CHAPTER 4

Configuring the Software

This chapter briefly describes procedures for configuring the router, and contains the following sections:

- Booting the Router for the First Time
- Passwords
- Configuring the Router for the First Time
- Cisco IOS Software Basics
- If You Need More Information

This chapter provides minimum software configuration information; it is not intended as complete router configuration instructions. Detailed software configuration information is available in the Cisco IOS configuration guide and command reference publications. These publications are available on the documentation CD that accompanied your order or you can order printed copies.

Booting the Router for the First Time

Each time you power on the router, it goes through the following boot sequence:

1. The router goes through power-on self-test diagnostics to verify basic operation of the CPU, memory, and interfaces.
2. The system bootstrap software executes and searches for a valid Cisco IOS image (router operating system software). The source of the Cisco IOS image (Flash memory or a Trivial File Transfer Protocol [TFTP] server) is determined by the configuration

register setting. The factory-default setting for the configuration register is 0x2102, which indicates that the router should attempt to load a Cisco IOS image from Flash memory.

3. If after five attempts a valid Cisco IOS image is not found in Flash memory, the router reverts to boot ROM mode (which is used to install or upgrade a Cisco IOS image).
4. If a valid Cisco IOS image is found, then the router searches for a valid configuration file.
5. If a valid configuration file is not found in NVRAM, the router runs the System Configuration Dialog so you can configure it manually. For normal router operation, there must be a valid Cisco IOS image in Flash memory and a configuration file in NVRAM.

The first time you boot your router, you will need to configure the router interfaces and then save the configuration to a file in NVRAM. See the section "Configuring the Router for the First Time" or refer to the configuration note for the appropriate module for interface configuration information. See the section "Saving Configuration Changes" later in this chapter for information on how to save the router configuration to NVRAM.

Passwords

Because many privileged-level EXEC commands are used to set operating parameters, you should password-protect access to privileged mode to prevent unauthorized use.

You can set two passwords to do this:

- The enable password, a less secure nonencrypted password.
- The enable secret password, a very secure encrypted password that is used in place of the enable password if it exists.

The enable password and enable secret password must be different. In both cases, a number cannot be the first character. Spaces are also valid password characters; for example, "two words" is a valid password. Leading spaces are ignored; trailing spaces are recognized.

For information about setting passwords, refer to the Cisco IOS configuration guides and command references. You can also set these passwords using the setup facility. See the section "Using the System Configuration Dialog" later in this chapter.

If you lose or forget your enable password, see the section “Recovering a Lost Enable Password” in the appendix “Troubleshooting.” The enable secret password is encrypted, and cannot be recovered; you must replace it with a new enable secret password.

Configuring the Router for the First Time

You can configure the router using one of the following procedures, which are described in this section:

- System Configuration Dialog—Recommended if you are not familiar with Cisco IOS commands.
- Configuration mode—Recommended if you are familiar with Cisco IOS commands.
- AutoInstall—Recommended for automatic installation if another router running Cisco IOS software is installed on the network. This configuration method must be set up by someone with experience using Cisco IOS software.

Proceed with the procedure that best fits the needs of your network configuration and Cisco IOS software experience level.

Timesaver Acquire the correct network addresses from your system administrator or consult your network plan to determine the correct addresses before you begin to configure the router.

If you will be using configuration mode or AutoInstall to configure the router, and you would like a quick review of the Cisco IOS software, refer to the section “Cisco IOS Software Basics” later in this chapter.

Using the System Configuration Dialog

If you do not plan to use AutoInstall, make sure all the WAN cables are disconnected from the router. The router will attempt to run AutoInstall whenever you power it on if there is a WAN connection on both ends and the router does not have a configuration file stored in NVRAM. It can take several minutes for the router to determine that AutoInstall is not connected to a remote Transmission Control Protocol/Internet Protocol (TCP/IP) host.

If your router does not have a configuration (setup) file and you are not using AutoInstall, the router will automatically start the setup command facility. An interactive dialog called the System Configuration Dialog appears on the console screen. This dialog helps you navigate through the configuration process by prompting you for the configuration information necessary for the router to operate.

Many prompts in the System Configuration Dialog include default answers, which are included in square brackets following the question. To accept a default answer, press **Return**; otherwise, enter your response.

This section gives an example configuration using the System Configuration Dialog. When you are configuring your router, respond as appropriate for your network.

At any time during the System Configuration Dialog, you can request help by typing a question mark (?) at a prompt.

Before proceeding with the System Configuration Dialog, obtain from your system administrator the node addresses and the number of bits in the subnet field (if applicable) of the router ports. For more information about IP addresses and subnets, refer to the *Internetworking Technology Overview* publication.

Note You can run the System Configuration Dialog any time you are at the privileged EXEC prompt (#) by entering the **setup** command.

Take the following steps to configure the router using the System Configuration Dialog:

Step 1 Connect a console terminal to the console port on the front panel of your router, and then power ON the router. (For more information, refer to the section "Connecting the Console Terminal and Modem" in the chapter "Installing the Router.")

Note The default parameters for the console port are 9600 baud, 8 data bits, no parity, and 2 stop bits.

Step 2 After about 30 seconds, information similar to the following is displayed on the console screen:

Note The messages displayed vary, depending on the interfaces on the rear panel of the router and the Cisco IOS release and feature set you selected. The screen displays in this section are for reference only and may not exactly reflect the screen displays on your console.

```
System Bootstrap, Version X.X(X) [XXXXX XXX], RELEASE SOFTWARE
Copyright (c) 1994-199X by cisco Systems, Inc.
C3600 processor with 16384 Kbytes of main memory
Main memory is configured to 64 bit mode with parity disabled
program load complete, entry point: 0x80008000, size: 0x30277c
Self decompressing the image :
################################################
################################################################################
##############
################################################################################
##############
#################### [OK]
Restricted Rights Legend

Use, duplication, or disclosure by the Government is
subject to restrictions as set forth in subparagraph
(c) of the Commercial Computer Software - Restricted
Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

           Cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706


Cisco Internetwork Operating System Software
IOS (tm) 3600 Software (XXXX-X-X), Version XX.X (XXX)_[XXXX XXX]
Copyright (c) 1986-199X by cisco Systems, Inc.
Compiled Mon 01-Jul-9X 21:38 by XXXXX
Image text-base: 0x60008890, data-base: 0x605CA000
```

```
cisco 3640 (R4700) processor (revision 0x00) with 12288K/4096K bytes
of memory.
Processor board ID 00000000
R4700 processor, Implementation XX, Revision X.X
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).
Basic Rate ISDN software, Version X.X.
1 Ethernet/IEEE 802.3 interface.
1 Token Ring/IEEE 802.5 interface.
1 Serial network interface.
1 ISDN Basic Rate interface.
DRAM configuration is 64 bits wide with parity disabled.
125K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read/Write)

Notice: NVRAM invalid, possibly due to write erase.
         --- System Configuration Dialog ---

At any point you may enter a question mark '?' for help.
Refer to the 'Getting Started' Guide for additional help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.
Would you like to enter the initial configuration dialog? [yes]:
```

Step 3 Press **Return** or enter **yes** to begin the configuration process.

Step 4 When the System Configuration Dialog asks whether you want to view the current interface summary, press **Return** or enter **yes**:

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

Any interface listed with OK? value “NO” does not have a valid
configuration

Interface      IP-Address    OK?   Method   Status   Protocol
BRI0/0         unassigned    NO    unset    up       up
Ethernet0/0    unassigned    NO    unset    up       down
Serial0/0      unassigned    NO    unset    down     down
TokenRing0/0   unassigned    NO    unset    reset    down
```

Step 5 Configure the global parameters. A typical configuration follows:

```
Configuring global parameters:

  Enter host name [Router]:
```

Next, you are prompted to enter an enable secret password. There are two types of privileged-level passwords:

- Enable secret password (a very secure, encrypted password)
- Enable password (a less secure, nonencrypted password)

The enable password is used when the enable secret password does not exist.

For maximum security, be sure the passwords are different. If you enter the same password for both, the router will accept your entry, but will display a warning message indicating that you should enter a different password.

Step 6 Enter an enable secret password:

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

  Enter enable secret: pail

The enable password is used when there is no enable secret
and when using older software and some boot images.
```

Step 7 Enter the enable and virtual terminal passwords:

```
Enter enable password: shovel
Enter virtual terminal password: vterm1
```

Step 8 Press **Return** to accept Simple Network Management Protocol (SNMP) management, or enter **no** to refuse it:

```
Configure SNMP Network Management? [yes]: no
```

Step 9 In the following example, the router is configured for AppleTalk, Internet Protocol (IP), and Internetwork Packet Exchange (IPX). Configure the appropriate protocols for your router:

```
Configure Vines? [no]:
Configure LAT? [no]:
Configure AppleTalk? [no]: yes
  Multizone networks? [no]: yes
Configure DECnet? [no]:
Configure IP? [yes]:
  Configure IGRP routing? [yes]:
  Your IGRP autonomous system number [1]: 15
Configure CLNS? [no]:
Configure bridging? [no]:
Configure IPX? [no]: yes
Configure XNS? [no]:
Configure Apollo? [no]:
```

Step 10 If your router includes an ISDN BRI port, enter the ISDN BRI switch type. The switch type appropriate for the router depends on the ISDN service provider's equipment. Table 4-1 lists the ISDN switch types.

```
Enter ISDN BRI Switch Type [none]: basic-5ess
```

Table 4-1 ISDN Switch Types

Country	ISDN Switch Type	Description
Australia	basic-ts013	Australian TS013 switches
Europe	basic-1tr6	German 1TR6 ISDN switches
	basic-nwnet3	Norwegian NET3 ISDN switches (phase 1)
	basic-net3	NET3 ISDN switches (UK and others)
Europe	basic-net5	NET5 switches (UK and Europe)
	vn2	French VN2 ISDN switches
	vn3	French VN3 ISDN switches

Table 4-1 ISDN Switch Types (Continued)

Country	ISDN Switch Type	Description
Japan	ntt	Japanese NTT ISDN switches
New Zealand	basic-nznet3	New Zealand NET3 switches
North America	basic-5ess	AT&T basic rate switches
	basic-dms100	NT DMS-100 basic rate switches
	basic-ni1	National ISDN-1 switches

Configuring the ISDN BRI Interface

This section describes how to configure the ISDN BRI interface. If your router does not include an ISDN BRI interface, proceed to the next section, "Configuring Ethernet Interfaces."

The ISDN BRI interface is configured to allow connection to ISDN WANs. Determine which protocols to support on the ISDN BRI interface and enter the appropriate responses. In the following example, the system is being configured for IP, AppleTalk, and IPX:

```
Configuring interface BRI0/0:
Is this interface in use? [yes]
Configure IP on this interface? [yes]
IP address for this interface: 172.16.71.1
Number of bits in subnet field [0]: 8
Class B network is 172.16.0.0, 8 subnet bits; mask is
    255.255.255.0
  Configure AppleTalk on this interface? [no]: yes
    Extended AppleTalk network? [no]: yes
    AppleTalk starting cable range [0]: 1
    AppleTalk ending cable range [1]: 2
    AppleTalk zone name [myzone]:
    AppleTalk additional zone name: otherzone
    AppleTalk additional zone name:
  Configure IPX on this interface? [no]: yes
    IPX network number [1]: B000
```

Configuring Ethernet Interfaces

The Ethernet interfaces are configured to allow connection to a LAN. To configure the interface parameters, you need to know the Ethernet interface network addresses.

Take the following steps to configure an Ethernet interface to allow communication over a LAN:

Step 1 Press **Return** or enter **yes** to configure the LAN interface:

```
Configuring interface Ethernet0/0:
  Is this interface in use? [yes]:
```

Step 2 Determine which protocols you want to support on the LAN interface and enter the appropriate responses. In the following example, the system is being configured for IP, AppleTalk, and IPX:

```
  Configure IP on this interface? [yes]:
    IP address for this interface: 172.16.72.1
    Number of bits in subnet field [8]: 8
    Class B network is 172.16.0.0, 8 subnet bits; mask is
    255.255.255.0
  Configure AppleTalk on this interface? [no]: yes
    Extended AppleTalk network? [no]: yes
    AppleTalk starting cable range [0]: 3
    AppleTalk ending cable range [1]: 3
    AppleTalk zone name [myzone]:
    AppleTalk additional zone name: otherzone
    AppleTalk additional zone name:
  Configure IPX on this interface? [no]: yes
    IPX network number [1]: B001
```

Step 3 If there is more than one LAN interface on your router, repeat this procedure to configure the second and subsequent LAN interfaces.

Configuring Token Ring Interfaces

The Token Ring interfaces are configured to allow connection to a LAN. To configure the interface parameters, you need to know the Token Ring interface network addresses.

Take the following steps to configure a Token Ring interface to allow communication over a LAN:

Step 1 Press **Return** or enter **yes** to configure the LAN interface:

```
Configuring interface TokenRing0/0:
   Is this interface in use? [yes]:
   Tokenring ring speed (4 or 16) ? [16]:
```

Step 2 Determine which protocols you want to support on the LAN interface and enter the appropriate responses. In the following example, the system is being configured for IP, AppleTalk, and IPX:

```
  Configure IP on this interface? [yes]:
    IP address for this interface: 172.16.73.1
    Number of bits in subnet field [8]: 8
    Class B network is 172.16.0.0, 8 subnet bits; mask is
    255.255.255.0
  Configure AppleTalk on this interface? [no]: yes
    Extended AppleTalk network? [no]: yes
    AppleTalk starting cable range [0]: 4
    AppleTalk ending cable range [1]: 4
    AppleTalk zone name [myzone]:
    AppleTalk additional zone name: otherzone
    AppleTalk additional zone name:
  Configure IPX on this interface? [no]: yes
    IPX network number [1]: B002
```

Step 3 If there is more than one LAN interface on your router, repeat this procedure to configure the second and subsequent LAN interfaces.

Configuring Serial Interface

The serial interfaces are configured to allow connection to WANs through a CSU/DSU. All serial ports are initially configured as synchronous ports. After the initial configuration is completed, configure the serial ports you plan to use as asynchronous ports using the **physical-layer** command in configuration mode.

Take the following steps to configure the serial port(s):

Step 1 Press **Return** or enter **yes** to configure serial port 0 in slot 0:

```
Configuring interface Serial0/0:
  Is this interface in use? [yes]:
```

Step 2 Determine which protocols you want on the synchronous serial interface and enter the appropriate responses. In the following example, the system is being configured for IP, AppleTalk, and IPX:

```
  Configure IP on this interface? [yes]:
  Configure IP unnumbered on this interface? [no]:
    IP address for this interface: 172.16.74.1
    Number of bits in subnet field [8]:
    Class B network is 172.16.0.0, 8 subnet bits; mask is
    255.255.255.0
  Configure AppleTalk on this interface? [no]: yes
    Extended AppleTalk network? [yes]:
    AppleTalk starting cable range [2]: 5
    AppleTalk ending cable range [3]: 5
    AppleTalk zone name [myzone]: ZZ Serial
    AppleTalk additional zone name:
  Configure IPX on this interface? [no]: yes
    IPX network number [2]: B003
```

Step 3 If there is more than one serial interface on your router, repeat this procedure to configure the remaining serial interfaces.

Step 4 The configuration you entered is now displayed and you are asked if you want to use the displayed configuration. If you enter **no**, you will lose the configuration information you just entered and you can begin the configuration again. If you enter **yes**, the configuration will be entered and saved in the startup configuration:

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


Press RETURN to get started!
```

If you have asynchronous serial, T1, or E1 interfaces installed in your router, proceed to the section "Additional Startup Configuration Tasks."

Refer to the section "Cisco IOS Software Basics" for more information about the Cisco IOS software.

Additional Startup Configuration Tasks

When you have completed the setup facility, you might need to complete some additional configuration tasks. Complete the following tasks that apply to your installation:

- Setting Asynchronous Serial Ports
- Setting Synchronous Serial Ports
- Setting Half-Duplex Mode
- Configuring T1 Interfaces
- Configuring E1 Interfaces

Setting Asynchronous Serial Ports

The ports you plan to use as low-speed asynchronous serial ports must be reconfigured after the initial setup.

Take the following steps to configure a synchronous serial port to be an asynchronous serial port:

Step 1 At the privileged EXEC prompt enter the **config terminal** command to enter configuration mode:

```
Router# config terminal
```

Step 2 Enter the **interface** command to select the port you are configuring:

```
interface serial 1/4
```

Step 3 Enter the **physical-layer** command to change the port to asynchronous:

```
physical-layer async
```

Step 4 Enter the IP address, the asynchronous mode, and the routing method:

```
ip address 172.16.2.2 255.0.0.0
async mode dedicated
asnync default routing
```

Step 5 When you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

Step 6 Write the new configuration to memory, as follows:

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

The system displays a confirmation message when the configuration is saved.

Step 7 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 8 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to configure a synchronous serial interface for asynchronous operation.

Setting Synchronous Serial Ports

Use this procedure if it is necessary to set a serial port previously configured for asynchronous operation back to synchronous operation.

Take the following steps to configure a low-speed asynchronous serial port to be a low-speed synchronous serial port:

Step 1 Enter the **config terminal** command at the privileged EXEC prompt to enter configuration mode:

```
Router# config terminal
```

Step 2 Enter the **interface** command to select the port you are configuring:

```
interface serial 1/4
```

Step 3 Enter the **physical-layer** command to set the port to synchronous:

```
physical-layer sync
```

Step 4 When you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

Step 5 Write the new configuration to memory, as follows:

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

The system displays a confirmation message when the configuration is saved.

Step 6 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 7 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to configure an asynchronous serial interface for synchronous operation.

Setting Half-Duplex Mode

Low-speed serial ports that are set as DCE can be set to use either controlled carrier mode or constant carrier mode.

Controlled carrier mode sets the interface to deactivate data carrier detect (DCD) until a transmission is sent to the interface. DCD is then activated, and the interface waits an amount of time you configure, and then transmits the data. After the transmission, the interface waits for a period of time and then deactivates DCD.

Constant carrier mode (the default for low-speed interfaces) activates DCD at all times.

Take the following steps to enable controlled carrier mode:

Step 1 Enter the **config terminal** command at the privileged EXEC prompt to enter configuration mode:

```
Router# config terminal
```

Step 2 Enter the **half-duplex** command to reset the port from constant carrier mode to controlled carrier mode:

```
interface serial 1/4
half-duplex controlled carrier
```

Step 3 Enter the **no half-duplex** command to return to constant carrier mode:

```
interface serial 1/4
no half-duplex controlled carrier
```

Step 4 Enter the **half-duplex timer** command to specify the time that the interface delays when in controlled carrier mode. For example, to configure the DCD drop delay, enter the following commands, using appropriate values for your system:

```
interface serial 1/4
half-duplex timer dcd-drop-delay 100
```

The amount of time is specified in milliseconds.

Step 5 Enter the **timer** command to tailor the delay times for the router ports. Table 4-2 lists the **timer** commands and their default settings.

Table 4-2 Half-Duplex Timer Commands

Timer	Syntax	Default Setting (Milliseconds)
CTS[1] delay	**half-duplex timer cts-delay**	100
CTS drop timeout	**half-duplex timer cts-drop-timeout**	5000
DCD drop delay	**half-duplex timer dcd-drop-delay**	100
DCD transmission start delay	**half-duplex timer dcd-txstart-delay**	100
RTS[2] drop delay	**half-duplex timer rts-drop-delay**	100
RTS timeout	**half-duplex timer rts-timeout**	2000
Transmit delay	**half-duplex transmit-delay**	0

1. CTS = Clear to send.
2. RTS = Ready to send.

Step 6 When you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

Step 7 Write the new configuration to memory, as follows:

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

The system displays a confirmation message when the configuration is saved.

Step 8 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 9 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to set half-duplex mode in a serial interface.

Configuring T1 Interfaces

If your router includes a CT1/PRI (or CT1/PRI-CSU) module, you must enter configuration mode to configure the interfaces.

This procedure can also be used to change the configuration of an existing CT1/PRI module or to configure a CT1/PRI module newly installed in an existing system. If you replaced a CT1/PRI module that was previously configured, the system will recognize the new module and bring it up with the existing configuration.

Use the privileged-level **configure** command to configure the new module. Have the following information ready when you begin your configuration:

- T1 information—for example, clock source, line code, and framing type
- Channel-group information and time-slot mapping
- Protocols and encapsulations you plan to use on the new interfaces
- IP addresses if you will configure the interfaces for IP routing
- Whether the new interface will use bridging

Take the following steps to complete a basic T1 configuration:

Step 1 At the privileged EXEC prompt, enter the **configure terminal** command to enter configuration mode and specify that the console terminal will be the source of the configuration commands:

```
Router# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
```

Step 2 Enter the **controller t1** command to specify the slot number and unit number of the module you are configuring. For more information on slot and unit numbers, refer to the sections “Slot Numbering” and “Unit Numbering” in the chapter “Overview.” For example, if you are configuring a T1 interface in slot 1 and that is unit 0, enter the following command:

```
Router(config)# cont t1 1/0
```

Step 3 Specify the clock source for the module. The **clock source** command determines which end of the circuit provides the clocking:

```
Router(config-controller)# clock source line
```

Note The clock source should only be set to use the internal clocking for testing the network or if the full T1 line is used as the channel group. Only one end of the T1 line should be set to internal.

Step 4 Specify the **framing** type:

```
Router(config-controller)# framing esf
```

Step 5 Specify the line code format:

```
Router(config-controller)# linecode b8zs
Router(config-controller)#
%CONTROLLER-3-UPDOWN: Controller T1 1, changed state to up
Router(config-controller)#
```

Step 6 Specify the channel group and time slots to be mapped. The command shown sets the channel group to 0 and time slots 1, 3 through 5, and 7 are selected for mapping.

```
Router(config-controller)# channel-group 0 timeslots 1,3-5,7
Router(config-controller)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0:0,
changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0:0,
changed state to up Router(config-controller)#
Router(config-controller)#
```

Step 7 Specify the serial interface, unit number, and channel group you want to modify:

```
Router(config-controller)# int serial 1/0:0
```

Step 8 Assign an IP address and subnet mask to the interface using the **ip address** command as follows, substituting the appropriate IP address and subnet mask for your site:

```
Router(config-if)# ip address 1.1.15.1 255.255.255.0
Router(config-if)#
```

Step 9 Add any additional configuration commands required to enable routing protocols and adjust the interface characteristics. Refer to the Cisco IOS configuration guides and command references for more information on configuration subcommands.

Step 10 When you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

Step 11 Write the new configuration to memory, as follows:

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

The system displays a confirmation message when the configuration is saved.

Step 12 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 13 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to configure a CT1/PRI interface.

Configuring E1 Interfaces

If your router includes a CE1/PRI module (balanced or unbalanced), you must enter configuration mode to configure the interface.

This procedure can also be used to change the configuration of an existing CE1/PRI module or to configure a CE1/PRI module newly installed in an existing system. If you replaced a CE1/PRI module that was previously configured, the system will recognize the new module and bring it up with the existing configuration.

When you have verified that the new CE1/PRI module is recognized by the router, use the privileged-level **configure** command to configure the new CE1/PRI module. Have the following information ready when you begin your configuration:

- E1 information—for example, line code and framing type
- Channel-group information and time-slot mapping
- Protocols and encapsulations you plan to use on the new interfaces
- IP addresses if you will configure the interfaces for IP routing
- Whether the new interface will use bridging

Take the following steps to complete a basic E1 configuration.

Step 1 At the privileged EXEC prompt, enter the **configure terminal** command to enter configuration mode and specify that the console terminal will be the source of the configuration commands:

```
Router# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
```

Step 2 Enter the **controller e1** command to specify the slot and unit number of the E1 interface you are configuring. For more information on slot and unit numbers, refer to the sections “Slot Numbering” and “Unit Numbering” in the chapter “Overview.” For example, if you are configuring an E1 interface that is in slot 1 and that is unit 0, enter the following command:

```
Router(config)# cont e1 1/0
```

Step 3 Specify the framing type:

```
Router(config-controller)# framing crc4
```

Step 4 Specify the channel group and time slots to be mapped. The command shown below sets the channel group to 0 and time slots 1, 3 through 5, and 7 are selected for mapping:

```
Router(config-controller)# channel-group 0 timeslots 1,3-5,7
Router(config-controller)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1:0, changed
state to down %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial1:0, changed state to up Router(config-controller)#
Router(config-controller)#
```

Step 5 Specify the serial interface, unit number, and channel group you want to modify:

```
Router(config-controller)# int serial 1/0:0
```

Step 6 Assign an IP address and subnet mask to the interface using the **ip address** command as follows, substituting the appropriate IP address and subnet mask for your site:

```
Router(config-if)# ip address 1.1.15.1 255.255.255.0
Router(config-if)#
```

Step 7 Add any additional configuration subcommands required to enable routing protocols and adjust the interface characteristics. Refer to the Cisco IOS configuration guides and command references for more information on configuration subcommands.

Step 8 When you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

Step 9 Write the new configuration to memory, as follows:

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

The system displays a confirmation message when the configuration is saved.

Step 10 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 11 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to configure a CE1/PRI interface.

Configuring the Router Using Configuration Mode

When you install a new module or WAN interface card, or if you want to change the configuration of an existing interface, you must enter configuration mode to configure the interfaces. If you replace a module or card that was already configured, the router recognizes it and brings up the interfaces in the existing configuration.

Before you configure an interface, have the following information available:

- Protocols you plan to route on each new interface
- IP addresses if you will configure the interfaces for IP routing
- Whether the new interfaces will use bridging
- Timing source for each new interface and clock speeds for external timing

Take the following steps to configure the router manually:

Step 1 Connect a console by following the instructions in the section "Console Port" in the chapter "Installing the Router," and power ON the router.

Step 2 When asked if you would like to enter the initial dialog, answer **no**:

```
Would you like to enter the initial dialog? [yes]: no
```

You now enter the normal operating mode of the router.

Step 3 After a few seconds you see the user EXEC prompt (Router>). Type **enable** to enter privileged EXEC mode:

```
Router> enable
```

Configuration changes can be made only in privileged EXEC mode. The prompt changes to the privileged EXEC (enable) prompt (Router#):

```
Router#
```

Step 4 Enter the **config terminal** command to enter configuration mode:

```
Router# config terminal
```

You can now enter changes to the configuration, one command per line. For information about configuration commands, refer to the Cisco IOS configuration guides and command references.

Step 5 When you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

To see the current operating configuration, including any changes you just made, enter the **show running-config** command at the privileged EXEC prompt:

```
Router# show running-config
```

To see the configuration currently stored in NVRAM, enter the **show startup-config** command at the privileged EXEC prompt.

```
Router# show startup-config
```

The results of the **show running-config** and **show startup-config** commands differ from each other if you have made changes to the configuration and have not yet written them to NVRAM.

To write your changes to NVRAM, making them permanent, enter the **copy running-config startup-config** command at the privileged EXEC prompt:

```
Router# copy running-config startup-config
Building configuration. . .
[OK]
Router#
```

The router is now configured to boot using the new configuration.

Configuring the Router Using AutoInstall

The AutoInstall process is designed to configure the router automatically after connection to your WAN. In order for AutoInstall to work properly, a TCP/IP host on your network must be configured to provide the required configuration files.

The TCP/IP host can reside anywhere on the network as long as the following two conditions are satisfied:

1. The host must be on the remote side of the router's synchronous serial connection to the WAN.
2. User Datagram Protocol (UDP) broadcasts to and from the router and the TCP/IP host must be enabled.

This functionality is coordinated by your system administrator at the site where the TCP/IP host is located. You should not attempt to use AutoInstall unless the required files have been installed on the TCP/IP host.

Take the following steps to prepare your router for the AutoInstall process:

Step 1 Attach the appropriate WAN cable to the router.

Step 2 Power ON the router.

The router loads the operating system image from Flash memory. If the remote end of the WAN connection is connected and properly configured, the AutoInstall process begins.

Step 3 If AutoInstall succeeds, you may want to write the configuration data to the router's NVRAM. To do this, enter the **copy running-config startup-config** command at the # prompt:

```
Hostname# copy running-config startup-config
```

This step saves the configuration settings that the AutoInstall process created. If you fail to do this, the new configuration will be lost the next time you reload the router.

Cisco IOS Software Basics

This section provides you with some basic information about the Cisco IOS software and includes the following sections:

- Cisco IOS Modes of Operation
- Getting Context-Sensitive Help
- Saving Configuration Changes
- Checking and Saving Your Settings
- Network Statistics

Cisco IOS Modes of Operation

Cisco IOS software provides access to several different command modes. Each command mode provides a different group of related commands.

For security purposes, Cisco IOS software provides two levels of access to commands: user and privileged. The unprivileged user mode is called user EXEC mode. The privileged mode is called privileged EXEC mode and requires a password. The commands available in user EXEC mode are a subset of the commands available in privileged EXEC mode.

Table 4-3 describes some of the most commonly used modes, how to enter the modes, and the resulting prompts. The prompt helps you identify which mode you are in and, therefore, which commands are available to you.

Table 4-3 Cisco IOS Operating Modes

Mode of Operation	Usage	How to Enter the Mode	Prompt
User EXEC	User EXEC commands allow you to connect to remote devices, change terminal settings on a temporary basis, perform basic tests, and list system information. The EXEC commands available at the user level are a subset of those available at the privileged level.	Log in.	Router>
Privileged EXEC	Privileged EXEC commands set operating parameters. The privileged command set includes those commands contained in user EXEC mode, and also the **configure** command through which you can access the remaining command modes. Privileged EXEC mode also includes high-level testing commands, such as **debug**.	From user EXEC mode, enter the **enable** EXEC command.	Router#
Global configuration	Global configuration commands apply to features that affect the system as a whole.	From global configuration mode, enter the **configure** privileged EXEC command.	Router(config)#

Table 4-3 Cisco IOS Operating Modes (Continued)

Mode of Operation	Usage	How to Enter the Mode	Prompt
Interface configuration	Interface configuration commands modify the operation of an interface such as an Ethernet, Token Ring, or serial port. Many features are enabled on a per-interface basis. Interface configuration commands always follow an interface global configuration command, which defines the interface type.	From global configuration mode, enter the **interface** *type number* command. For example, enter the **interface serial 0** command to configure the serial 0 interface.	Router(config-if)#
ROM monitor	ROM monitor commands are used to perform low-level diagnostics. You can also use the ROM monitor commands to recover from a system failure and stop the boot process in a specific operating environment.[1]	From privileged EXEC mode, enter the **reload** EXEC command. Press **Break** during the first 60 seconds while the system is booting.	rommon>

1. You can modify the configuration register value using the **config-reg** configuration command. Refer to the appendix "ROM Monitor" for more information.

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

Getting Context-Sensitive Help

In any command mode, you can get a list of available commands by entering a question mark (**?**).

```
Router> ?
```

To obtain a list of commands that begin with a particular character sequence, enter those characters followed immediately by the question mark (**?**). Do not include a space. This form of help is called word help, because it completes a word for you.

```
Router# co?
configure  connect  copy
```

To list keywords or arguments, enter a question mark in place of a keyword or argument. Include a space before the question mark. This form of help is called command syntax help, because it reminds you which keywords or arguments are applicable based on the command, keywords, and arguments you have already entered.

```
Router# configure ?
  memory    Configure from NV memory
  network   Configure from a TFTP network host
  terminal  Configure from the terminal
  <cr>
```

You can also abbreviate commands and keywords by entering just enough characters to make the command unique from other commands. For example, you can abbreviate the **show** command to **sh**.

Saving Configuration Changes

Any time you make changes to the router configuration, you must save the changes to memory because if you do not, they will be lost if there is a system reload or power outage. There are two types of configuration files: the running (currently operating) configuration and the startup configuration. The running configuration is stored in RAM; the startup configuration is stored in NVRAM.

To display the current running configuration, enter the **show running-config** command. Enter the **copy running-config startup-config** command to save the current running configuration to the startup configuration file in NVRAM.

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

To display the startup configuration, enter the **show startup-config** command. Enter the **copy startup-config running-config** command to write the startup configuration to the running configuration:

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

To erase both configuration files (and start over), enter the **write erase** and **reload** commands:

```
Router> enable
Router# write erase
Router# reload
```

Caution This command sequence will erase the entire router configuration in RAM and NVRAM and reload the router.

Checking and Saving Your Settings

To check the settings you have configured, enter the **show running-config** command at the enable (#) prompt:

```
Router# show running-config
```

To store the configuration, enter the **copy running-config startup-config** command at the enable (#) prompt:

```
Hostname# copy running-config startup-config
```

This command saves the configuration settings that the setup process created. If you fail to do this, your new configuration will be lost the next time you reload the router.

Network Statistics

When you have finished configuring the network interfaces, use the **show interface** command to check network interface statistics. Options to the **show interface** command include the following:

- *interface*—the type of interface (for example, serial)
- *number*—the unit and slot number of the interface, separated by a slash (/)

The following example shows the output of the **show interface serial 0/0** command:

```
Router> show interface serial 0/0

Serial0/0 is administratively down, line protocol is down
  Hardware is QUICC Serial
  Internet address is 172.16.74.1/24
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive set (10 sec)
  Last input never, output never, output hang never
  Last clearing of “show interface” counters never
  Input queshowue: 0/75/0 (size/max/drops); Total output drops: 0
  Output queue: 0/64/0 (size/threshold/drops)
     Conversations  0/0 (active/max active)
     Reserved Conversations 0/0 (allocated/max allocated)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 16 interface resets
     0 output buffer failures, 0 output buffers swapped out
     0 carrier transitions
```

To display the current internal status of a module, use the **show controller** command with the *interface number* options. The following example shows the output of the **show controller serial 0/1** command:

```
Router> show controller serial 0/1

Interface Serial0/1
Hardware is Quicc 68360
idb at 0x60879DA8, driver data structure at 0x6087E140
SCC Registers:
General [GSMR]=0x2:0x00380000, Protocol-specific [PSMR]=0x0
Events [SCCE]=0x0000, Mask [SCCM]=0x0000, Status [SCCS]=0x0000
Transmit on Demand [TODR]=0x0, Data Sync [DSR]=0x7E7E
Interrupt Registers:
Config [CICR]=0x00C9CF00, Pending [CIPR]=0x00000000
Mask   [CIMR]=0xA0000000, In-srv  [CISR]=0x00000000
SDMA Registers:
[SDSR]=0x00000000, [SDAR]=0x00010428, [SDCR]=0x00000772
Command register [CR]=0x640
Port A [PADIR]=0x0130, [PAPAR]=0xFFFF
       [PAODR]=0x0000, [PADAT]=0xD8FF
Port B [PBDIR]=0x0011FF, [PBPAR]=0x00100E
       [PBODR]=0x000000, [PBDAT]=0x00FF7C
Port C [PCDIR]=0x0000, [PCPAR]=0x020E
       [PCSO]=0x0030,  [PCDAT]=0x0DFF, [PCINT]=0x0001
Receive Ring
        rmd(3C010020): status 9000 length 600 address C84E44
        rmd(3C010028): status 9000 length 600 address C85484
        rmd(3C010030): status 9000 length 600 address C85AC4
        rmd(3C010038): status 9000 length 600 address C86104
        rmd(3C010040): status 9000 length 600 address C86744
        rmd(3C010048): status 9000 length 600 address C86D84
        rmd(3C010050): status 9000 length 600 address C873C4
        rmd(3C010058): status 9000 length 600 address C87A04
        rmd(3C010060): status 9000 length 600 address C88044
        rmd(3C010068): status 9000 length 600 address C88684
        rmd(3C010070): status 9000 length 600 address C88CC4
        rmd(3C010078): status 9000 length 600 address C89304
        rmd(3C010080): status 9000 length 600 address C89944
        rmd(3C010088): status 9000 length 600 address C89F84
        rmd(3C010090): status 9000 length 600 address C8A5C4
        rmd(3C010098): status B000 length 600 address C8AC04
```

```
Transmit Ring
        tmd(3C0100A0): status 0 length 0 address 0
        tmd(3C0100A8): status 0 length 0 address 0
        tmd(3C0100B0): status 0 length 0 address 0
        tmd(3C0100B8): status 0 length 0 address 0
        tmd(3C0100C0): status 0 length 0 address 0
        tmd(3C0100C8): status 0 length 0 address 0
        tmd(3C0100D0): status 0 length 0 address 0
        tmd(3C0100D8): status 0 length 0 address 0
        tmd(3C0100E0): status 0 length 0 address 0
        tmd(3C0100E8): status 0 length 0 address 0
        tmd(3C0100F0): status 0 length 0 address 0
        tmd(3C0100F8): status 0 length 0 address 0
        tmd(3C010100): status 0 length 0 address 0
        tmd(3C010108): status 0 length 0 address 0
        tmd(3C010110): status 0 length 0 address 0
        tmd(3C010118): status 2000 length 0 address 0
No serial cable attached
SCC GENERAL PARAMETER RAM (at 0x3C010C00)
Rx BD Base [RBASE]=0x20, Fn Code [RFCR]=0x18
Tx BD Base [TBASE]=0xA0, Fn Code [TFCR]=0x18
Max Rx Buff Len [MRBLR]=1536
Rx State [RSTATE]=0x0, BD Ptr [RBPTR]=0x20
Tx State [TSTATE]=0x4000, BD Ptr [TBPTR]=0xA0
SCC HDLC PARAMETER RAM (at 0x3C010C38)
CRC Preset [C_PRES]=0xFFFF, Mask [C_MASK]=0xF0B8
Errors: CRC [CRCEC]=0, Aborts [ABTSC]=0, Discards [DISFC]=0
Nonmatch Addr Cntr [NMARC]=0
Retry Count [RETRC]=0
Max Frame Length [MFLR]=1524
Rx Int Threshold [RFTHR]=1, Frame Cnt [RFCNT]=1
User-defined Address 0000/0000/0000/0000
User-defined Address Mask 0x0000
buffer size 1524
QUICC SCC specific errors:
0 input aborts on receiving flag sequence
0 throttles, 0 enables
0 overruns
0 transmitter underruns
0 transmitter CTS losts
Router>
```

Note that in this example, the cable type is shown as *no cable*. If a cable is attached to the port, the cable type is shown, as in the following example:

```
buffer size 2108  Universal Serial: DTE V.24 (RS-232) cable
```

If the cable is DCE, the output of the **show controller** command displays the clock rate. For complete command descriptions and instructions, refer to the Cisco IOS configuration guides and command references.

If You Need More Information

If you need more information, refer to the publications that shipped with the router:

- Information packet
- *Regulatory Compliance and Safety Information* document, which provides international regulatory compliance information

The router runs Cisco IOS software. The Cisco IOS configuration guides and command references are available in the following forms:

- As printed publications
- On the documentation CD-ROM
- At the World Wide Web URL http://www.cisco.com