the Router# prompt.

If a Telnet session stops responding to your keystrokes, it is likely that the remote router is no longer able to respond. This can happen when a remote router is rebooted while you are remotely accessing it. In this case, you can disconnect the Telnet session from the initiating side.

Step 19 You should now have one Telnet session still active. Check this with the **show sessions** command. Now, from your router, leave the command executive by entering: Router# **exit**.

What does the router do with the active sessions?

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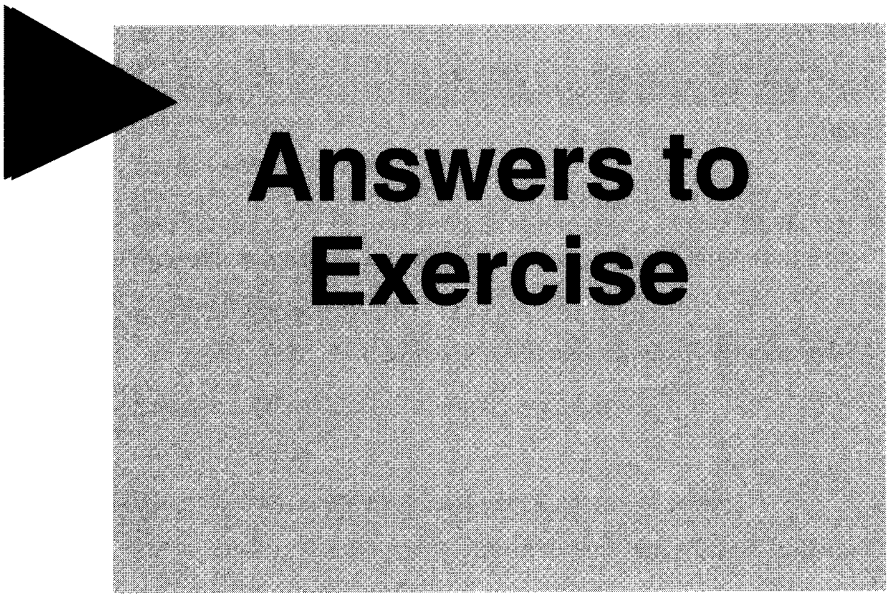

38

Answers to Exercise

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Exercise: Router Commands

Router Element	Command(s)
RAM	show version show running-config
NVRAM	show startup-config show config
Flash	show flash
Console privileged EXEC mode	enable
Auxiliary virtual terminal port	telnet
Interfaces	show interfaces

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CHAPTER 7

Initial Configuration

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Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

- **Describe the router's startup sequence and load sources**
- **Identify the main Cisco IOS commands for router startup**
- **List the conditions that cause a setup-mode dialog**
- **Check an initial configuration using the *setup* command**

2

This chapter discusses how to start a router the first time it is used. It explains the startup sequence and shows the setup dialog screens that the router uses to create an initial configuration file.

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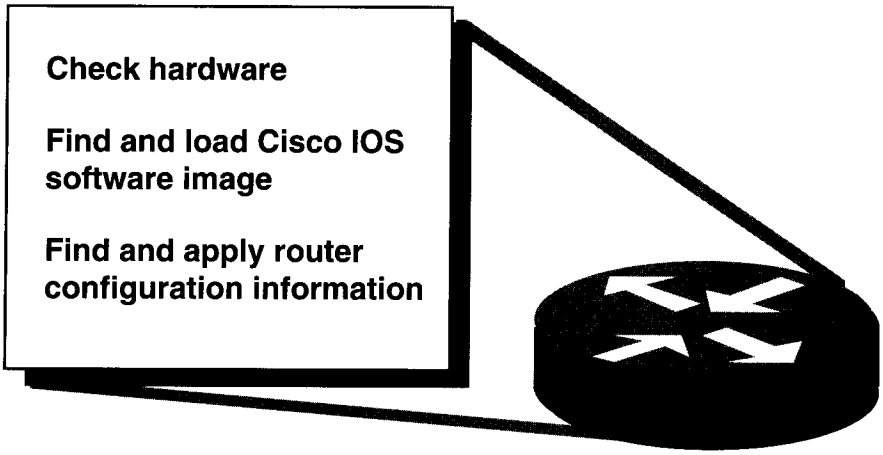
An Overview of System Startup



- System startup routines initiate router software
- Fallback routines provide startup alternatives as needed

3

The startup routines for Cisco IOS software have the goal of starting router operations. The router must deliver reliable performance connecting the user networks it was configured to serve. To do this, the startup routines must:

- Make sure that the router comes up with tested hardware.
- Find and load the Cisco IOS software that the router uses for its operating system.
- Find and apply the configuration statements about router-specific attributes, protocol functions, and interface addresses.

The router will make sure that it comes up with tested hardware. When a Cisco router powers up, it performs a power-up self-test. During this self test, the router executes diagnostics from ROM on all modules. These diagnostics verify the basic operation of the CPU, memory, and interface circuitry.

After verifying the hardware functions, the router proceeds with software initialization. Some startup routines act as fallback operations that are able to perform the router startup should other routines be unable to do so. This flexibility allows Cisco IOS software to start up in a variety of initial situations.

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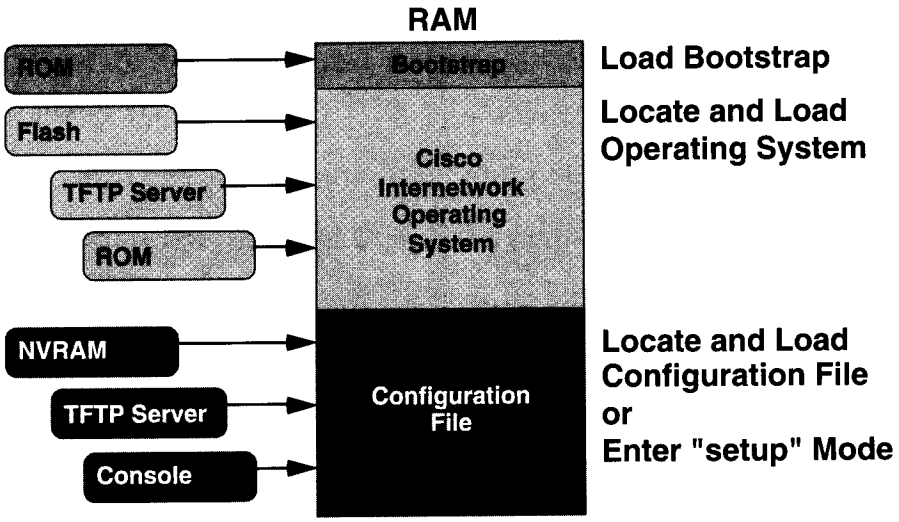
Startup Sequence



4

After the power-up self test on the router, the following events occur when the router initializes:

1 The generic bootstrap loader executes from ROM on the CPU card.

   A bootstrap is a simple, preset operation to load instructions that in turn cause other instructions to be loaded into memory, or cause entry into other configuration modes. The term comes from the data processing concept of the system "pulling itself up by its own bootstraps."

2 The operating system source is determined from the boot field of the configuration register. If the boot field indicates a Flash or network load, **boot system** commands in the configuration file indicate the exact location of the image.

3 The operating system image is loaded into low-addressed memory. Once loaded and operational, the operating system determines the hardware and software components and lists the results on the console terminal.

4 The saved configuration file in NVRAM is loaded into main memory and executed one line at a time. These configuration commands start routing processes, supply addresses for interfaces, set media characteristics, and so on.

5 If no valid configuration file exists in NVRAM, the operating system executes a question-driven initial configuration routine referred to as the system configuration dialog. This special mode is also called the setup dialog.

Setup is not intended as the mode for entering complex protocol features in the router. Use setup to bring up a minimal configuration. Instead of setup, network administrators use various config-mode commands for most router configuration tasks.

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Commands Relating to Startup

```
Router# show startup-config
        (show config)*
```

```
Router# show running-config
        (write term)*
```

```
Router# erase startup-config
        (write erase)*
```

```
Router# reload
```

```
Router# setup
```

***Use these commands for routers running Release 10.3 or earlier** 5

The top two commands in the graphic display the backup and active configuration files.

The **erase startup-config** command deletes the backup configuration file in NVRAM.

The **reload** command reloads the router, causing it to run through the entire configuration process.

The last command is used to enter setup mode from the privileged EXEC prompt.

Note The commands **show config**, **write term**, and **write erase** used with Cisco IOS Release 10.3 and earlier have been replaced by new commands. The commands that have been replaced continue to perform their normal functions in the current release but are no longer documented. Support for these commands will cease in a future release.

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Setup: The System Configuration Dialog

```
#setup

        --- System Configuration Dialog ---

At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.

Continue with configuration dialog? [yes]:

First, would you like to see the current interface summary? [yes]:

Interface      IP-Address    OK?  Method   Status     Protocol
TokenRing0     unassigned    NO   not set  down       down
Ethernet0      unassigned    NO   not set  down       down
Serial0        unassigned    NO   not set  down       down
Fddi0          unassigned    NO   not set  down       down
```

6

One routine for initial configuration is the setup mode. The primary purpose of the setup mode is to rapidly bring up a minimal-feature configuration for any router that cannot find its configuration from some other source.

For many of the prompts in the system configuration dialog of the **setup** command facility, default answers appear in square brackets ([ ]) following the question. Pressing the Return key allows you to use the defaults. If the system was previously configured, the defaults that appear are the currently configured values. If you are configuring the system for the first time, the factory defaults are provided. If there is no factory default, as in the case of passwords, nothing is displayed after the question mark (**?**).

At this point, you can choose not to continue with the system configuration dialog and can exit by entering **No** at the prompt. To begin the initial configuration process, enter **Yes**. You can press Control-C to terminate the process and start over at any time. When you are using the command form of **setup** (Router# setup), Control-C returns you to the privileged EXEC prompt (Router#).

If a "-- More --" prompt appears, press the space bar to continue.

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Setup Global Parameters

```
Configuring global parameters:

  Enter host name [Router]:

The enable secret is a one-way cryptographic secret used
instead of the enable password when it exists.

  Enter enable secret [<Use current secret>]:

  Enter enable password [san-fran]:
% Please choose a password that is different from the enable secret
  Enter enable password [san-fran]:
  Enter virtual terminal password [san-fran]:
  Configure SNMP Network Management? [no]:
```

7

You are prompted for global parameters at the console. You use the configuration values you have determined for your router to enter the global parameters at the prompts.

The first global parameter allows you to set the router host name. This host name will precede the Cisco IOS prompts for all configuration modes. At initial configuration, the router name default is shown between the square brackets as [Router].

Use the next global parameters shown to set the various passwords used on the router.

You must enter an enable secret password. When you enter a string of password characters for the prompt to "Enter enable secret," the characters are processed by Cisco-proprietary encryption. This can enhance the security of the password string. Whenever anyone lists the contents of the router configuration file, this enable password appears as a meaningless string of characters. Setup recommends, but does not require, that the enable password be different from the enable secret password.

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Setup Global Parameters (cont.)

```
Configure IP? [yes]:
 Configure IGRP routing? [yes]:
  Your IGRP autonomous system number [1]: 200
Configure DECnet? [no]:
Configure XNS? [no]:
Configure Novell? [no]: yes
Configure Apollo? [no]:
Configure AppleTalk? [no]: yes
 Multizone networks? [no]: yes
Configure Vines? [no]:
Configure bridging? [no]:
```

8

You are prompted for global parameters at the console. You use the configuration values you have determined for your route to enter the global parameters at the prompts.

When you answer "yes" to a prompt, additional subordinate questions may appear about that protocol.

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Setup Interface Parameters

```
Configuring interface parameters:

Configuring interface TokenRing0:
 Is this interface in use? [yes]:
  Tokenring ring speed (4 or 16)? [16]:
 Configure IP on this interface? [no]: yes
  IP address for this interface: 172.16.92.67
  Number of bits in subnet field [0]:
  Class B network is 172.16.0.0, 0 subnet bits; mask is 255.255.0.0
 Configure Novell on this interface? [no]: yes
  Novell network number [1]:

Configuring interface Serial0:
 Is this interface in use? [yes]:
 Configure IP on this interface? [yes]:
 Configure IP unnumbered on this interface? [no]:
  IP address for this interface: 172.16.97.67
  Number of bits in subnet field [0]:
  Class B network is 172.16.0.0, 0 subnet bits; mask is 255.255.0.0
 Configure Novell on this interface? [yes]: no

Configuring interface Serial1:
 Is this interface in use? [yes]:no
```

9

You are prompted for parameters for each installed interface. You use the configuration values you have determined for your interface to enter the interface parameters at the prompts.

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Setup Script Review and Use

```
The following configuration command script was created:

hostname router
enable secret 5 $1$g722$c
enable password san-fran
enable password san-fran
line vty 0 4
password san-fran
snmp-server community
!
ip routing
no decnet routing
no xns routing
novell routing
no apollo routing
appletalk routing
no clns routing
no vines
no bridge
no mop enabled
-- More --
interface TokenRing0
ip address 172.16.92.67 255.255.0.0
novell network 1
no mop enabled
!
interface Serial0
ip address 172.16.97.67 255.255.0.0

interface Serial1
shutdown
!
router igrp 200
network 172.16.0.0
!
end

Use this configuration? [yes/no]: yes
[OK]
Use the enabled mode 'configure' command to
modify this configuration.
```

- **The script is stored in NVRAM as a backup configuration file**

10

When you complete the configuration process for all installed interfaces on your router, the **setup** command facility presents the configuration command script that was created.

The **setup** command facility asks you whether you want to use this configuration. If you answer Yes, the configuration is executed and saved to NVRAM. If you answer No, the configuration is not saved and the process begins again. There is no default for this prompt; you must answer either Yes or No.

Once you have answered Yes to this last question, your system is ready to use. If you want to modify the configuration you have just established, you must configure manually.

The script tells you to use configuration mode to modify the command after setup has been used. The script file generated by setup is additive; you can turn on features with setup, but you cannot turn them off. Also, setup does not support many of the advanced features of the router or those features that require a more complex configuration.

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Summary

The router initializes by loading a bootstrap, the operating system, and a configuration file

If the router cannot find a configuration file, the router enters setup mode

The router stores a backup copy of the new configuration from setup mode in NVRAM

11

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Exercise: Checking the Initial Configuration

Problem 1

Objective: Describe the router's startup sequence and load sources.

Fill in the three types of initial configuration software in the column titled "The Router Loads This." In the next column fill in the primary or normally used source for each software type for "Router Loads from." Fill in the other fallback alternatives for each software type in the column titled "Alternative Load Sources."

Step	The Router Loads This	Router Loads from	Alternate Load Sources
1			
2			
3			

Problem 2

Objective: Identify the main Cisco IOS commands for router startup.

A) List the Cisco IOS software commands to examine the backup configuration file, and the command to examine the active configuration file.

_____

_____

B) The _____command causes the router to find and load the Cisco IOS image.

Problem 3

Objective: List the conditions that cause a setup-mode dialog.

List two situations that can cause Cisco IOS software to enter the system configuration dialog.

_____

_____

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Lab: Setup Display

Objective: Check an initial configuration using the setup command.

Step 1 Press **Return** to begin.

Enter user mode with the password: **cisco**

Enter privileged mode by using the **enable** command and the enable password: **san-fran**.

Step 2 Enter the **setup** command at the Router# prompt.

What indicates a default setting? How do you accept the default setting?

How do you abort your setup dialog or make sure that you do not change any setting?

Step 3 Check the current interface summary.

What determines the list of interfaces that appears in the left-hand column?

Write the name of each interface shown as administratively down.

_____

_____

Step 4 If there is no default enable secret password set, enter the enable secret **san-fran**.

When is the enable secret password used instead of the enable password?

Note For this course lab, disregard the advice that you should choose an enable password that is different from the enable secret password.

Step 5 Check the configuration command script that the setup dialog creates.

What is the difference between the enable secret password and the enable password?

What term describes interfaces that are administratively down?

Step 6 At the end of the configuration command script display, answer the final setup question as shown below.

Use this configuration? [yes/no] **no**

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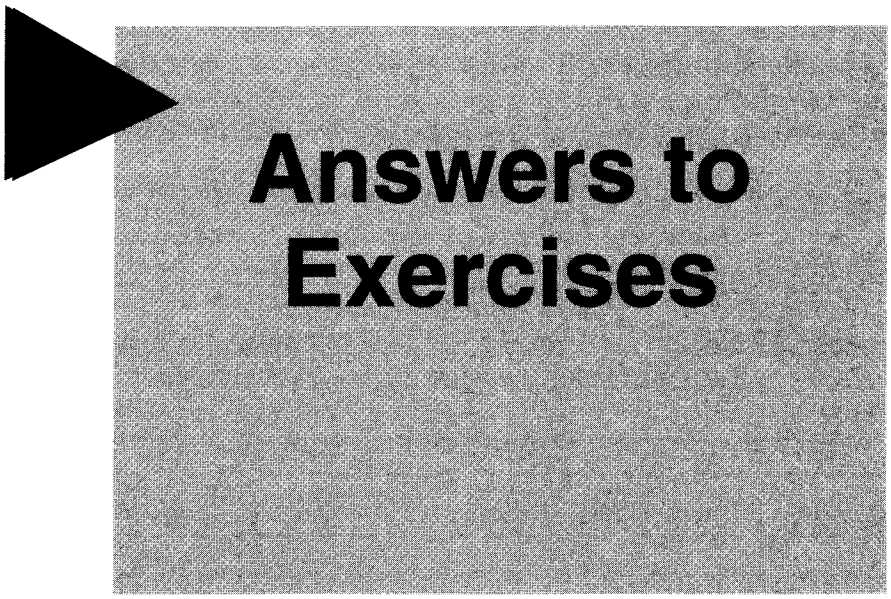

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Answers to Exercises

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Exercise: Checking the Initial Configuration

Problem 1

Step	The Router Loads This	Router Loads from	Alternate Load Sources
1	Bootstrap	ROM	None
2	Cisco IOS	Flash	TFTP server RAM
3	Config file	NVRAM	TFTP server console

Problem 2

A) Use the command **show startup-config** to examine the backup configuration file.

Use the command **show running-config** to examine the active configuration file.

B) **reload**

Problem 3

Two situations are as follows:

- During router initialization if the Cisco IOS software is unable to locate and load a configuration file.
- After router startup if the system administrator enters the privileged EXEC command **setup**.

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CHAPTER 8

Configuration Methods and Modes

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Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

Manage configuration files from the privileged EXEC mode

Move between configuration modes

Control router passwords, identification, and banner

2

This chapter discusses how to update the configuration file. It includes an overview of router modes and discusses configuration methods for current and prior versions of Cisco IOS software.

Sections:

- Router Modes
- Configuration Methods

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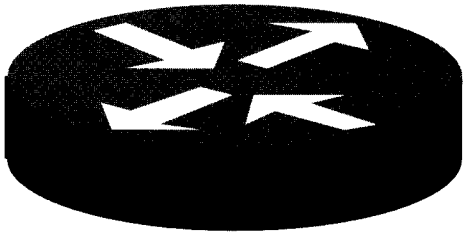
Router Configuration Overview

- Cisco IOS software version
- Router identification
- Boot file locations
- Protocol information
- Interface configurations



3

The router uses information from the configuration file when it starts up. The configuration file contains commands to customize router operation.

As you saw in the previous chapter, if there is no configuration file available, the system configuration dialog setup guides you through creating one.

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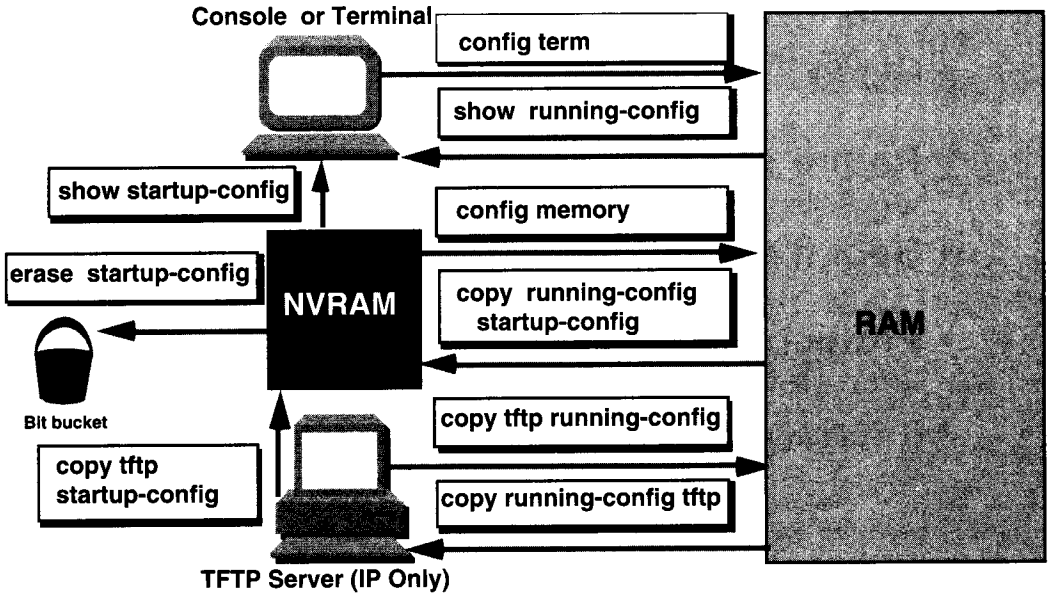
Working with 11.x Config Files



- **Use these commands for routers running Cisco IOS Release 11.0 or later** 4

Router configuration information can be generated by several means.

The privileged EXEC **configure** command can be used to configure from either a virtual (remote) terminal or the console terminal, allowing you to enter changes to an existing configuration at any time. The privileged EXEC **configure** command can also be used to load a configuration from a network TFTP server, allowing you to maintain and store configuration information at a central site.

Configuration command summary:

- **configure terminal**—Configure manually from the console terminal.
- **configure memory**—Load configuration information from NVRAM.
- **copy tftp running-config**—Load configuration information from a network TFTP server.
- **show running-config**—Display the current configuration in RAM.
- **copy running-config startup-config**—Store the current configuration in RAM into NVRAM.
- **copy running-config tftp**—Store the current configuration in RAM on a network TFTP server.
- **show startup-config**—Display the saved configuration, which is the contents of NVRAM.
- **erase startup-config**—Erase the contents of NVRAM.

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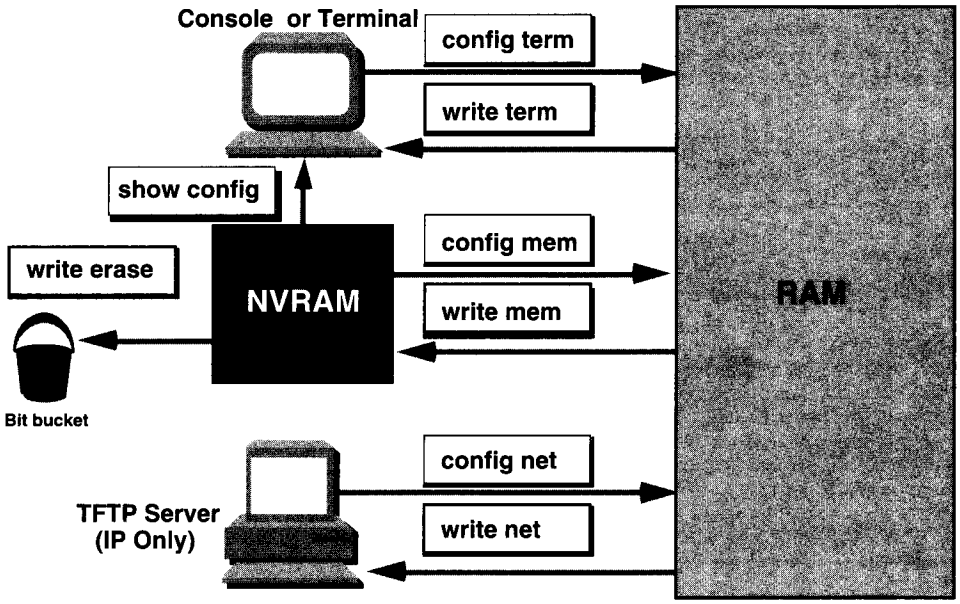
Working with Pre-11.0 Config Files



- **Use these commands for routers running Cisco IOS Release 10.3 or earlier** [5]

The commands shown in the graphic are used with Cisco IOS Release 10.3 and earlier and have been replaced by new commands. The commands that have been replaced continue to perform their normal function in the current release but are no longer documented. Support for these commands will cease in a future release.

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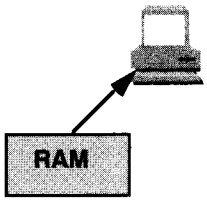
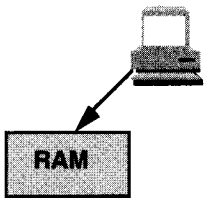
Using a TFTP Server

```
tokyo# copy running-config tftp
Remote host []? 131.108.2.155
Name of configuration file to write [tokyo-confg]?   tokyo.2
Write file tokyo.2 to 131.108.2.155? [confirm]  y
Writing tokyo.2 !!!!!!!! [OK]
tokyo#
```




```
Router# copy tftp running-config
Host or network configuration file [host]?
IP address of remote host [255.255.255.255]?  131.108.2.155
Name of configuration file [Router-confg]?  tokyo.2
Configure using tokyo.2 from 131.108.2.155? [confirm]  y
Booting tokyo.2 from 131.108.2.155:!! [OK - 874/16000 bytes]
tokyo#
```



6

A current copy of the configuration can be stored on a TFTP server. Use the **copy running-config tftp** command to store the current configuration in RAM on a network TFTP server.

You can configure the router by retrieving the configuration file stored on one of your network servers. To do so, complete the following tasks:

Step 1 Enter configuration mode by entering the **copy tftp running-config** command.

Step 2 At the system prompt, select a host or network configuration file. The network configuration file contains commands that apply to all routers and terminal servers on the network. The host configuration file contains commands that apply to one router in particular.

Step 3 At the system prompt, enter the optional IP address of the remote host from which you are retrieving the configuration file. In this example, the router is configured from the TFTP server at IP address 131.108.2.155. At the system prompt, enter the name of the configuration file or accept the default name. The filename convention is UNIX-based. The default filename is *hostname-config* for the host file and *network-config* for the network configuration file. In the DOS environment, the server filenames are limited to eight characters plus a three-character extension (for example, *router.cfg*). Confirm the configuration filename and the server address that the system supplies.

In the second example in the graphic, notice that the router prompt changes to tokyo immediately. This is evidence that the reconfiguration happens as soon as the new file is downloaded.

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Using NVRAM with Release 11.x

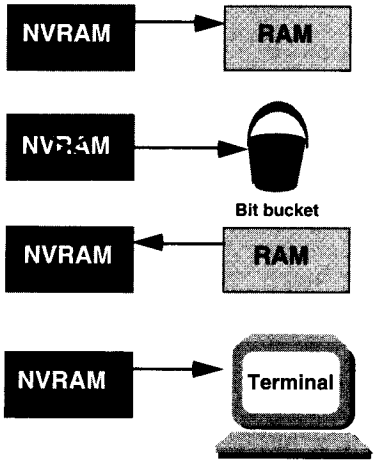
```
Router# configure memory
[OK]
Router#
```

```
Router# erase startup-config
[OK]
Router#
```

```
Router# copy running-config startup-config
Router#
```

```
Router# show startup-config

Using 5057 out of 32768 bytes
!
enable-password san-fran
!
interface Ethernet 0
ip address 131.108.100.5 255.255.255.0
!
-- More --
```



7

These commands manage the contents of NVRAM:

- **configure memory**—Load configuration information from NVRAM.
- **erase startup-config**—Erase the contents of NVRAM.
- **copy running-config startup-config**—Store the current configuration in RAM (the running configuration) into NVRAM (as the startup configuration).
- **show startup-config**—Display the saved configuration, which is the contents of NVRAM.

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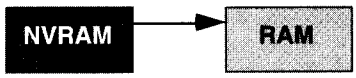
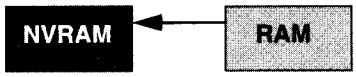
Using NVRAM with Pre-11.0 IOS

```
Router# configure memory
[OK]
Router#
```



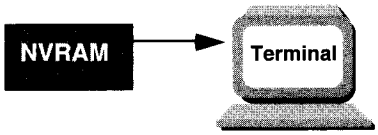

```
Router# write erase
[OK]
Router#
```

```
Router# write memory
[OK]
Router#
```




```
Router# show configuration

Using 5057 out of 32768 bytes
!
enable-password san-fran
!
interface Ethernet 0
ip address 131.108.100.5 255.255.255.0
!
     -- More --
```



8

- **Use these commands for routers running Cisco IOS Release 10.3 or earlier**

The commands shown in the graphic are used with Cisco IOS Release 10.3 and earlier. These commands have been replaced by new commands. The commands that have been replaced continue to perform their normal function in the current release, but are no longer documented. Support for these commands will cease in a future release.

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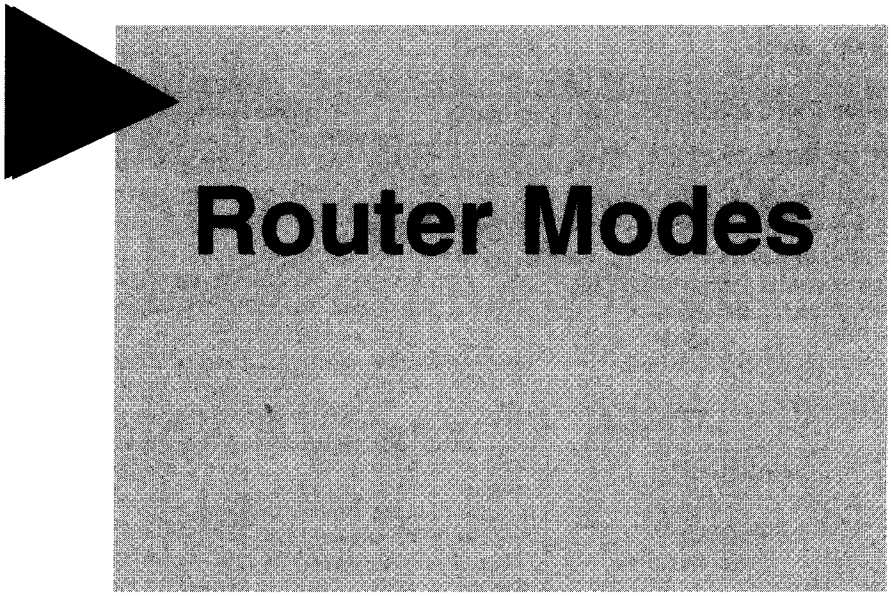
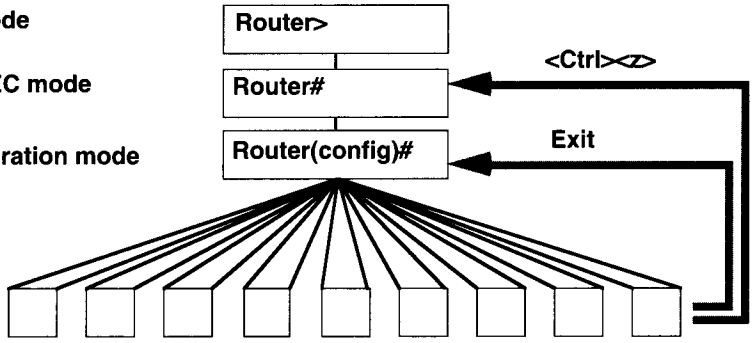


9

Router Modes

Overview of Router Modes

- User EXEC mode
- Privileged EXEC mode
- Global configuration mode



Configuration Mode	Prompt
Interface	`Router(config-if)#`
Subinterface	`Router(config-subif)#`
Controller	`Router(config-controller)#`
Map-list	`Router(config-map-list)#`
Map-class	`Router(config-map-class)#`
Line	`Router(config-line)#`
Router	`Router(config-router)#`
IPX-router	`Router(config-ipx-router)#`
Route-map	`Router(config-route-map)#`

10

The command interpreter is called the EXEC. The EXEC interprets the commands you type and carries out the corresponding operations. You must log into the router before you can enter an EXEC command. There are two EXEC modes. The EXEC commands available at the user mode are a subset of the EXEC commands available at the privileged mode. From the privileged level, you can also access global configuration mode and specific configuration modes, some of which are listed:

- Interface
- Subinterface
- Controller
- Map-list
- Map-class
- Line
- Router
- IPX-router
- Route-map

If you type **exit**, the router will back out one level, eventually allowing you to log out. In general, typing **exit** from one of the specific configuration modes will return you to global configuration mode. Pressing Control-Z leaves configuration mode completely and returns the router to privileged EXEC mode.

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Configuration Modes

```
Router# config term
Router(config)#    :  :  :
Router(config)#  (commands)
Router(config)#
Router(config)#exit
Router#

Router# config term    :  :  :
Router(config)# router protocol
Router(config-router)#   :  :  :
Router(config-router)# (commands)
Router(config-router)#   :  :  :
Router(config-router)# exit
Router(config)# interfacetype port
Router(config-if)#    :  :  :
Router(config-if)#  (commands)
Router(config-if)#    :  :  :
Router(config-if)# exit
Router(config)#exit
Router#
```

- **Global Configuration Mode**
  Used for system-wide configurations requiring one command line. Includes commands to enter other configuration modes.
- **Other Configuration Modes**
  Used for other configurations requiring multiple command lines

11

Global configuration commands apply to features that affect the system as a whole.

Use the privileged EXEC command **configure** to enter global configuration mode. When you enter this command, the EXEC prompts you for the source of the configuration commands. You can then specify the terminal, NVRAM, or a file stored on a network server as the source.

The default is to type in commands from the terminal console. Pressing the Return key begins this configuration method.

Commands to enable a particular routing or interface function begin with global configuration commands.

- To configure a routing protocol (indicated by the prompt config-router) you first enter a global router protocol command type.
- To configure an interface (indicated by the prompt config-if) you first enter the global interface type and number command.

Commands to configure the access line to the router using the directly connected console or the virtual terminal used with Telnet also begin with global configuration commands.

- To enable console configuration mode, begin with the global command **line console 0**.
- To enable the virtual terminal ports configuration modes to set up remote console access, begin with global command **line vty** followed by the line number and ending line number if you want to configure a range of lines.

After entering commands in any of these modes, finish with the command **exit**.

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IP Routing Protocol Mode

```
Router(config)#  router ?
   bgp        Border Gateway Protocol (BGP)
   egp        Exterior Gateway Protocol (EGP)
   eigrp      Enhanced Interior Gateway Routing Protocol (EIGRP)
   igrp       Interior Gateway Routing Protocol (IGRP)
   isis       ISO IS-IS
   iso-igrp   IGRP for OSI networks
   mobile     Mobile routes
   odr        On Demand stub Routes
   ospf       Open Shortest Path First (OSPF)
   rip        Routing Information Protocol (RIP)
   static     Static routes

Router(config)#  router rip
Router(config-router)# ?
Router configuration commands:
  default-information  Control distribution of default information
  default-metric       Set metric of redistributed routes
  distance             Define an administrative distance
  distribute-list      Filter networks in routing updates
  exit                 Exit from routing protocol configuration mode
-- More --
```

12

After a routing protocol is enabled by a global command, the router configuration mode prompt Router (config-router)# is displayed. Type a question mark (?) to list the router configuration commands.

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Interface Configuration Mode

```
Router(config)#  interface  type port
Router(config)#  interface  type slot/port
```

- *type* includes serial, ethernet, tokenring, fddi, hssi, loopback, dialer, null, async, atm, bri, and tunnel

```
Router(config-if)#  shutdown
```

- Use this command to administratively turn off an interface without altering its other configuration entries

```
Router(config-if)#  no shutdown
```

- Turn on an interface that has been *shutdown*

```
Router(config-if)#  exit
```

- Quit from current config-interface mode

```
Router(config)#  interface  type number.subinterface
```

- After designating the primary interface, use this to establish virtual interfaces on the single physical interface

13

Many features are enabled on a per-interface basis. Interface configuration commands modify the operation of an Ethernet, Token Ring, FDDI, or serial port. Interface subcommands always follow an interface command; the interface command defines the interface type.

You can configure a number of virtual interfaces on a single physical serial interface. These virtual interfaces are logical constructs called subinterfaces.

For details on interface configuration commands that affect general interface parameters such as bandwidth, clock rate, and so on, see the Cisco IOS command reference publications.

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Interface Configuration Examples

USED BY IGRP. DOES NOT SET BANDWIDTH

- **For a serial interface to provide clocking (DCE), use a clockrate command**

```
Router(config)# interface serial 1/0
Router(config-if)# bandwidth 56
Router(config-if)# clockrate 56000
```

- **On a Token Ring, you must specify the ring speed**

```
Router(config)# interface tokenring 2/0
Router(config-if)# early-token release
Router(config-if)# ring-speed 16
```

- **On Cisco 4x00 routers, select the media-type connector for the Ethernet interface**

```
Router(config)# interface ethernet 2
Router(config-if)# media-type 10baset
```

- **Before establishing subinterfaces, you must first configure the primary interface**

```
Router(config)# interface serial 0
Router(config-if)# int s 0.1 point-to-point
Router(config-if)# int s 0.2 point-to-point
```

14

These commands are examples of how to complete common interface tasks.

The first set of commands are associated with interfaces. On serial links, one side must provide a clocking signal, DCE; the other side is a DTE. By default, Cisco routers are DTE devices, but in some cases they can be used as DCE devices. If you are using an interface to provide clocking, you must specify a rate with the **clock rate** command. The **bandwidth** command overrides the default bandwidth that is displayed in the **show interface** command and is used by some routing protocols such as IGRP.

The second set of commands are for Token Ring. On Token Ring you must specify the ring speed—either 4 or 16 Mbps. Early token release is also supported.

The third set of commands are associated with the Cisco 4000 series routers. On the Cisco 4000, there are two connections on the outside of the box for Ethernet interfaces—an attachment unit interface (AUI) connector and a 10BaseT connector. The default is AUI, so you must specify **media-type 10BaseT** if you want to use the other connection.

The final set of commands configure the primary interface before you can establish subinterfaces.

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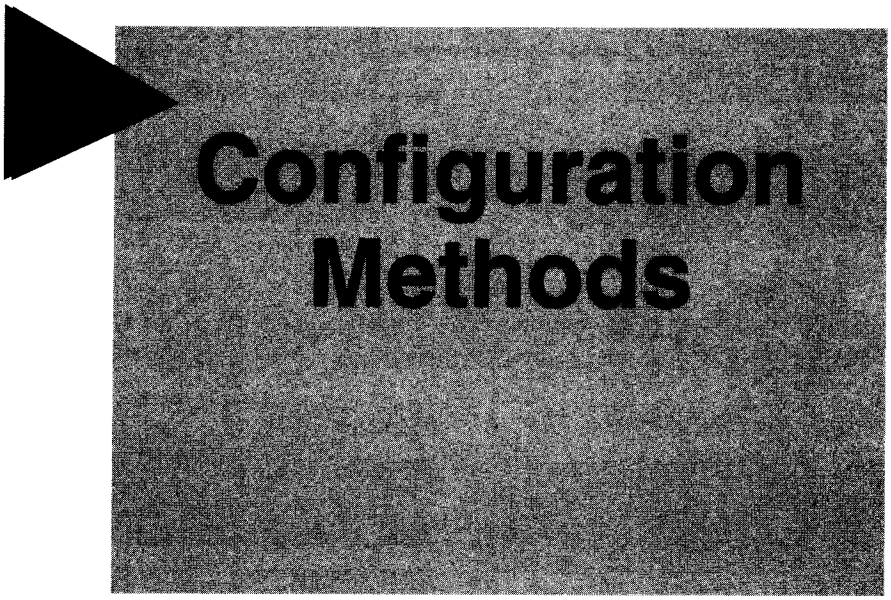

15

Configuration Methods

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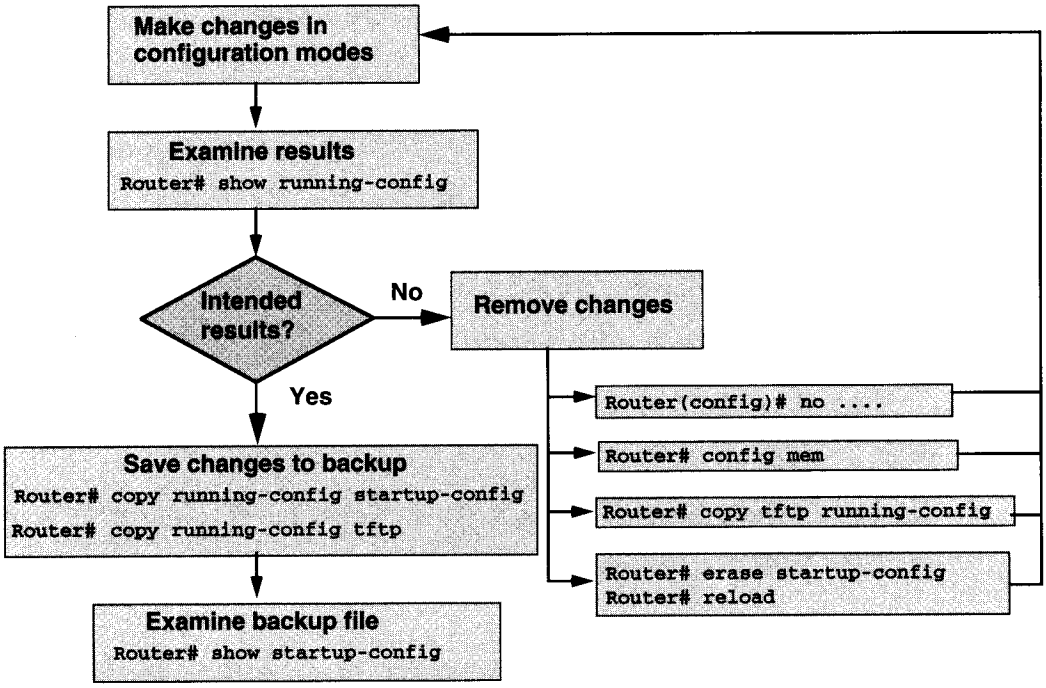
Release 11.x Configuration Methods



16

The graphic shows a methodology you can use to:

- Enter configuration statements
- Save the changes to a backup the router will use when it starts up
- Examine the changes you have made
- If necessary, modify or remove configuration statements

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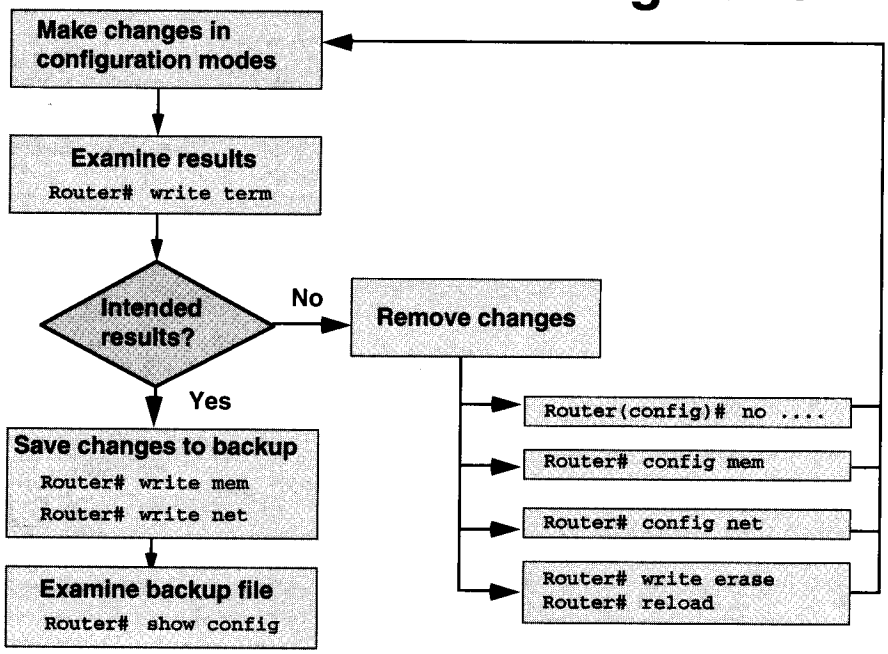
Pre-11.0 Release Configuration



- **Use these commands for routers running Cisco IOS Release 10.3 or earlier** 17

The commands shown here are used with Cisco IOS Release 10.3 and earlier. They have been replaced by new commands. The commands that have been replaced continue to perform their normal function in the current release but are no longer documented. Support for these commands will cease in a future release.

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Password Configuration

Console Password

```
Router(config)# line console 0
Router(config-line)# login
Router(config-line)# password cisco
```

Virtual Terminal Password

```
Router(config)# line vty 0 4
Router(config-line)# login
Router(config-line)# password cisco
```

Enable Password

```
Router(config)# enable-password san-fran
```

ENABLE SECRET

Perform Password Encryption

```
Router(config)# service password-encryption
        (set passwords here)
Router(config)# no service password-encryption
```

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You can secure your system by using passwords to restrict access. Passwords can be established both on individual lines and in the privileged EXEC mode.

The **line console 0** command establishes a password on the console terminal.

The **line vty 0 4** command establishes password protection on incoming Telnet sessions.

The **enable-password** command restricts access to the privileged EXEC mode.

The enable-secret password from the System Configuration Dialog to setup global parameters uses a Cisco-proprietary encryption process to alter the password character string.

Password can be further protected from display through the use of the **service password-encryption** command. The encryption algorithm does not match the Data Encryption Standard (DES).

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Configuring Router Identification

Router Name

```
Router(config)#  hostname  Tokyo
Tokyo#
```

Login Banner

```
Tokyo(config)#  banner motd #
     Welcome to router Tokyo
     Accounting Department
     3rd Floor
#
```

Interface Description

```
Tokyo(config)#  interface e 0
Tokyo(config-if)#  description  Engineering LAN, Bldg. 18
```

- **Sets local identity or message for the accessed router or interface** 19

The configuration of network devices determines the network's behavior. To manage device configurations, you need to list and compare configuration files on running devices, store configuration files on network servers for shared access, and perform software installations and upgrades.

One of the first basic tasks is to name your router. The name of the router is considered to be the host name and is the name displayed by the system prompt. If no name is configured, the system default router name is *Router*. You can name the router in global configuration mode. In the example shown, the router name is set to *Tokyo*.

You can configure a message-of-the-day banner to be displayed on all connected terminals. This banner is displayed at login and is useful for conveying messages that affect all network users, such as impending system shutdowns. To configure this message, use the **banner motd** command in global configuration mode.

Motd
Message of The Day

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Summary

- Configuration files can come from the console, VRAM, or a TFTP server
- The router has several modes:
  - Privileged mode used for copying and managing entire configuration files
  - Global configuration mode used for one-line commands and commands that change the entire router
  - Other configuration modes used for multiple command lines and detailed configurations
- The router provides a host name, a banner, and interface descriptions to aid in identification

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Lab: Router Configuration

Objective: Manage configuration files from the privileged EXEC mode.

Objective: Move between configuration modes.

Objective: Control router passwords, identification, and banner.

Step 1 Press **Return** to begin.

Enter user mode with the password: **cisco**

Enter privileged mode by using the **enable** command and the enable password: **san-fran**

Step 2 Enter the **show running-config** command at the Router# prompt.

(Use **write term** with Cisco IOS Release 10.3 and earlier.)

Locate the **hostname** command in the active configuration file.

Is the prompt on your command line the same as the hostname command?

Step 3 Enter the **show startup-config** command at the Router# prompt.

(Use **show config** with Cisco IOS Release 10.3 and earlier.)

Is the hostname the same in this file as in the active file?

Step 4 Enter configuration mode by entering the **config term** command at the Router# prompt.

Get help by entering: Router(config)# **ho ?**

How many commands begin with the letters "ho"?

Get help by entering: Router(config)**# hostname ?**

According to this, what syntax is required for the hostname command?

Return to privileged mode by entering: Router(config)**# exit**

Step 5 Enter the following:

Router(config)# **hostname learner**

Router(config)# **Ctrl-Z**

learner#

Notice the message:

%SYS-5-CONFIG_I: Configured from console by console

This message lets you know that the router has been configured.

Press **Return** to acknowledge the message.

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Step 6 Enter the following commands:

learner# **config term**

learner(config)# **banner motd #**

Create a two-line banner for your router. Type # at the end of the banner to return to the prompt.

learner(config)# **interface e 0**

learner(config-if)# **description Student Lab**

learner(config-if)# **exit**

learner(config)# **Ctrl-Z**

%SYS-5-CONFIG_I: Configured from console by console **Return**

Step 7 Enter the **show running-config** command at the learner# prompt.

(Use **write term** with Cisco IOS Release 10.3 and earlier.)

Is the prompt on your command line the same as the hostname command?

Does the banner entry reflect your new message as message of the day?

Congratulations! You have just configured a router. You have demonstrated your understanding of the basic process. The rest of the course is simply building on what you already know and learning more about the commands contained in this configuration file.

Step 8 Enter the **show startup-config** command at the learner# prompt.

(Use **show config** with Cisco IOS Release 10.3 and earlier.)

What is the hostname in the startup-configuration file?

Notice that all of the changes that you make to the router change the active configuration file. After you are certain that these changes produce the intended result, you must explicitly tell the router to save those changes to the backup configuration file in NVRAM. For now, use the backup file to recover the original host name.

Step 9 Enter the **config mem** command at the learner# prompt.

Has the prompt on the command line changed?

%SYS-5-CONFIG_I: Configured from memory by console **Return**

Step 10 Enter the **sho run** command at the Router# prompt.

Notice that you only have to enter the minimum number of characters to make a command unique. This can save some typing.

Has the hostname command in the active configuration file changed?

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Step 11 Enter the **show history** command at the Router# prompt.

This shows a list of the last several commands you entered.

Press **Control-P** several times. Notice that it gives you progressively older commands in the history. Now press **Control-N** to move to newer commands in the list. The command history is a powerful feature that can save you a lot of typing when you are using the same commands repeatedly.

Step 12 To exit, enter the **exit** command at the Router# prompt.

Good work!

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CHAPTER 9

Sources for Cisco IOS Software

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Objectives

Upon completion of this chapter, you will be able to perform the following tasks:

List the commands to load Cisco IOS software from:

- **Flash memory**
- **A TFTP server**
- **ROM**

Prepare to back up, upgrade, and load a backup Cisco IOS software image

2

This chapter discusses how to locate and load the Cisco IOS software onto a router. It explains the functions of the configuration register, discusses how to determine what version of the file you have, and describes how to use a TFTP server as a software source. It also explains how to back up and upgrade your Cisco IOS software.

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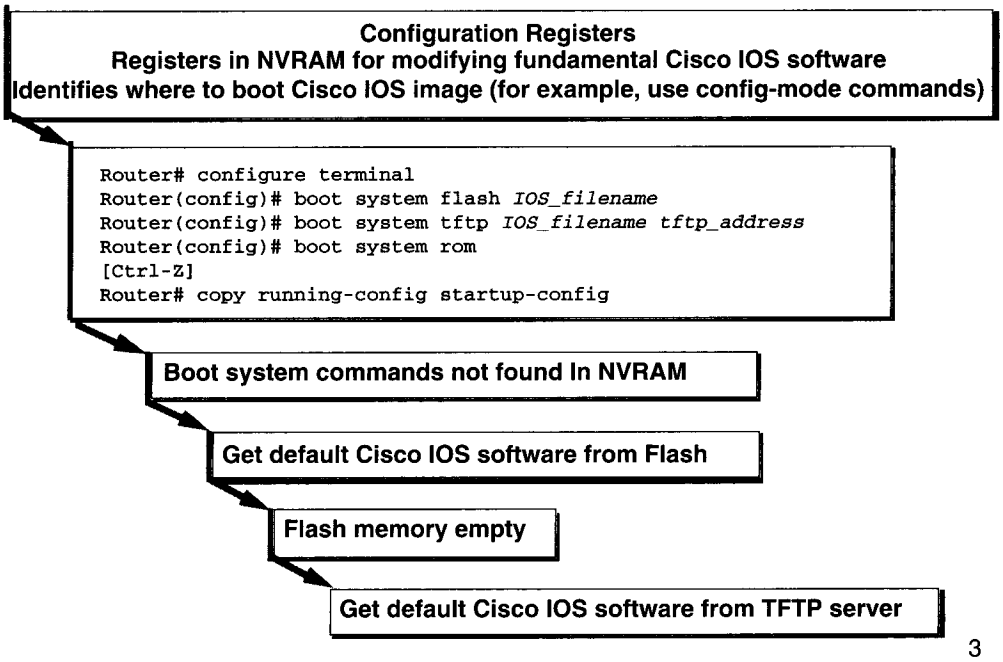
Locating the Cisco IOS Software



The default source for Cisco IOS software depends on the hardware platform, but most commonly the router looks to the configuration commands saved in NVRAM. Cisco IOS software offers several alternatives. You can specify other sources where the router should look for software, or the router will use its own fall back sequence as necessary to load software.

- Settings in the configuration register enable alternatives for where the router will bootstrap Cisco IOS software.
- You can specify enabled config-mode **boot system** commands to enter fallback sources for the router to use in sequence. Save these statements in NVRAM to use during the next startup with the command **copy running-config startup-config**.

  The router will use these commands as needed, in sequence, when it restarts.
- However, if NVRAM lacks **boot system** commands the router can use, the system has its own fall back alternatives. The router will fall back and use default Cisco IOS in Flash memory.

  If Flash memory is empty, the router will try its next TFTP alternative. The router uses the configuration register value to form a filename from which to boot a default system image stored on a network server.

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Configuration Register Values

```
Router# configure terminal
Router(config)# config-register 0x10F
[Ctrl-Z]
```

- **Configuration register bits 3, 2, 1, and 0 set boot option**

Configuration-Register Value	Meaning
0x0	Use ROM monitor mode (Manually boot using the *b* command)
0x1	Automatically boot from ROM (default if router has no flash)
0x2 to 0xF	Examine NVRAM for *boot system* commands (0x2 default if router has Flash)

- **Check configuration register setting with *show version***

4

The order in which the router looks for system bootstrap information depends on the boot field setting in the configuration register. You can change the default configuration register setting with the enabled config-mode command **config-register**. Use a hexadecimal number as the argument to this command. In this example, the configuration register is set so that the router will examine the startup file in NVRAM for boot system options. The configuration register is a 16-bit register in NVRAM. The lowest four bits of the configuration register (bits 3, 2, 1, and 0) form the boot field.

To change the boot field and leave all other bits set to their default values, follow these guidelines:

- Set the configuration register value to 0x100 if you need to enter the ROM monitor, primarily a programmer's environment. From ROM monitor, boot the operating system manually using the **b** command at the ROM monitor prompt. (This value sets the boot field bits to 0-0-0-0.)
- Set the configuration register to 0x101 to configure the system to boot automatically from ROM. (This value sets the boot field bits to 0-0-0-1.)
- Set the configuration register to any value from 0x102 to 0x10F to configure the system to use the boot system commands in NVRAM. This is the default. (These values set the boot field bits to 0-0-1-0 through 1-1-1-1.)

To check the boot field setting, for example, to verify the **config-register** command, you must use the **show version** command.

ØX INDICATES WHAT FOLLOWS IS IN HEX

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show version Command

```
Router# show version
Cisco Internetwork Operating System Software
IOS (tm) 4500 Software (C4500-J-M), Experimental Version 11.2(19960626:214907) ]
Copyright (c) 1986-1996 by cisco Systems, Inc.
Compiled Fri 28-Jun-96 16:32 by rbeach
Image text-base: 0x600088A0, data-base: 0x6076E000

ROM: System Bootstrap, Version 5.1(1) [daveu 1], RELEASE SOFTWARE (fc1)
ROM: 4500-XBOOT Bootstrap Software, Version 10.1(1), RELEASE SOFTWARE (fc1)

router uptime is 1 week, 3 days, 32 minutes
System restarted by reload
System image file is "c4500-j-mz", booted via tftp from 171.69.1.129

--More--
```

5

The **show version** command displays information about the Cisco IOS software version that is currently running on the router. This includes the boot field setting (shown on the continued example on the next page).

In the example, the Cisco IOS version and descriptive information is highlighted on the second output line. The screen captured shows an experimental version of Release 11.2.

The final line in the graphic shows the system image name. You will learn about Cisco IOS software Release 11.2 image naming conventions later in this chapter. For now, notice the portion of the filename that indicates this image is for a Cisco 4500 platform.

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show version Command (cont.)

```
cisco 4500 (R4K) processor (revision 0x00) with 32768K/16384K bytes of memory.
Processor board ID 01217941
R4600 processor, Implementation 32, Revision 1.0
G.703/E1 software, Version 1.0.
Bridging software.
SuperLAT software copyright 1990 by Meridian Technology Corp).
X.25 software, Version 2.0, NET2, BFE and GOSIP compliant.
TN3270 Emulation software (copyright 1994 by TGV Inc).
Primary Rate ISDN software, Version 1.0.
2 Ethernet/IEEE 802.3 interfaces.
48 Serial network interfaces.
2 Channelized T1/PRI ports.
128K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read/Write)
4096K bytes of processor board Boot flash (Read/Write)

Configuration register is 0x0 ( will be 0x10F at next reload )
```

6

As it continues to output, the **show version** command displays information about the type of platform where the version of Cisco IOS software is currently running.

The highlighted text provides the results of the command **config-register 0x10f**, which is used to enter configuration register values.

Note You will not see evidence of any config-register setting in output from either the **show running-config** or **show startup-config** commands.

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Bootstrap Options in Software

Flash

```
Router# configure terminal
Router(config)# boot system flash gsnew-image
[Ctrl-Z]
Router# copy running-config startup-config
```

Network

```
Router# configure terminal
Router(config)# boot system tftp test.exe 172.16.13.111
[Ctrl-Z]
Router# copy running-config startup-config
```

ROM

```
Router# configure terminal
Router(config)# boot system rom
[Ctrl-Z]
Router# copy running-config startup-config
```

- **Multiple *boot system* commands select bootstrap fallback sequence**

7

These examples show how you can enter multiple **boot system** commands to specify the fallback sequence for booting Cisco IOS software. The three examples show boot system entries that specify that a Cisco IOS image will load first from Flash memory, next from a network server, and finally from ROM.

- Flash memory

  Using this approach, you can copy a system image without changing electrically erasable programmable read-only memory (EEPROM). Information stored in Flash memory is not vulnerable to network failures that can occur when loading system images from TFTP servers.

- Network server

  To provide for a backup in case flash memory becomes corrupted, you can specify that a system image should then be loaded from a TFTP server.

- ROM

  If both Flash memory is corrupted and the network server fails to load the image, booting from ROM is the final bootstrap option in software. However, the system image in ROM will likely be a subset of Cisco IOS software, lacking the protocols, features, and configurations of full Cisco IOS software. It may also be an older version of Cisco IOS software if you have updated software since you purchased the router.

The command **copy running-config startup-config** saves the command in NVRAM. The router will execute the **boot system** commands as needed in the order in which they were originally entered into configuration mode.

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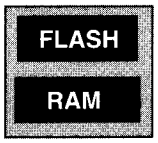
Preparing for TFTP



TFTP Server

```
Router# show flash
4096K bytes of flash memory on embedded flash (in XX).

file  offset      length        name
 0     0x40        1204637     xk09140z
  [903848/2097152 bytes free]
```

```
Router# ping tftp_address
...
!!!!!
```

```
(On the TFTP server, for example, a UNIX host)
ls gs7-j-mz.112-0.11
```

- **Check memory, access the server, and verify image name** 8

Production internetworks usually span wide areas and contain multiple routers. These geographically distributed routers need a source or backup location for software images. Using a TFTP server allows image and configuration uploads and downloads over the network.

The TFTP server can be another router, or it can be a host system. In the graphic, the TFTP server is shown as a workstation running UNIX. The host could also be a laptop computer running DOS or Windows. The TFTP host can be any system with TFTP loaded and operating that is able to contain files on the TCP/IP network.

You will be copying software between the TFPT host and Flash memory in the router. To prepare for using the TFPT server, you must check for preliminary conditions:

- Check on the router to make sure that you can see and write into Flash. Verify that the router has sufficient room in Flash to accommodate the Cisco IOS software image.
- Check on the TFTP server to make sure that you can access it over the TCP/IP network. Use the **ping** command as one method to check this.
- Check on the TFTP server to make sure you know the file or file space for the Cisco IOS software image. For upload and download operations, you will need to specify a path or filename.

It is more efficient to perform these preparation steps. These steps help ensure a successful file copy. If you rush into the file copy itself, chances are good that the copy will fail and you will have to begin troubleshooting the cause of the copy failure.

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show flash Command

```
Router# show flash
4096K bytes of flash memory sized on embedded flash.
File  name/status
 0  master/california//i11/bin/gs7-j-mz.112-0.11 [deleted]
 [0/4194304 bytes free/total]
```

- **Verify that Flash memory has room for the Cisco IOS image**

9

Use the **show flash** command to verify that you have sufficient memory on your system for the Cisco IOS software you want to load.

The example shows that the router has 4 MB of Flash, all of it free. Compare this with the length of the Cisco IOS software image. Sources for this image size may include the software order document or output from the configuration software application on the Cisco Connection Online (CCO) World Wide Web site.

If there is insufficient free memory, you will not be able to copy or load the image. If that obstacle occurs, you can either try to obtain a smaller Cisco IOS software image or increase the memory available on the router.

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Cisco IOS Naming Conventions

• Examples from 11.2—subject to change

	Hardware Product Platform	-	Feature Capabilities	-	Run Location Compressed Status
cpa25-cg-l	cpa25 CiscoPro 2500	-	cg Comm-server/ Remote Access Server, ISDN	-	l relocatable not compressed
igs-inr-l	igs Cisco IGS, 25xx, and 3xxx	-	inr IP subset, Novell IPX, and IBM base option	-	l relocatable not compressed
c4500-aj-m	c4500 Cisco 4500, 4700	-	aj APPN and Enterprise subset for low-end/midrange	-	m RAM not compressed
gs7-k-mz	gs7 Cisco 7000, 7010	-	k Enterprise for high-end range	-	mz RAM zip compressed

10

Cisco products have expanded beyond the generic router to include many plaforms at all ends of the network product spectrum.

To optimize how Cisco IOS software operates on these various platforms, Cisco is working to develop many different Cisco IOS software images. These images accommodate the various platforms, available memory resources, and feature set needs customers have for their network devices.

With Cisco IOS Release 11.2, the naming convention for Cisco IOS contains three parts.

- The first part of the image name contains the platform on which the image runs.
- The second part of the image name identifies the special capabilities of the image. A letter or series of letters identifies the feature sets supported in the image.
- The third part of the image name specifies where the image runs and if it has been "zip" compressed.

The Cisco IOS software naming conventions, name part field meaning, image content, and other details are subject to change. Refer to your sales representative, distribution channel, or Cisco Connection Online (CCO) for updated details.

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Creating a Software Image Backup

```
Router# show flash
4096K bytes of flash memory on embedded flash (in XX).

file  offset      length        name
 0     0x40        1204637     xk09140z
  [903848/2097152 bytes free]

Router# copy flash tftp
IP address of remote host [255.255.255.255]? 172.16.13.111
filename to write on tftp host? c4500-i
writing C4500-I !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
successful tftp write.
Router#
```

- **Back up current files prior to updating Flash**

11

You can copy a system image back to a network server. This copy of the system image can serve as a backup copy and also can be used to verify that the copy in Flash is the same as the original disk file.

The example uses the **show flash** command to learn the name of the system image file (xk09140z), and the **copy flash tftp** command to copy the system image to a TFTP server. The files can be renamed during transfer.

In the example, an administrator is backing up the current image to the TFTP server. One scenario for this upload to the server would be to provide a fallback copy of the current image prior to updating the image with a new version. Then, if the new version has trouble, the administrator can download the backed-up image and return to the image that was running before the update attempt.

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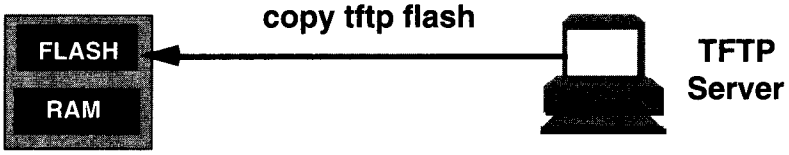
Upgrading the Image from the Net




```
Router# copy tftp flash
IP address or name of remote host [255.255.255.255]?    172.16.13.111
Name of tftp filename to copy into flash []?    c4500-aj-m
copy C4500-AJ-M from 172.16.13.111 into flash memory? [confirm]   <Return>
xxxxxxxx bytes available for writing without erasure.
erase flash before writing? [confirm]  <Return>
Clearing and initializing flash memory (please wait)####...##
Loading from 172.16.13.111: !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!(text omitted) [OK - 324572/524212 bytes]
Verifying checksum...
VVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVV
VVVVVV(text omitted)
Flash verification successful. Length = 1804637, checksum = 0xA5D3
```

- **Erase flash occurs before loading new image**

12

After you have provided for a backup copy of the current Cisco IOS software image, proceed to load a new image. Download the new image from the TFTP server using the command **copy tftp flash**.

The example shows that this command begins operation by requesting the IP address of the remote host that will act as a TFTP server. Next you are prompted for the image name of the update image. By preparing for this, you can enter the correct and appropriate filename of the update image as it is named on the TFTP server.

Following an opportunity to confirm your entries, the procedure asks if you are willing to erase Flash. This makes room for the new image. Often, there is not sufficient Flash memory for more than a single Cisco IOS image.

You have the option of erasing the existing Flash memory before writing onto it. If no free Flash memory space is available, or if the Flash memory has never been written to, the erase routine is usually required before new files can be copied. The system informs you of these conditions and prompts you for a response. Note that the Flash memory is erased at the factory before shipment.

Each exclamation point (!) means that one User Datagram Protocol (UDP) segment has successfully transferred. The series of Vs indicates successful check run verification of a segment.

Use the **show flash** command to view the file and to compare its size with that of the original on the server before changing the **boot system** commands to use the updated image. Following a successful copy, the **reload** command boots up the router as specified with the boot system using the updated image.

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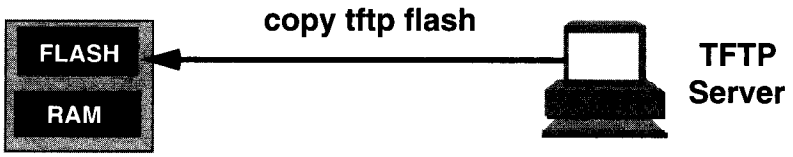
Loading a Software Image Backup




```
Router# copy tftp flash
IP address or name of remote host [255.255.255.255]?  172.16.13.111
Name of tftp filename to copy into flash []?  c4500-i
File C4500-I already exists; it will be invalidated!
Copy C4500-I from 172.16.13.111 into flash memory? [confirm] <Return>
xxxxxxxx bytes available for writing without erasure.
erase flash before writing? [confirm] <Return>
Clearing and initializing flash memory (please wait)####...##
Loading from 172.16.13.111: !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!(text omitted) [OK - 324572/524212 bytes]
Verifying checksum...
VVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVVV
VVVVVV(text omitted)
Flash verification successful. Length = 1204637, checksum = 0x95D9
```

- **Note message that image already exists**

13

If you need to load the backup Cisco IOS version, use this variation of the **copy tftp flash** command. With this variation of the command, you can download the image that you previously uploaded to the TFTP server.

Once you enter the **copy tftp flash** command, the system prompts you for the IP address (or name) of the TFTP server. This can be another router serving ROM or Flash system software images. You are then prompted for the filename of the software image. The example shows sample output from copying a system image named C4500-I into Flash memory.

If you attempt to copy a file into Flash memory that is already there, a prompt tells you that a file with the same name already exists. This file is "deleted" when you copy the new file into Flash. The first copy of the file still resides within Flash memory, but is rendered unusable in favor of the newest version, and will be listed with the *[deleted]* tag when you use the **show flash** command.

If you abort the copy process, the newer file is marked *[deleted]* because the entire file was not copied and is therefore not valid. In this case, the original file still resides within Flash memory and is available to the system.

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Summary

Routers boot Cisco IOS software from:

- **Flash**
- **TFTP server**
- **ROM (not full Cisco IOS)**

Multiple source options provide flexibility and fallback alternatives

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Lab: Checking IOS Load Options

Objective: List the commands to load Cisco IOS software from:

- **Flash memory**
- **A TFTP server**
- **ROM**

Objective: Prepare to back up, upgrade, and load a backup Cisco IOS software image.

Step 1 Press **Return** to begin.

Enter user mode with the **cisco** password.

Enter privileged mode by using the **enable** command and the **san-fran** enable password.

Step 2 Enter the **show startup-config** command at the Router# prompt.

(Use **sho config** with Cisco IOS Release 10.3 and earlier.)

Is there any indication of the configuration register setting?

Step 3 Use the commands discussed in the chapter to discover and write the following information:

Version of the Cisco IOS software:_____

Name of the Cisco IOS image file:_____

Platform type of the router:_____

Revision level of the image:_____

Memory in NVRAM:_____

Memory in RAM:_____

Step 4 Identify and write the setting of the configuration register and what boot type this setting specifies.

_____

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Step 5 What command would you use to set the config-register for the following boot types:

Boot from ROM:_____

Boot from commands in NVRAM:_____

Enter the ROM monitor:_____

Step 6 If the router is in the ROM monitor mode, what command would manually boot the Cisco IOS image?

_____

Step 7 Use the commands discussed in the chapter to discover and write the following information:

Cisco IOS image name and length:_____

Step 8 Which configuration mode commands would you use to specify an IOS image name to load from:

Flash memory:_____

A TFTP server:_____

ROM (a limited subset of the Cisco IOS):_____

Step 9 What details must you have in preparation for using a TFTP server?

_____

_____

_____

Step 10 List any attributes you can identify from fields in the Cisco IOS system image filename on your system.

_____

_____

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Step 11 Why is it a good idea to use the procedure that starts when you issue the command **copy flash tftp**?

_____

_____

_____

_____

Step 12 How can you tell if you are loading a software backup image of Cisco IOS software rather than a new image?

_____

_____

Step 13 **(Optional)** Repeat the discovery process you tried in step 3 on some other different router in class. Note any differences you discover.

_____

_____

Step 14 **(Optional)** Check for additional information about the memory on your router using the following Cisco IOS commands:

show memory

show stacks

show buffers

Step 15 To exit from this lab, enter the **exit** command at the Router# prompt.

Good work!

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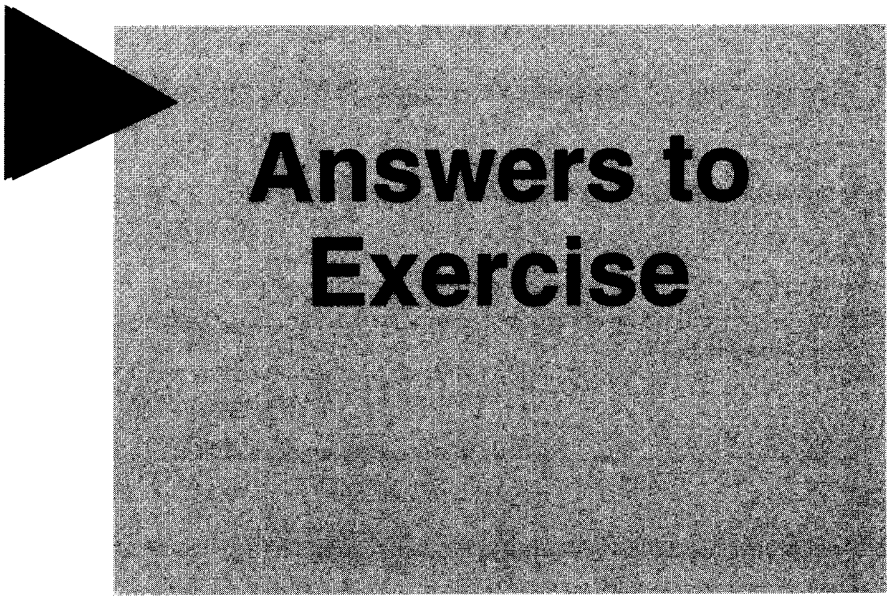

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Answers to Exercise

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Lab: Checking IOS Load Options

Step 5

Boot from ROM: **config-register 0x101**

Boot from commands in NVRAM: a command in the range **config-register 0x102** to **config-register 0x10f**

Enter the ROM monitor: **config-register 0x100**

Step 6

b

Step 8

Flash memory: **boot system flash**

A TFTP server: **boot system tftp**

ROM: **boot system rom**

Step 9

- IP address of TFTP server
- Software image name and path
- Assurance of enough Flash memory

Step 10

- Hardware product platform (for example, Cisco 4500)
- Feature capabilities (for example, IP subset with IPX and IBM base option)
- Run location (for example, relocatable or run in RAM); compressed image or not compressed

Note: These examples are from Cisco IOS Release 11.2 and are subject to change.

Step 11

This command stores a copy of your running config on the TFTP server, so it is available if you need to restore it later.

Step 12

If you are loading a backup image, Cisco IOS software displays a message indicating the image already exists.

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