CHAPTER 5

Software Configuration

This chapter describes the procedures for configuring Cisco IOS software for Cisco 4000 series routers, and it contains the following sections:

- Powering Up the Router
- Booting the Router for the First Time
- Using the Enable Secret and the Enable Passwords
- Configuring the Router
- Additional Configuration Tasks
- Checking the Router Configuration
- Saving the Router Configuration
- If You Need More Information

To configure your router, you need to connect a terminal or PC running terminal emulation software to the router. Configuration requires access to the console port.

Powering Up the Router

Caution Never operate the router unless the chassis is completely closed to ensure adequate cooling.

Take the following steps to power up the router:

Step 1 If you have an AC-powered system, plug the system power cord into a 3-terminal, single-phase power source that provides power within the acceptable range (100–240 VAC, 50–60 Hz, 3.0–1.5A).

Step 2 If you have a DC-powered system, make sure to connect the input power supply as described in the section "DC-Input Power Supply Connection" in the chapter "Router Installation."

Warning This product relies on the building's installation for short-circuit (overcurrent) protection. Ensure that a fuse or circuit breaker no larger than 120 VAC, 15A U.S. (240 VAC, 10A international) is used on the phase conductors (all current-carrying conductors).

Step 3 Turn ON the system power switch. The LED labeled POWER on the front panel should go on.

Step 4 Verify that the OK LED on the right side of the front panel goes ON after a few seconds delay.

Booting the Router for the First Time

You configure Cisco 4000 series routers using the Cisco command interpreter, which is called the EXEC. 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 EXEC mode and privileged EXEC mode.

To enter the privileged mode you must enter the enable secret password.

Using the Enable Secret and the Enable Passwords

The commands available in user EXEC mode are a subset of those available in privileged EXEC mode. Because many privileged-level EXEC commands are used to set operating parameters, you should password-protect these commands to prevent unauthorized use.

You use two commands to do this:

- **enable secret** *password* (which is a very secure, encrypted password)
- **enable** *password* (which is a less secure, or nonencrypted password)

You must enter an enable secret password to gain access to privileged-level commands.

For maximum security, the passwords should be different. If you enter the same password for both during the setup script, the system will accept it, but you will receive a warning message indicating that you should enter a different password.

An enable secret password can contain from 1 to 25 uppercase and lowercase alphanumeric characters; an enable password can contain any number of uppercase and lowercase alphanumeric characters. 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.

Configuring the Router

You can configure the router following the procedures described in one of the following sections:

- Configuring the Router Using Configuration Mode
- Configuring the Router Using AutoInstall
- Configuring the Router Manually Using the Setup Facility

Follow the procedure that best fits the needs of your network configuration.

Note You will need to obtain the correct network addresses from your system administrator or consult your network plan to determine correct addresses before you can complete the router configuration.

Before continuing the configuration process, check the current state of the router by entering the **show version** command. The show version command will display the release of Cisco IOS software that is available on the router.

Configuring the Router Using Configuration Mode

You can configure the router manually if you prefer not to use the setup facility or AutoInstall. Take the following steps to configure the router manually:

Step 1 Connect a console terminal by following the instructions in the section "Console Port and Auxiliary Port Connection Considerations" in the chapter "Cable Connection" and then power up the router to the EXEC prompt (Router>).

Step 2 When you are asked if you would like to enter the initial dialog, answer **no** to go into the normal operating mode of the router:

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

Step 3 After a few seconds you will see the user EXEC prompt (Router>). Enter the **enable** command to enter enable mode. You can only make configuration changes in enable mode:

```
Router> enable
```

The prompt will change to the enable prompt, indicated by the "#" sign:

```
Router#
```

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

```
Router# config terminal
```

You can now enter any changes to the configuration that you want to make. Press **Ctrl-Z** to exit configuration mode.

To see the currently operating configuration, enter the command **show running-config** at the enable prompt:

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

To see the configuration in nonvolatile random-access memory (NVRAM), enter the command **show config** at the enable prompt.

```
Router# show config
```

To make your changes permanent, enter the command **copy running-config startup-config** at the enable prompt:

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

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

The router is now configured and will boot with the configuration you have entered.

Configuring the Router Using AutoInstall

The AutoInstall process is designed to configure the router automatically after connection to your WAN. This process is useful when you must configure the router over serial 0.

In order for AutoInstall to work properly, a Transmission Control Protocol/Internet Protocol (TCP/IP) host on your network must be preconfigured to provide the required configuration files. The TCP/IP host may exist anywhere on the network as long as the following conditions are maintained:

- The host must be on the remote side of the router's synchronous serial connection to the WAN.

- 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 synchronous serial cable to the router.

Step 2 Turn ON power to the router.

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

If the AutoInstall completes successfully, you might want to write the configuration data to the router's NVRAM. Perform the next step to complete this task.

Step 3 At the enable prompt, enter the **copy running-config startup-config** command:

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

Taking this step will save the configuration settings that the AutoInstall process created in the router. If you fail to do this, your configuration will be lost the next time you reload the router.

Configuring the Router Manually Using the Setup Facility

If you do not plan to use AutoInstall, do not connect the router's serial (WAN) cable to the channel service unit/data service unit (CSU/DSU). The router will attempt to run AutoInstall whenever you start it if the serial (WAN) connection is connected on both ends and the router does not have a configuration stored in NVRAM. It can take several minutes for the router to determine that AutoInstall is not set up to a remote TCP/IP host.

Once the router has determined that AutoInstall is not configured, it will default to the setup facility. If the serial (WAN) cable is not connected, the router will boot from Flash memory and go into the setup facility.

Note You can run the setup facility any time you are at the enable prompt by entering the **setup** command.

Configuring the Global Parameters

When you first start the setup program you must configure the global parameters, which are used for controlling system-wide settings.

Note The screen displays shown in this section may vary from those displayed on your console terminal, depending on the configuration of your router.

Take the following steps to enter the global parameters:

Step 1 Connect a console terminal by following the instructions in the section "Console Port Connections" in the chapter "Cable Connection," and then power up the router to the EXEC prompt (Router>).

Step 2 When you have booted from Flash memory, copyright and router hardware information will be displayed on the console screen after about 30 seconds. After the router hardware information is displayed, you will see a message similar to the following. When you see this information displayed, you have successfully booted your router.

```
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 '[]'.
```

Step 3 Enter **yes** (the default) or press **Return** when you are asked if you would like to enter the configuration dialog and if you would like to see the current interface summary.

```
Would you like to enter the initial configuration dialog? [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
Ethernet0    unassigned      NO   not set    up      down
Ethernet1    unassigned      NO   not set    down    down
Serial0      unassigned      NO   not set    down    down
Serial1      unassigned      NO   not set    down    down
Serial2      unassigned      NO   not set    down    down
Serial3      unassigned      NO   not set    down    down
```

Step 4 Choose which protocols to support on your first Ethernet interface. For IP-only installations, you can accept the default values for most of the questions. A typical configuration using IP, Internetwork Packet Exchange (IPX), and AppleTalk follows:

```
Configuring global parameters:

  Enter host name [Router]: router
```

Step 5 Enter the enable secret password, the enable password, and the virtual terminal password:

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

  Enter enable secret : shovel

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

  Enter enable password : trowel
    Enter virtual terminal password: pail
```

Enter **yes** or **no** to accept or refuse Simple Network Management Protocol (SNMP) management:

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

SNMP is the most widely supported open standard for network management. It provides a means to access and set configuration and run-time parameters of routers and communication servers. SNMP defines a set of functions that can be used to monitor and control network elements.

Step 6 If you are using IP routing, you must also select an interior routing protocol. You can specify only one of two interior routing protocols to operate on your system using the setup facility, Interior Gateway Routing Protocol (IGRP) or Routing Information Protocol (RIP).

Enter **yes** (the default) or press **Return** to configure IP, and then select an interior routing protocol for IP:

```
Configure IP? [yes]:
  Configure IGRP routing? [yes]:
    Your IGRP autonomous system number [1]: 15
```

Step 7 Respond to the prompts as follows to enable routing on IPX and AppleTalk; IP has already been selected:

```
Configure IPX? [no]: yes

Configure AppleTalk? [no]: yes
    Multizone networks? [no]: yes

Configure LAT? [yes]: no
```

Step 8 If your router has an ISDN network processor module installed, you will be prompted to select the switch type for your router. The ISDN switch type appropriate for your router depends on the ISDN provider's equipment. Table 5-1 lists the ISDN switch types.

Enter the ISDN switch type:

```
Enter ISDN BRI Switch Type [none]: basic-ni1
```

Table 5-1 ISDN BRI Switch Types

ISDN Switch Type	Description
basic-1tr6	German 1TR6 ISDN switches
basic-5ess	AT&T basic rate switches
basic-dms100	NT DMS-100 basic rate switches
basic-net3	NET3 ISDN switches (U. K. and others)
basic-ni1	National ISDN-1 switches
basic-nwnet3	Norwegian NET3 ISDN switches (phase 1)
basic-nznet3	New Zealand NET3 ISDN switches
basic-ts013	Australian TS013 switches
none	Switch type not defined
ntt	Japanese NTT ISDN switches
vn2	French VN2 ISDN switches
vn3	French VN3 ISDN switches

This completes the procedure to configure the global parameters.

Additional Configuration Tasks

When you have completed the setup facility, you might need to complete some additional configuration tasks. See the following sections:

- Configuring the Ethernet Interface
- Configuring the T1 Interface
- Configuring the E1 Interface
- Configuring the ISDN BRI Interface
- Configuring the ATM Network Processor Module Interface
- Configuring the Synchronous Serial Interfaces

- Configuring the Asynchronous/Synchronous Serial Interfaces
- Configuring G.703/G.704 Interfaces

Configuring the Ethernet Interface

If your router has an Ethernet network processor module installed, you need to configure the Ethernet ports.

Take the following steps to configure the Ethernet interfaces:

Step 1 Respond as follows to the prompts, substituting the correct IP address and number of subnet bits for your site. In the following example, the system is being configured for an Ethernet LAN using IP.

```
Configuring interface parameters:

Configuring interface Ethernet0:
  Is this interface in use? [yes]:
 Configure IP on this interface? [yes]:
    IP address for this interface: 172.16.72.1
    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
```

Step 2 Enter **yes** if you will be using AppleTalk on the interface, enter **yes** to configure for extended AppleTalk networks, and then enter the cable range number, the zone name, and any other additional zones that will be associated with your local zone:

```
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:
```

Step 3 If you are going to enable IPX on this interface, enter the unique IPX network number:

```
Configure IPX on this interface? [no]: yes
    IPX network number [1]: B001
Configure XNS on this interface? [no]
```

Step 4 Repeat Step 1 through Step 3 to configure each Ethernet interface in your router.

You must also select the type of media connection to the module by entering media-type commands in the router's configuration file. For NP-1E, NP-2E, or NP-6E modules, enter one of the following for each Ethernet interface on the router:

```
media-type aui
```

or

```
media-type 10baset
```

For NP-FE modules, select one of the following for each Fast Ethernet interface on the router

```
media-type 100baset
```

or

```
media-type mii
```

The following is an example of configuring the Ethernet 0 interface for an AUI connection:

```
router> ena
Password:
router# configure terminal
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
interface ethernet 0
media-type aui
^z
router# write memory
```

For more information about the **media-type** command, refer to the Cisco IOS configuration guides and command references.

Configuring the T1 Interface

If you installed a new channelized T1/ ISDN PRI (CT1/PRI) network processor module, or if you want to change the configuration of an existing network processor module, you must enter configuration mode to configure or reconfigure the interface. If you replaced a CT1/PRI module that was previously configured, the system will recognize the new CT1/PRI module and bring it up with the existing configuration.

When you have verified that the new CT1/PRI module is recognized by the router, use the **configure** command to configure the new CT1/PRI module. Have the following information ready when you begin your configuration:

- T1 information—for example, clock source, line code, and framing type
- Channel group and time-slot mapping
- Protocols and encapsulations you plan to use on the new interfaces
- Internet protocol (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-level prompt, enter the **configuration 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 unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section “Unit Numbering” in the chapter “Cable Connection.” For example, if you are configuring unit number 1, enter the following command:

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

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, changed
state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1:0, 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
```

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 10.1.15.1 255.255.255.0
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# write memory
```

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 channelized T1 interface.

Configuring the E1 Interface

If you installed a new channelized E1/ISDN PRI (CE1/PRI) network processor module or if you want to change the configuration of an existing network processor module, you must enter configuration mode to configure or reconfigure the interface. If you replaced a CE1/PRI module that was previously configured, the system will recognize the new CE1/PRI 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 **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 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-level prompt, enter the **configuration 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 unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section "Unit Numbering" in the chapter "Cable Connection." For example, if you are configuring unit number 1, enter the following command:

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

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
```

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 10.1.15.1 255.255.255.0
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# write memory
```

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 channelized E1 interface.

Configuring the ISDN BRI Interface

If your router has a ISDN BRI network processor module installed, you need to configure the ISDN BRI ports.

The BRI interface is configured to allow connection to ISDN WANs through an NT1 device.

Take the following steps to configure the BRI interfaces:

Step 1 Respond as follows to the prompts, substituting the correct IP address and number of subnet bits for your site:

```
Configuring interface BRI0:
  Is this interface in use? [yes]:
  Configure IP on this interface? [yes]:
    IP address for this interface: 172.16.21.15
    Number of bits in subnet field [0]:
```

```
    Class B network is 172.16.0.0, 8subnet bits; mask is
255.255.255.0
```

Step 2 Repeat Step 1 for each BRI interface installed in your router.

Configuring the ATM Network Processor Module Interface

If you installed a new ATM network processor module or if you want to change the configuration of an existing module, you must enter the configuration mode. If you replaced an ATM network processor module that was previously configured, the system will recognize the new module and bring it up in the existing configuration.

When you have verified that the new ATM network processor module is recognized by the router, use the privileged-level **configure** command to configure the new module. You should have available the following information:

- ATM transceiver framing type (STS-3c, STM-1, DS-3, or E3)
- Network protocol addresses
- Permanent virtual circuit (PVC) connections and their attributes
- Static address mappings (address lists)

The following steps describe a basic ATM configuration using just PVCs. Press **Return** after each step.

Step 1 At the privileged-level prompt (Router #), enter configuration mode and specify that the console terminal will be the source of the configuration commands:

```
Router# conf t
```

Step 2 Specify the unit to configure by entering the **int atm** command and the unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section "Unit Numbering" in the chapter "Making External Connections to the Cisco 4000 Series." The following example is for an ATM module with unit number 0:

```
Router(config)# int atm 0
```

Step 3 Specify the framing type.

If you are using a SONET interface, there is only one framing type, STM-1, which is the default and need not be entered:

```
Router(config-if)# atm sonet stm-1
```

If you are specifying the framing type for an E3 interface, there are two framing types: G.751 ADM (entered as g751adm) and G.832 ADM (entered as g832adm).

```
Router(config-if)# atm framing g832adm
```

If you are specifying the framing type for a DS-3 interface, there are three framing types: C-bit PLCP (entered as cbitplcp), M23 ADM (entered as m23adm) and M23 PLCP (entered as m23plcp).

```
Router(config-if)# atm framing m23adm
```

Step 4 Assign protocol addresses to the interface:

```
Router(config-if)# ip address 10.1.15.1 255.255.255.0
```

Step 5 Create the PVCs. A PVC requires the whole path from source to destination to be set up manually. If there are any switches in the path, they have to be properly configured also. The command has the format **atm pvc** *vc-id vpi vci encap* [*peak-rate sustained-rate burst-size*]:

```
Router(config-if)# atm pvc 1 1 32 aal5snap
Router(config-if)# atm pvc 2 1 33 aal5snap
```

Note Virtual channel identifier (VCI) values 0–31 are reserved by ITU-T and the ATM Forum.

Step 6 Assign the appropriate map list to the interface:

```
Router(config-if)# map-group list1
```

Step 7 Enable the interface:

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

Step 8 Create the mapping of protocol addresses to PVCs. Map lists are used to assign protocol addresses to virtual circuits (VCs):

```
Router(config-if)# map-list list1
Router(config-map-list)# ip 1.1.1.2 atm-vc 1 broadcast
Router(config-map-list)# ip 1.1.1.3 atm-vc 2 broadcast
```

Step 9 Press **Ctrl-Z** to complete the configuration.

Step 10 Write the new configuration to memory:

```
Router# write memory
```

Step 11 Exit the privileged level and return to the user level:

```
Router# disable
```

The following example shows a basic configuration using switched virtual circuits (SVCs). Press **Return** after each step.

Step 1 At the privileged-level prompt (Router #), enter configuration mode and specify that the console terminal will be the source of the configuration commands:

```
Router# conf t
```

Step 2 Specify the unit to configure by entering the command **int atm** and the unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section "Unit Numbering" in the chapter "Making External Connections to the Cisco 4000 Series." The following example is for an ATM module with unit number 0:

```
Router(config)# int atm 0
```

Step 3 Specify the framing type.

If you are using a SONET interface, there is only one framing type, STM-1, which is the default and need not be entered:

```
Router(config-if)# atm sonet stm-1
```

If you are specifying the framing type for an E3 interface, there are two framing types: G.751 ADM (entered as g751adm) and G.832 ADM (entered as g832adm).

```
Router(config-if)# atm framing g832adm
```

If you are specifying the framing type for a DS-3 interface, there are three framing types: C-bit PLCP (entered as cbitplcp), M23 ADM (entered as m23adm) and M23 PLCP (entered as m23plcp).

```
Router(config-if)# atm framing m23adm
```

Step 4 Assign protocol addresses to the interface:

```
Router(config-if)# ip address 10.1.15.1 255.255.255.0
```

Step 5 Create the signaling PVC, which is required by the signaling software to communicate with a switch in order to dynamically set up SVCs. In the following example, signaling virtual channel 1 uses VPI 0 and VCI 5:

```
Router(config-if)# atm pvc 1 0 5 qsaal
```

Step 6 Configure the ATM network service access point (NSAP) address:

```
Router(config-if)# atm nsap-address nsap-addr
```

where *nsap-addr* could be:

```
AB.CDEF.01.234567.890A.BCDE.F012.3456.7890.1234.12
```

Step 7 Assign the appropriate map list to the interface:

```
Router(config-if)# map-group list2
```

Step 8 Enable the interface:

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

Step 9 Create the mapping of protocol addresses to ATM NSAP addresses, as follows:

```
Router(config-if)# map-list list2
Router(config-map-list)# ip 10.1.15.1 nsap-addr nsap-addr broadcast
Router(config-map-list)# ip 10.1.15.1 nsap-addr nsap-addr broadcast
```

Step 10 Press **Ctrl-Z** to complete the configuration.

Step 11 Write the new configuration to memory:

```
Router# write memory
```

Step 12 Exit the privileged level and return to the user level:

```
Router# disable
```

Configuring the Synchronous Serial Interfaces

If you have a serial network processor module installed, you need to configure the synchronous serial interfaces to allow connection to WANs through a CSU/DSU. Take the following steps to configure the serial ports:

Step 1 Determine which protocols you will allow on the synchronous serial interface and enter the appropriate responses:

```
Configure IP unnumbered on this interface? [no]: no
    IP address for this interface: 172.16.73.1
    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]: 3
    AppleTalk ending cable range [3]: 3

    AppleTalk zone name [myzone]: ZZ Serial
    AppleTalk additional zone name:

Configure IPX on this interface? [no]: yes
    IPX network number [2]: B000
```

Step 2 Repeat Step 1 for the remaining serial interfaces.

The following sections describe the commands for configuring an external clock signal for a data communications equipment (DCE) interface and for configuring a port for NRZI encoding or 32-bit cyclic redundancy check (CRC). Configuration commands are executed from the privileged level of the EXEC command interpreter. (For G.703/G.704 interface configuration, see the section “Configuring G.703/G.704 Interfaces” later in this chapter.)

Configuring Timing (Clock) Signals for Serial Interfaces

All interfaces support both data terminal equipment (DTE) and DCE modes, depending on the mode of the interface cable attached to the port. To use a port as a DTE interface, connect a DTE adapter cable to the port. When the system detects the DTE mode cable, it automatically uses the external timing signal. To use a port in DCE mode, you must connect a DCE interface cable and set the clock speed with the **clockrate** command. This section describes how to set the clock rate on a DCE port and, if necessary, how to invert the clock to correct a phase shift between the data and clock signals.

Note Serial ports configured as DCE must also be configured with the **clockrate** command. An error message will be generated if there is a mismatch between the cable and the software configuration of the port—for example, if the cable is DTE and the clock rate is set, or if the cable is DCE and the clock rate is not configured.

Setting the Clock Rate on Serial Interfaces

All DCE interfaces require a noninverted internal transmit clock signal, which is generated by the serial module. The default operation on a DCE interface is for the DCE device to generate its own transmit clock signal (TXC) and send it to the remote DTE. The remote DTE device returns the clock signal to the DCE. The **clockrate** command specifies the rate as a bits-per-second value. In the following example, the clock rate for the top serial interface on a dual-port serial module is defined as 72 kbps:

```
interface serial 1
clockrate 72000
```

Use the **no clockrate** command to remove the clock rate for DTE operation. Following are the acceptable clock rate settings:

1200	125000
2400	148000
4800	500000
9600	800000
19200	1000000
38400	1300000
56000	2000000
64000	4000000
72000	

Speeds above 64 kbps (64000) are not supported for EIA/TIA-232. On all interface types, if your cable is too long, faster speeds might not work.

Inverting the Clock Signal on Serial Interfaces

Systems that use long cables may experience high error rates when operating at higher transmission speeds. Slight variances in cable construction, temperature, and other factors can cause the clock and data signals to shift out of phase. If a DCE port is reporting a high number of error packets, the problem might be caused by a phase shift. Inverting the clock can often correct this shift.

When a port is operating in DCE mode, the default operation is for the attached DTE device to return the serial clock transmit external (SCTE) to the DCE port. The DCE sends serial clock transmit (SCT) and serial clock receive (SCR) clock signals to the DTE, and the DTE returns an SCTE clock signal to the DCE. If the DTE device does not return SCTE, you must use the **dce-terminal-timing-enable** command to configure the DCE port to use its own clock signal instead of the SCTE signal that would normally be returned from the DTE device.

To configure an interface to accept the internal clock generated by the serial module instead of the SCTE clock that is normally returned by the DTE device, specify the interface followed by the **dce-terminal-timing-enable** command. In the example that follows, the serial 0 port is configured to accept the internal clock signal:

```
interface serial 0
dce-terminal-timing-enable
```

To turn off this command, use the **no dce-terminal-timing-enable** command.

When the serial port is a DTE, the **invert-txc** command inverts the TXC clock signal it receives from the remote DCE. When the serial port is a DCE, this command inverts the clock signal to the remote DTE port. Use the **no invert-txc** command to change the clock signal back to its original phase. The **no invert-txc** command is redundant with the four-port serial module because the module will automatically discover the polarity of the clock and invert the signal.

If the network processor module is operating as DTE in NRZI mode, the sense of the **dte-invert-timing** command must be manually changed. For instance, if the command **no dte-invert-timing** was previously entered in the configuration file, then **dte-invert-timing** must be configured for the module to operate as DTE in NRZI mode.

Configuring NRZI Format on Serial Interfaces

All interfaces support both nonreturn to zero (NRZ) and NRZI formats. Both formats use two different voltage levels for transmission. NRZ signals maintain constant voltage levels with no signal transitions (no return to a zero voltage level) during a bit interval and are decoded using absolute values (0 and 1). NRZI uses the same constant signal levels but interprets the presence of data at the beginning of a bit interval as a signal transition and the absence of data as no transition. NRZI uses differential encoding to decode signals, rather than determining absolute values.

NRZ format, the factory default on all interfaces, is the most common. NRZI format is commonly used with EIA/TIA-232 connections in IBM environments. To enable NRZI encoding on any interface, specify the port address of the interface followed by the command **nrzi-encoding**. In the example that follows, serial port 0 is configured for NRZI encoding:

```
router# configure terminal
interface serial 0
nrzi-encoding
^Z
```

To disable NRZI encoding on a port, specify the port and use the **no nrzi-encoding** command. Refer to the Cisco IOS configuration guides and command references for complete command descriptions and instructions.

Calculating CRCs on Cisco 4000 Series Serial Interfaces

On Cisco 4000 series routers, all serial interfaces support CRC-ITU-T, a 16-bit cyclic redundancy check (CRC). CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data. The sender of a data frame divides the bits in the frame by a predetermined number to calculate a remainder or *frame check sequence* (FCS). Before it sends the frame, the sender appends the FCS value to the message so that the frame contents are exactly divisible by the predetermined number. The receiver divides the frame contents by the same predetermined number. If the result is not 0, the receiver assumes that a transmission error occurred and sends a request to the sender to resend the frame.

The designator *16* indicates the number of check digits per frame that are used to calculate the FCS. CRC-16, which transmits streams of 8-bit characters, generates a 16-bit FCS. Both the sender and the receiver must use the same setting of *16*.

The default for all serial interfaces is for 16-bit CRC.

Configuring the Asynchronous/Synchronous Serial Interfaces

If you have a NP-2T16S serial network processor module installed, the ports you plan to use for asynchronous operation must be reconfigured after the initial setup. The following steps provide an example of how to configure a synchronous serial port to be an asynchronous serial port.

Step 1 Enter the command **config terminal** to enter configuration mode:

```
Router# config terminal
Router(config)#
```

The router enters global configuration mode, indicated by the Router(config)# prompt.

Step 2 Select the serial interface to configure:

```
Router(config)# interface serial 2
Router(config-if)#
```

The prompt changes again to show that you are in interface configuration mode.

Step 3 Because all serial ports are initially configured as synchronous, you must change the port to asynchronous operation by entering the **physical-layer** command:

```
Router(config-if)# physical-layer async
```

Configure other asynchronous parameters according to your needs, for example:

```
Router(config-if)# async mode dedicated
Router(config-if)# async default routing
```

Step 4 To configure asynchronous line settings, use the **line async** command. A serial port's line number is related to its slot number and unit number in the following way:

line-number = (16 x *slot-number*) + *unit-number* + 1

For example, serial port 1/2 corresponds to line number (16 x 1) + 2 + 1 = 19. To set this port to a speed of 115200 bps, you would enter the following commands:

```
Router(config-if)# line async 2
Router(config-if)# speed 115200
```

Note Future releases of Cisco IOS will support automatic line configuration. Existing asynchronous ports will be renumbered according to a different line numbering convention.

To return an asynchronous port to synchronous operation, use the configuration mode **physical-layer sync** command.

Step 5 If 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.

Note For older versions of software, use the **write mem** command to write the new configuration to memory.

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.

Note On Step 2, the serial interface numbers for the low-speed ports can be 2–17 or 20–35 as previously described in Table 4-4.

Configuring G.703/G.704 Interfaces

This section describes how to configure individual interfaces for framed or unframed mode, four-bit CRC, loopback, and for specifying a clock source.

When you have verified that the new G.703/G.704 network processor modules are installed correctly (the enabled LED goes on), use the privileged-level **configure** command to configure the new interfaces.

Be prepared with the information you will need, such as the following:

- Timing source for each new interface (a line-derived or internal clock signal)
- Whether you will use framed or unframed mode on E1-G.703/G.704 interfaces

The following are the default settings for all E1-G.703/G.704 interfaces; each can be enabled or disabled:

- Unframed mode
- No CRC enabled
- Time slot 16 is not used for payload
- No loopback

- Clock source operation (line or internal)

Note Always enter the **clear interface** command after altering the configuration of an interface, particularly after changing a time slot or CRC-4 setting.

Configuring Framed and Unframed Mode for E1-G.703/G.704 Interfaces

The E1-G.703/G.704 interfaces support both framed (G.704) and unframed (G.703) modes of operation; the default is for unframed operation. To enable framed operation, you must specify the start and stop slots. Following is a sample display of the **timeslot** command with a start slot of 1 and a stop slot of 13:

```
router# timeslot 1-13
```

Invalid combinations of start and stop slots will be ignored and the interface will be left unchanged.

The system default is not to use time slot 16 for data. To use slot 16 for data, use the **timeslot 16** command. To restore the system default, use the **no timeslot 16** command.

Configuring Timing (Clock) Signals for E1-G.703/G.704 Interfaces

The E1-G.703/G.704 port operates either with an external clock signal that it recovers from the received data stream (the default clocking) or with its own internal clock signal. To specify the clock source, use the **clock source** {**line** | **internal**} command.

To change the default and use the internal clock, use the **clock source internal** command.

To return the interface to the default state, use the **clock source line** command. (You can also negate either of these commands to change a setting; for example, the **no clock source internal** command also returns the interface to the default state.) All E1-G.703/G.704 interfaces operate at a default clock rate of 2.048 Mbps; the clock rate cannot be configured.

Configuring CRC-4 for E1-G.703/G.704 Interfaces

CRC-4 is a 4-bit error checking technique that uses a calculated numeric value to perform an ongoing data integrity check and detect errors in transmitted data. The E1-G.703/G.704 network processor module supports CRC in framed mode only. By default, CRC-4 is not enabled.

To enable CRC-4 on the E1 interface, specify the port address of the interface followed by the command **crc4**. Press **Ctrl-Z** after altering the configuration and before exiting the configuration mode. In the example that follows, *serial port 3* on an E1-G.703/G.704 network processor module is configured for CRC:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router (config)# interface serial 3
(config-if)# crc4
(config-if)# ^Z
```

To disable CRC and return to the default of no CRC error checking, specify the port and use the **no crc4** command. For complete command descriptions and instructions refer to the Cisco IOS configuration guides and command references.

Checking the Router Configuration

When you have configured the serial interfaces, use the **show interface** command to check the network interface statistics. Options to the **show interface** command include the type of interface (for example, *serial*), and the unit number of the interface. The following example shows the output of **show interface** *serial 0*:

```
router> show interface serial 0

Serial 0 is up, line protocol is up
  Hardware is HD64570
  Internet address is 193.195.74.236, subnet mask is 255.255.255.248
  MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive not set
  Last input 0:00:01, output 0:00:10, 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 0 bits/sec, 0 packets/sec
  Five minute output rate 0 bits/sec, 0 packets/sec
     2922 packets input, 5844 bytes, 0 no buffer
```

```
Received 0 broadcasts, 0 runts, 0 giants
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
145 packets output, 185562 bytes, 0 underruns
0 output errors, 0 collisions, 1 interface resets, 0 restarts
880 carrier transitions
```

The field *underrun* in the output of the **show interface** command may be nonzero in approximately one of 250,000 packets.

To display the current internal status of a network processor module, use the **show controller** command with the *interface type and unit* number options. (Note in the following example that universal serial means the four-port serial module.) The following is the output of the **show controller serial 2** command:

```
router# show controller s 2
HD unit 2, idb 0x246AAC, ds 0x248240
buffer size 2108  Universal Serial: No cable
DCD=0  DSR=0  DTR=0  RTS=0  CTS=0
cpb = 0x4, eda = 0xDA18, cda = 0xD798
RX ring with 32 entries at 0x604D798
00 bd_ptr=0xD798 pak=0x604E728 ds=0x604E87C status=80 pak_size=0
01 bd_ptr=0xD7AC pak=0x604EEAC ds=0x604F000 status=80 pak_size=0
02 bd_ptr=0xD7C0 pak=0x604F630 ds=0x604F784 status=80 pak_size=0
(some screen output deleted)
32 bd_ptr=0xDA18 pak=0x605D7A8 ds=0x605D8FC status=80 pak_size=0
cpb = 0x4, eda = 0xE1E0, cda = 0xE1E0
TX ring with 8 entries at 0x604E1E0
00 bd_ptr=0xE1E0 pak=0x000000 ds=0x000000 status=80 pak_size=0
01 bd_ptr=0xE1F4 pak=0x000000 ds=0x000000 status=80 pak_size=0
02 bd_ptr=0xE208 pak=0x000000 ds=0x000000 status=80 pak_size=0
03 bd_ptr=0xE21C pak=0x000000 ds=0x000000 status=80 pak_size=0
04 bd_ptr=0xE230 pak=0x000000 ds=0x000000 status=80 pak_size=0
05 bd_ptr=0xE244 pak=0x000000 ds=0x000000 status=80 pak_size=0
06 bd_ptr=0xE258 pak=0x000000 ds=0x000000 status=80 pak_size=0
07 bd_ptr=0xE26C pak=0x000000 ds=0x000000 status=80 pak_size=0
08 bd_ptr=0xE280 pak=0x000000 ds=0x000000 status=80 pak_size=0
0 missed datagrams, 0 overruns, 0 bad frame addresses
0 bad datagram encapsulations, 0 memory errors
0 transmitter underruns
```

Note that the cable type is shown as *no cable*. If a cable is attached to the port, the cable type would be 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.

Saving the Router Configuration

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

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

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

If You Need More Information

The Cisco IOS software running your router contains extensive features and functionality. The effective use of many of these features is easier if you have more information at hand. The complete Cisco IOS documentation set is included on the Dcoumentation CD-ROM shipped with the router. The same information is also available on the World Wide Web at http://www.cisco.com.

The Documentation CD is updated and shipped monthly, so it might be more current than printed documentation. To order the Documentation CD, contact your local sales representative or call Customer Service. The CD is available both as a single CD and as an annual subscription.