Configuring the Switch for the First Time

This chapter describes how to initially configure a Catalyst 4500 series switch.

The information presented here supplements the administration information and procedures in this publication: *Cisco IOS Configuration Fundamentals Command Reference*, Release 12.2SR, at this URL:

http://www.cisco.com/en/US/docs/ios/12_2/configfun/command/reference/frfabout.html

This chapter includes the following major sections:

Note For complete syntax and usage information for the switch commands used in this chapter, look at the *Cisco Catalyst 4500 Series Switch Command Reference* and related publications at this location:

http://www.cisco.com/en/US/products/hw/switches/ps4324/index.html

If the command is not found in the Catalyst 4500 Command Reference, it is located in the larger Cisco IOS library. Refer to the *Catalyst 4500 Series Switch Cisco IOS Command Reference* and related publications at this location:

http://www.cisco.com/en/US/products/ps6350/index.html

Default Switch Configuration

This section describes the default configurations for the Catalyst 4500 series switch. Table 3-1 shows the default configuration settings for each feature.

Table 3-1 Default Switch Configuration

Feature	Default Settings
Administrative connection	Normal mode
Global switch information	No default value for system name, system contact, and location
System clock	No value for system clock time
Passwords	No passwords are configured for normal mode or enable mode (press the **Return** key)
Switch prompt	`Switch>`
Interfaces	Enabled, with speed and flow control autonegotiated, and without IP addresses

Configuring DHCP-Based Autoconfiguration

These sections describe how to configure DHCP-based autoconfiguration.

If your DHCP server is a Cisco device, or if you are configuring the switch as a DHCP server, refer to the "*IP Addressing and Services*" section in the *Cisco IOS IP and IP Routing Configuration Guide for Cisco IOS Release 12.1* for additional information about configuring DHCP.

Understanding DHCP-Based Autoconfiguration

Note Starting with Release 12.2(20)EW, you can enable DHCP AutoConfiguration by issuing the **write erase** command. This command clears the startup-config in NVRAM. In images prior to Release 12.2(20)EW, this command will not enable autoconfiguration.

DHCP provides configuration information to Internet hosts and internetworking devices. This protocol consists of two components: one component for delivering configuration parameters from a DHCP server to a device and another component that is a mechanism for allocating network addresses to devices. DHCP is built on a client-server model, in which designated DHCP servers allocate network addresses and deliver configuration parameters to dynamically configured devices. The switch can act as both a DHCP client and a DHCP server.

With DHCP-based autoconfiguration, no DHCP client-side configuration is needed on your switch because your switch (the DHCP client) is automatically configured at startup with IP address information and a configuration file. However, you need to configure the DHCP server or the DHCP server feature on your switch for various lease options associated with IP addresses. If you are using DHCP to relay the configuration file location on the network, you might also need to configure a Trivial File Transfer Protocol (TFTP) server and a Domain Name System (DNS) server.

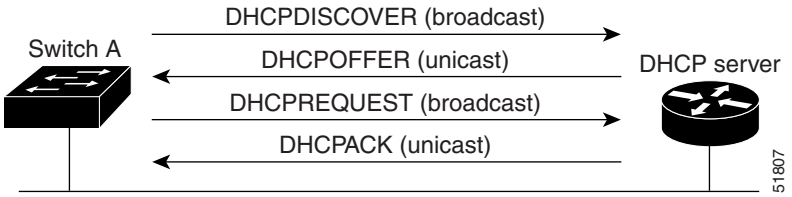
DHCP-based autoconfiguration replaces the BOOTP client functionality on your switch.

DHCP Client Request Process

At startup the switch automatically requests configuration information from a DHCP server if a configuration file is not present on the switch.

Figure 3-1 shows the sequence of messages that are exchanged between the DHCP client and the DHCP server.

Figure 3-1 DHCP Client and Server Message Exchange



The client, Switch A, broadcasts a DHCPDISCOVER message to locate a DHCP server. The DHCP server offers configuration parameters (such as an IP address, subnet mask, gateway IP address, DNS IP address, lease for the IP address, and so forth) to the client in a DHCPOFFER unicast message.

In a DHCPREQUEST broadcast message, the client returns a formal request for the offered configuration information to the DHCP server. The formal request is broadcast so that all other DHCP servers that received the DHCPDISCOVER broadcast message from the client can reclaim the IP addresses that they offered to the client.

The DHCP server confirms that the IP address has been allocated to the client by returning a DHCPACK unicast message to the client. With this message, the client and server are bound, and the client uses the configuration information that it received from the server. The amount of information the switch receives depends on how you configure the DHCP server. For more information, see the "Configuring the DHCP Server" section on page 3-4.

If the configuration parameters sent to the client in the DHCPOFFER unicast message are invalid (if configuration error exists), the client returns a DHCPDECLINE broadcast message to the DHCP server.

The DHCP server sends the client a DHCPNAK denial broadcast message, which means that the offered configuration parameters have not been assigned, that an error has occurred during the negotiation of the parameters, or that the client has been slow in responding to the DHCPOFFER message (the DHCP server might have assigned the parameters to another client).

A DHCP client might receive offers from multiple DHCP servers and can accept any of them; however, the client usually accepts the first offer it receives. The offer from the DHCP server is not a guarantee that the IP address will be allocated to the client; however, the server usually reserves the address until the client has had a chance to formally request the address.

Configuring the DHCP Server

A switch can act as both the DHCP client and the DHCP server. By default, the Cisco IOS DHCP server and relay agent features are enabled on your switch.

You should configure the DHCP server, or the DHCP server feature running on your switch, with reserved leases that are bound to each switch by the switch hardware address.

If you want the switch to receive IP address information, you must configure the DHCP server with these lease options:

- IP address of the client (required)
- Subnet mask of the client (required)
- DNS server IP address (optional)
- Router IP address (required)

Note The router IP address is the default gateway address for the switch.

If you want the switch to receive the configuration file from a TFTP server, you must configure the DHCP server with these lease options:

- TFTP server name or IP address (required)
- Boot filename (the name of the configuration file that the client needs) (recommended)
- Host name (optional)

Depending on the settings of the DHCP server or the DHCP server feature running on your switch, the switch can receive IP address information, the configuration file, or both.

If you do not configure the DHCP server, or the DHCP server feature running on your switch, with the lease options described earlier, the switch replies to client requests with only those parameters that are configured. If the IP address and subnet mask are not in the reply, the switch is not configured. If the router IP address or TFTP server name (or IP address) are not found, the switch might send broadcast, instead of unicast, TFTP requests. Unavailability of other lease options does not impact autoconfiguration.

The DHCP server, or the DHCP server feature running on your switch, can be on the same LAN or on a different LAN than the switch. If the DHCP server is running on a different LAN, you should configure a DHCP relay, which forwards broadcast traffic between two directly connected LANs. A router does not forward broadcast packets, but it forwards packets based on the destination IP address in the received packet. For more information on relay devices, see the "Configuring the Relay Device" section on page 3-5.

Configuring the TFTP Server

Based on the DHCP server configuration, the switch attempts to download one or more configuration files from the TFTP server. If you configured the DHCP server to respond to the switch with all the options required for IP connectivity to the TFTP server, and if you configured the DHCP server with a TFTP server name, address, and configuration filename, the switch attempts to download the specified configuration file from the specified TFTP server.

If you did not specify the configuration filename or the TFTP server name, or if the configuration file could not be downloaded, the switch attempts to download a configuration file using various combinations of filenames and TFTP server addresses. The files include the specified configuration

filename (if any) and the following files: network-confg, cisconet.cfg, *hostname*.confg, or *hostname*.cfg, where *hostname* is the current hostname of the switch and router-confg and ciscortr.cfg. The TFTP server addresses used include the specified TFTP server address (if any) and the broadcast address (255.255.255.255).

For the switch to successfully download a configuration file, the TFTP server must contain one or more configuration files in its base directory. The files can include the following:

- The configuration file named in the DHCP reply (the actual switch configuration file).
- The network-confg or the cisconet.cfg file (known as the default configuration files).
- The router-confg or the ciscortr.cfg file. (These files contain commands common to all switches. Normally, if the DHCP and TFTP servers are properly configured, these files are not accessed.)

If you specify the TFTP server name in the DHCP server-lease database, you must also configure the TFTP server name-to-IP-address mapping in the DNS-server database.

If the TFTP server you plan to use is on a different LAN from the switch, or if it is to be accessed by the switch through the broadcast address (which occurs if the DHCP server response does not contain all the required information described earlier), a relay must be configured to forward the TFTP packets to the TFTP server. For more information, see the "Configuring the Relay Device" section on page 3-5. The preferred solution is to configure either the DHCP server or the DHCP server feature running on your switch with all the required information.

Configuring the DNS Server

The DHCP server, or the DHCP server feature running on your switch, uses the DNS server to resolve the TFTP server name to an IP address. You must configure the TFTP server name-to-IP address map on the DNS server. The TFTP server contains the configuration files for the switch.

You can configure the IP addresses of the DNS servers in the lease database of the DHCP server where the DHCP replies will retrieve them. You can enter up to two DNS server IP addresses in the lease database.

The DNS server can be on the same or on a different LAN as the switch. If it is on a different LAN, the switch must be able to access it through a router.

Configuring the Relay Device

You must configure a relay device to forward received broadcast packets to the destination host whenever a switch sends broadcast packets to which a host on a different LAN must respond. Examples of such broadcast packets are DHCP, DNS, and in some cases, TFTP packets.

If the relay device is a Cisco router, enable IP routing (**ip routing** global configuration command), and configure helper addresses (**ip helper-address** interface configuration command). For example, in Figure 3-2, configure the router interfaces as follows:

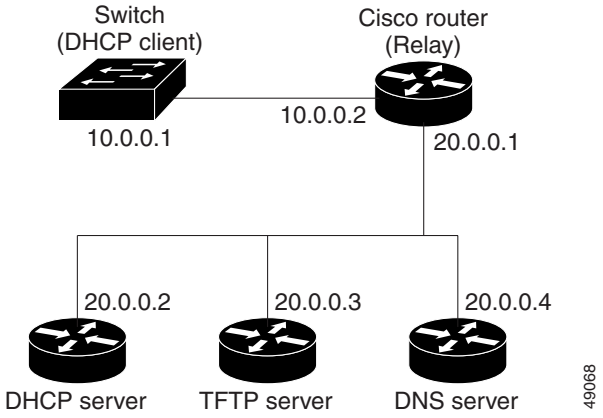
On interface 10.0.0.2:

```
router(config-if)# ip helper-address 20.0.0.2
router(config-if)# ip helper-address 20.0.0.3
router(config-if)# ip helper-address 20.0.0.4
```

On interface 20.0.0.1

```
router(config-if)# ip helper-address 10.0.0.1
```

Figure 3-2 Relay Device Used in Autoconfiguration



Obtaining Configuration Files

Depending on the availability of the IP address and the configuration filename in the DHCP reserved lease, the switch obtains its configuration information in these ways:

- The IP address and the configuration filename are reserved for the switch and provided in the DHCP reply (one-file read method).

  The switch receives its IP address, subnet mask, TFTP server address, and the configuration filename from either the DHCP server or the DHCP server feature running on your switch. The switch sends a unicast message to the TFTP server to retrieve the named configuration file from the base directory of the server, and upon receipt, completes its boot-up process.

- The IP address and the configuration filename is reserved for the switch, but the TFTP server address is not provided in the DHCP reply (one-file read method).

  The switch receives its IP address, subnet mask, and the configuration filename from either the DHCP server or the DHCP server feature running on your switch. The switch sends a broadcast message to a TFTP server to retrieve the named configuration file from the base directory of the server, and upon receipt, completes its boot-up process.

- Only the IP address is reserved for the switch and provided in the DHCP reply. The configuration filename is not provided (two-file read method).

  The switch receives its IP address, subnet mask, and the TFTP server address from either the DHCP server or the DHCP server feature running on your switch. The switch sends a unicast message to the TFTP server to retrieve the network-confg or cisconet.cfg default configuration file. (If the network-confg file cannot be read, the switch reads the cisconet.cfg file.)

  The default configuration file contains the host names-to-IP-address mapping for the switch. The switch fills its host table with the information in the file and obtains its host name. If the host name is not found in the file, the switch uses the host name in the DHCP reply. If the host name is not specified in the DHCP reply, the switch uses the default *Switch* as its host name.

  After obtaining its host name from the default configuration file or the DHCP reply, the switch reads the configuration file that has the same name as its host name (*hostname*-confg or *hostname*.cfg, depending on whether or not the network-confg file or the cisconet.cfg file was read earlier) from the TFTP server. If the cisconet.cfg file is read, the filename of the host is truncated to eight characters.

If the switch cannot read the network-confg, cisconet.cfg, or the hostname file, it reads the router-confg file. If the switch cannot read the router-confg file, it reads the ciscortr.cfg file.

Note The switch broadcasts TFTP server requests provided that either 1) the TFTP server is not obtained from the DHCP replies, 2) all attempts to read the configuration file through unicast transmissions fail, or 3) the TFTP server name cannot be resolved to an IP address.

Example Configuration

Figure 3-3 shows a sample network for retrieving IP information using DHCP-based autoconfiguration.

Figure 3-3 DHCP-Based Autoconfiguration Network Example

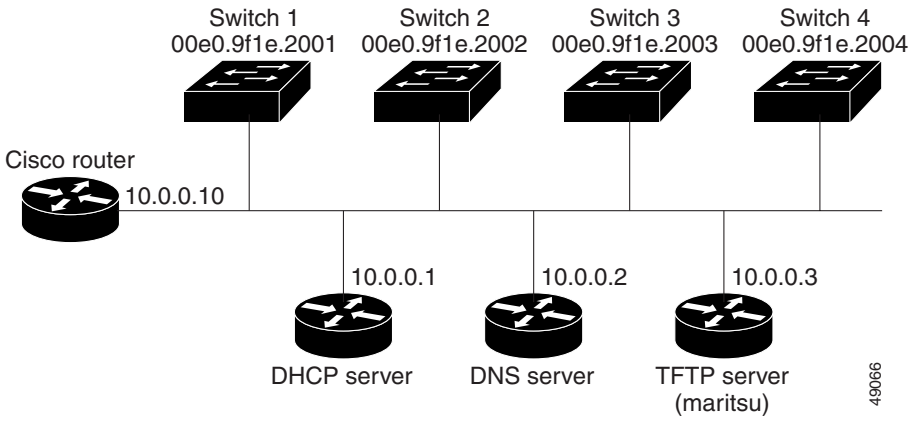


Table 3-2 shows the configuration of the reserved leases on either the DHCP server or the DHCP server feature running on your switch.

Table 3-2 DHCP Server Configuration

	Switch-1	Switch-2	Switch-3	Switch-4
Binding key (hardware address)	00e0.9f1e.2001	00e0.9f1e.2002	00e0.9f1e.2003	00e0.9f1e.2004
IP address	10.0.0.21	10.0.0.22	10.0.0.23	10.0.0.24
Subnet mask	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0
Router address	10.0.0.10	10.0.0.10	10.0.0.10	10.0.0.10
DNS server address	10.0.0.2	10.0.0.2	10.0.0.2	10.0.0.2
TFTP server name	maritsu or 10.0.0.3	maritsu or 10.0.0.3	maritsu or 10.0.0.3	maritsu or 10.0.0.3
Boot filename (configuration file) (optional)	switch1-confg	switch2-confg	switch3-confg	switch4-confg
Host name (optional)	switch1	switch2	switch3	switch4

DNS Server Configuration

The DNS server maps the TFTP server name *maritsu* to IP address 10.0.0.3.

TFTP Server Configuration (on UNIX)

The TFTP server base directory is set to /tftpserver/work/. This directory contains the network-confg file used in the two-file read method. This file contains the host name to be assigned to the switch based on its IP address. The base directory also contains a configuration file for each switch (*switch1-confg*, *switch2-confg*, and so forth) as shown in the following display:

```
prompt> cd /tftpserver/work/
prompt> ls
network-confg
switch1-confg
switch2-confg
switch3-confg
switch4-confg
prompt> cat network-confg
ip host switch1 10.0.0.21
ip host switch2 10.0.0.22
ip host switch3 10.0.0.23
ip host switch4 10.0.0.24
```

DHCP Client Configuration

No configuration file is present on Switch 1 through Switch 4.

Configuration Explanation

In Figure 3-3, Switch 1 reads its configuration file as follows:

- Switch 1 obtains its IP address 10.0.0.21 from the DHCP server.
- If no configuration filename is given in the DHCP server reply, Switch 1 reads the network-confg file from the base directory of the TFTP server.
- Switch 1 adds the contents of the network-confg file to its host table.
- Switch 1 reads its host table by indexing its IP address 10.0.0.21 to its host name (switch1).
- Switch 1 reads the configuration file that corresponds to its host name; for example, it reads *switch1-confg* from the TFTP server.

Switches 2 through 4 retrieve their configuration files and IP addresses in the same way.

Configuring the Switch

The following sections describe how to configure your switch:

Using Configuration Mode to Configure Your Switch

To configure your switch from configuration mode, perform this procedure:

Step 1 Connect a console terminal to the console interface of your supervisor engine.

Step 2 After a few seconds, you will see the user EXEC prompt (`Switch>`). Now, you may want to enter privileged EXEC mode, also known as enable mode. Type **enable** to enter enable mode:

```
Switch> enable
```

Note You must be in enable mode to make configuration changes.

The prompt will change to the enable prompt (#):

```
Switch#
```

Step 3 At the enable prompt (#), enter the **configure terminal** command to enter global configuration mode:

```
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#
```

Step 4 At the global configuration mode prompt, enter the **interface** *type slot/interface* command to enter interface configuration mode:

```
Switch(config)# interface fastethernet 5/1
Switch(config-if)#
```

Step 5 In either of these configuration modes, enter changes to the switch configuration.

Step 6 Enter the **end** command to exit configuration mode.

Step 7 Save your settings. (See the "Saving the Running Configuration Settings to Your Start-up File" section on page 3-10.)

Your switch is now minimally configured and can boot with the configuration you entered. To see a list of the configuration commands, enter **?** at the prompt or press the **help** key in configuration mode.

Checking the Running Configuration Settings

To verify the configuration settings you entered or the changes you made, enter the **show running-config** command at the enable prompt (#), as shown in this example:

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

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Switch
```

```
<...output truncated...>

!
line con 0
 transport input none
line vty 0 4
 exec-timeout 0 0
 password lab
 login
 transport input lat pad dsipcon mop telnet rlogin udptn nasi
!
end
Switch#
```

Saving the Running Configuration Settings to Your Start-up File

Caution This command saves the configuration settings that you created in configuration mode. If you fail to do this step, your configuration will be lost the next time you reload the system.

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

```
Switch# copy running-config startup-config
```

Reviewing the Configuration in NVRAM

To display information stored in NVRAM, enter the **show startup-config** EXEC command.

The following example shows a typical system configuration:

```
Switch# show startup-config
Using 1579 out of 491500 bytes, uncompressed size = 7372 bytes
Uncompressed configuration from 1579 bytes to 7372 bytes
!
version 12.1
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
service compress-config
!
hostname Switch
!
!
ip subnet-zero
!
!
!
!
interface GigabitEthernet1/1
 no snmp trap link-status
!
interface GigabitEthernet1/2
 no snmp trap link-status
!--More--

<...output truncated...>
```

```
!
line con 0
 exec-timeout 0 0
 transport input none
line vty 0 4
 exec-timeout 0 0
 password lab
 login
 transport input lat pad dsipcon mop telnet rlogin udptn nasi
!
end

Switch#
```

Configuring a Default Gateway

Note The switch uses the default gateway only when it is not configured with a routing protocol.

Configure a default gateway to send data to subnets other than its own when the switch is not configured with a routing protocol. The default gateway must be the IP address of an interface on a router that is directly connected to the switch.

To configure a default gateway, perform this task:

	Command	Purpose
Step 1	`Switch(config)# ip default-gateway` *IP-address*	Configures a default gateway.
Step 2	`Switch# show ip route`	Verifies that the default gateway is correctly displayed in the IP routing table.

This example shows how to configure a default gateway and how to verify the configuration:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# ip default-gateway 172.20.52.35
Switch(config)# end
3d17h: %SYS-5-CONFIG_I: Configured from console by console
Switch# show ip route
Default gateway is 172.20.52.35

Host               Gateway           Last Use    Total Uses  Interface
ICMP redirect cache is empty
Switch#
```

Configuring a Static Route

If your Telnet station or SNMP network management workstation is on a different network from your switch and a routing protocol has not been configured, you might need to add a static routing table entry for the network where your end station is located.

To configure a static route, perform this task:

	Command	Purpose
Step 1	`Switch(config)# ip route dest_IP_address mask {forwarding_IP | vlan vlan_ID}`	Configures a static route to the remote network.
Step 2	`Switch# show running-config`	Verifies that the static route is displayed correctly.

This example shows how to use the **ip route** command to configure a static route to a workstation at IP address 171.10.5.10 on the switch with a subnet mask and IP address 172.20.3.35 of the forwarding router:

```
Switch# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)# ip route 171.10.5.10 255.255.255.255 172.20.3.35
Switch(config)# end
Switch#
```

This example shows how to use the **show running-config** command to confirm the configuration of the static route:

```
Switch# show running-config
Building configuration...
.
<...output truncated...>
.
ip default-gateway 172.20.52.35
ip classless
ip route 171.10.5.10 255.255.255.255 172.20.3.35
no ip http server
!
line con 0
 transport input none
line vty 0 4
 exec-timeout 0 0
 password lab
 login
 transport input lat pad dsipcon mop telnet rlogin udptn nasi
!
end

Switch#
```

This example shows how to use the **ip route** command to configure the static route IP address 171.20.5.3 with subnet mask and connected over VLAN 1 to a workstation on the switch:

```
Switch# configure terminal
Switch(config)# ip route 171.20.5.3 255.255.255.255 vlan 1
Switch(config)# end
Switch#
```

This example shows how to use the **show running-config** command to confirm the configuration of the static route:

```
Switch# show running-config
Building configuration...
.
<...output truncated...>
.
```

```
ip default-gateway 172.20.52.35
ip classless
ip route 171.20.5.3 255.255.255.255 Vlan1
no ip http server
!
!
x25 host z
!
line con 0
 transport input none
line vty 0 4
 exec-timeout 0 0
 password lab
 login
 transport input lat pad dsipcon mop telnet rlogin udptn nasi
!
end

Switch#
```

Controlling Access to Privileged EXEC Commands

The procedures in these sections let you control access to the system configuration file and privileged EXEC commands:

Setting or Changing a Static enable Password

To set or change a static password that controls access to the enable mode, perform this task:

Command	Purpose
`Switch(config)# enable password` *password*	Sets a new password or changes an existing password for the privileged EXEC mode.

This example shows how to configure an enable password as “lab” at the privileged EXEC mode:

```
Switch# configure terminal
Switch(config)# enable password lab
Switch(config)#
```

For instructions on how to display the password or access level configuration, see the “Displaying the Password, Access Level, and Privilege Level Configuration” section on page 3-17.

Using the enable Password and enable secret Commands

To provide an additional layer of security, particularly for passwords that cross the network or that are stored on a TFTP server, you can use either the **enable password** or **enable secret** commands. Both commands configure an encrypted password that you must enter to access the enable mode (the default) or any other privilege level that you specify.

We recommend that you use the **enable secret** command.

If you configure the **enable secret** command, it takes precedence over the **enable password** command; the two commands cannot be in effect simultaneously.

To configure the switch to require an enable password, perform either one of these tasks:

Command	Purpose
`Switch(config)# enable password [level level] {password | encryption-type encrypted-password}`	Establishes a password for the privileged EXEC mode.
`Switch(config)# enable secret [level level] {password | encryption-type encrypted-password}`	Specifies a secret password that will be saved using a nonreversible encryption method. (If **enable password** and **enable secret** commands are both set, users must enter the enable secret password.)

When you enter either of these password commands with the **level** option, you define a password for a specific privilege level. After you specify the level and set a password, give the password only to users who need to have access at this level. Use the **privilege level** configuration command to specify commands accessible at various levels.

If you enable the **service password-encryption** command, the password you enter is encrypted. When you display the password with the **more system:running-config** command, the password displays the password in encrypted form.

If you specify an encryption type, you must provide an encrypted password—an encrypted password you copy from another Catalyst 4500 series switch configuration.

Note You cannot recover a lost encrypted password. You must clear NVRAM and set a new password. See the "Recovering a Lost Enable Password" section on page 3-18 for more information.

For information on how to display the password or access level configuration, see the "Displaying the Password, Access Level, and Privilege Level Configuration" section on page 3-17.

Setting or Changing a Privileged Password

To set or change a privileged password, perform this task:

Command	Purpose
`Switch(config-line)# password password`	Sets a new password or changes an existing password for the privileged level.

For information on how to display the password or access level configuration, see the "Displaying the Password, Access Level, and Privilege Level Configuration" section on page 3-17.

Setting TACACS+ Password Protection for Privileged EXEC Mode

For complete information about TACACS+ and RADIUS, refer to these publications:

- The "Authentication, Authorization, and Accounting (AAA)" chapter in the *Cisco IOS Security Configuration Guide*, Release 12.2, at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/secur_c/scprt1/index.htm
- *Cisco IOS Security Command Reference*, Release 12.2, at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/secur_r/index.htm

To set the TACACS+ protocol to determine whether a user can access privileged EXEC mode, perform this task:

Command	Purpose
`Switch(config)# enable use-tacacs`	Sets the TACACS-style user ID and password-checking mechanism for the privileged EXEC mode.

When you set TACACS password protection at the privileged EXEC mode, the **enable** EXEC command prompts you for a new username and a new password. This information is then passed to the TACACS+ server for authentication. If you are using the extended TACACS, another extension to the older TACACS protocol that provides additional functionality, it also passes any existing UNIX user identification code to the TACACS+ server.

An extension to the older TACACS protocol, supplying additional functionality to TACACS. Extended TACACS provides information about protocol translator and router use. This information is used in UNIX auditing trails and accounting files.

Note When used without extended TACACS, the **enable use-tacacs** command allows anyone with a valid username and password to access the privileged EXEC mode, creating a potential security risk. This problem occurs because the query resulting from entering the **enable** command is indistinguishable from an attempt to log in without extended TACACS.

Encrypting Passwords

Because protocol analyzers can examine packets (and read passwords), you can increase access security by configuring the Cisco IOS software to encrypt passwords. Encryption prevents the password from being readable in the configuration file.

To configure the Cisco IOS software to encrypt passwords, perform this task:

Command	Purpose
`Switch(config)# service password-encryption`	Encrypts a password.

Encryption occurs when the current configuration is written or when a password is configured. Password encryption is applied to all passwords, including authentication key passwords, the privileged command password, console and virtual terminal line access passwords, and Border Gateway Protocol (BGP) neighbor passwords. The **service password-encryption** command keeps unauthorized individuals from viewing your password in your configuration file.

Caution The **service password-encryption** command does not provide a high level of network security. If you use this command, you should also take additional network security measures.

Although you cannot recover a lost encrypted password (that is, you cannot get the original password back), you can regain control of the switch after having lost or forgotten the encrypted password. See the "Recovering a Lost Enable Password" section on page 3-18 for more information.

For information on how to display the password or access level configuration, see the "Displaying the Password, Access Level, and Privilege Level Configuration" section on page 3-17.

Configuring Multiple Privilege Levels

By default, the Cisco IOS software has two modes of password security: user EXEC mode and privileged EXEC mode. You can configure up to 16 hierarchical levels of commands for each mode. By configuring multiple passwords, you can allow different sets of users to have access to specified commands.

For example, if you want many users to have access to the **clear line** command, you can assign it level 2 security and distribute the level 2 password fairly widely. If you want more restricted access to the **configure** command, you can assign it level 3 security and distribute that password to fewer users.

The procedures in the following sections describe how to configure additional levels of security:

Setting the Privilege Level for a Command

To set the privilege level for a command, perform this task:

	Command	Purpose
Step 1	`Switch(config)# privilege` *mode* `level` *level command*	Sets the privilege level for a command.
Step 2	`Switch(config)# enable password level` *level* `[`*encryption-type*`]` *password*	Specifies the enable password for a privilege level.

For information on how to display the password or access level configuration, see the "Displaying the Password, Access Level, and Privilege Level Configuration" section on page 3-17.

Changing the Default Privilege Level for Lines

To change the default privilege level for a given line or a group of lines, perform this task:

Command	Purpose
`Switch(config-line)# privilege level level`	Changes the default privilege level for the line.

For information on how to display the password or access level configuration, see the "Displaying the Password, Access Level, and Privilege Level Configuration" section on page 3-17.

Logging In to a Privilege Level

To log in at a specified privilege level, perform this task:

Command	Purpose
`Switch# enable level`	Logs in to a specified privilege level.

Exiting a Privilege Level

To exit to a specified privilege level, perform this task:

Command	Purpose
`Switch# disable level`	Exits to a specified privilege level.

Displaying the Password, Access Level, and Privilege Level Configuration

To display detailed password information, perform this task:

	Command	Purpose
Step 1	`Switch# show running-config`	Displays the password and access level configuration.
Step 2	`Switch# show privilege`	Shows the privilege level configuration.

This example shows how to display the password and access level configuration:

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

Current configuration:
!
version 12.0
service timestamps debug datetime localtime
service timestamps log datetime localtime
no service password-encryption
!
hostname Switch
!
boot system flash sup-bootflash
enable password lab
!
<...output truncated...>
```

This example shows how to display the privilege level configuration:

```
Switch# show privilege
Current privilege level is 15
Switch#
```

Recovering a Lost Enable Password

Note For more information on the configuration register which is preconfigured in NVRAM, see "Configuring the Software Configuration Register" section on page 3-19.

Perform these steps to recover a lost enable password:

Step 1 Connect to the console interface.

Step 2 Stop the boot sequence and enter ROM monitor by pressing **Ctrl-C** during the first 5 seconds of bootup.

Step 3 Configure the switch to boot-up without reading the configuration memory (NVRAM).

Step 4 Reboot the system.

Step 5 Access enable mode (this can be done without a password if a password has not been configured).

Step 6 View or change the password, or erase the configuration.

Step 7 Reconfigure the switch to boot-up and read the NVRAM as it normally does.

Step 8 Reboot the system.

Modifying the Supervisor Engine Startup Configuration

These sections describe how the startup configuration on the supervisor engine works and how to modify the configuration register and BOOT variable:

Understanding the Supervisor Engine Boot Configuration

The supervisor engine boot process involves two software images: ROM monitor and supervisor engine software. When the switch is booted or reset, the ROMMON code is executed. Depending on the NVRAM configuration, the supervisor engine either stays in ROMMON mode or loads the supervisor engine software.

Two user-configurable parameters determine how the switch boots: the configuration register and the BOOT environment variable. The configuration register is described in the "Modifying the Boot Field and Using the boot Command" section on page 3-21. The BOOT environment variable is described in the "Specifying the Startup System Image" section on page 3-23.

Understanding the ROM Monitor

The ROM monitor (ROMMON) is invoked at switch bootup, reset, or when a fatal exception occurs. The switch enters ROMMON mode if the switch does not find a valid software image, if the NVRAM configuration is corrupted, or if the configuration register is set to enter ROMMON mode. From ROMMON mode, you can manually load a software image from bootflash or a Flash disk, or you can boot up from the management interface. ROMMON mode loads a primary image from which you can configure a secondary image to boot up from a specified source either locally or through the network using the BOOTLDR environment variable. This variable is described in the "Switch#" section on page 3-24.

You can also enter ROMMON mode by restarting the switch and then pressing **Ctrl-C** during the first five seconds of startup. If you are connected through a terminal server, you can escape to the Telnet prompt and enter the **send break** command to enter ROMMON mode.

Note **Ctrl-C** is always enabled for five seconds after you reboot the switch, regardless of whether the configuration-register setting has **Ctrl-C** disabled.

The ROM monitor has these features:

- Power-on confidence test
- Hardware initialization
- Boot capability (manual bootup and autoboot)
- File system (read-only while in ROMMON)

Configuring the Software Configuration Register

The switch uses a 16-bit software configuration register, which allows you to set specific system parameters. Settings for the software configuration register are preconfigured in NVRAM.

Following are some reasons you might want to change the software configuration register settings:

- To select a boot source and default boot filename
- To control broadcast addresses
- To set the console terminal baud rate
- To load operating software from Flash memory
- To recover a lost password
- To manually boot the system using the **boot** command at the bootstrap program prompt
- To force an automatic bootup from the system bootstrap software (boot image) or from a default system image in onboard Flash memory, and read any **boot system** commands that are stored in the configuration file in NVRAM

Caution To avoid possibly halting the Catalyst 4500 series switch switch, remember that valid configuration register settings might be combinations of settings and not just the individual settings listed in Table 3-3. For example, the factory default value of 0x2101 is a combination of settings.

Table 3-3 lists the meaning of each of the software configuration memory bits. Table 3-4 defines the *boot field*.

Table 3-3 Software Configuration Register Bits

Bit Number[1]	Hexadecimal	Meaning
00 to 03	0x0000 to 0x000F	Boot field (see Table 3-4)
04	0x0010	Unused
05	0x0020	Bit two of console line speed
06	0x0040	Causes system software to ignore NVRAM contents
07	0x0080	OEM[2] bit enabled
08	0x0100	Unused
09	0x0200	Unused
10	0x0400	IP broadcast with all zeros
11 to 12	0x0800 to 0x1000	Bits one and zero of Console line speed (default is 9600 baud)
13	0x2000	Loads ROM monitor after netboot fails
14	0x4000	IP broadcasts do not have network numbers

1. The factory default value for the configuration register is 0x0102. This value is a combination of the following: binary bit 13, bit 8 = 0x0100 and binary bits 00 through 03 = 0x0001 (see Table 3-4).
2. OEM = original equipment manufacturer.

Table 3-4 Explanation of Boot Field (Configuration Register Bits 00 to 03)

Boot Field	Meaning
00	Stays at the system bootstrap prompt (does not autoboot).
01	Boots the first system image in onboard Flash memory.
02 to 0F	Autoboots using image(s) specified by the BOOT environment variable. If more than one image is specified, the switch attempts to boot the first image specified in the BOOT variable. As long as the switch can successfully boot from this image, the same image will be used on a reboot. If the switch fails to boot from the image specified in the BOOT variable, the switch will try to boot from the next image listed in the BOOT variable. If the end of the BOOT variable is reached without the switch booting successfully, the switch attempts the boot from the beginning of the BOOT variable. The autoboot continues until the switch successfully boots from one of the images specified in the BOOT variable.

Modifying the Boot Field and Using the boot Command

The configuration register boot field determines whether the switch loads an operating system image and, if so, where it obtains this system image. The following sections describe how to use and set the configuration register boot field and the procedures you must perform to modify the configuration register boot field. In ROMMON, you can use the **confreg** command to modify the configuration register and change boot settings.

Bits 0 through 3 of the software configuration register contain the boot field.

Note The factory default configuration register setting for systems and spares is 0x2101. However, the recommended value is 0x0102.

When the boot field is set to either 00 or 01 (0-0-0-0 or 0-0-0-1), the system ignores any boot instructions in the system configuration file and the following occurs:

- When the boot field is set to 00, you must boot up the operating system manually by issuing the **boot** command at the system bootstrap or ROMMON prompt.
- When the boot field is set to 01, the system boots the first image in the bootflash single in-line memory module (SIMM).
- When the entire boot field equals a value between 0-0-1-0 and 1-1-1-1, the switch loads the system image specified by **boot system** commands in the startup configuration file.

Caution If you set bootfield to a value between 0-0-1-0 and 1-1-1-1, you must specify a value in the **boot system** command, else the switch cannot boot up and will remain stuck in ROMMON.

You can enter the **boot** command only, or enter the command and include additional boot instructions, such as the name of a file stored in Flash memory, or a file that you specify for booting from a network server. If you use the **boot** command without specifying a file or any other boot instructions, the system boots from the default Flash image (the first image in onboard Flash memory). Otherwise, you can instruct the system to boot up from a specific Flash image (using the **boot system flash** *filename* command).

You can also use the **boot** command to boot up images stored in the compact Flash cards located in slot 0 on the supervisor engine.

Modifying the Boot Field

Modify the boot field from the software configuration register. To modify the software configuration register boot field, perform this task:

	Command	Purpose
Step 1	`Switch# show version`	Determines the current configuration register setting.
Step 2	`Switch# configure terminal`	Enters configuration mode, and specify the **terminal** option.
Step 3	`Switch(config)# config-register` *value*	Modifies the existing configuration register setting to reflect the way you want the switch to load a system image.

	Command	Purpose
Step 4	`Switch(config)# end`	Exits configuration mode.
Step 5	`Switch# reload`	Reboots the switch to make your changes take effect.

To modify the configuration register while the switch is running Cisco IOS software, follow these steps:

Step 1 Enter the **enable** command and your password to enter privileged level, as follows:

```
Switch> enable
Password:
Switch#
```

Step 2 Enter the **configure terminal** command at the EXEC mode prompt (#), as follows:

```
Switch# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#
```

Step 3 Configure the configuration register to 0x102 as follows:

```
Switch(config)# config-register 0x102
```

Set the contents of the configuration register by specifying the *value* command variable, where *value* is a hexadecimal number preceded by 0x (see Table 3-3 on page 3-20).

Step 4 Enter the **end** command to exit configuration mode. The new value settings are saved to memory; however, the new settings do not take effect until the system is rebooted.

Step 5 Enter the **show version** EXEC command to display the configuration register value currently in effect; it will be used at the next reload. The value is displayed on the last line of the screen display, as shown in this sample output:

```
Configuration register is 0x141 (will be 0x102 at next reload)
```

Step 6 Save your settings. (See the "Saving the Running Configuration Settings to Your Start-up File" section on page 3-10. Note that configuration register changes take effect only after the system reloads, such as when you enter a **reload** command from the console.)

Step 7 Reboot the system. The new configuration register value takes effect with the next system boot up.

Verifying the Configuration Register Setting

Enter the **show version** EXEC command to verify the current configuration register setting. In ROMMON mode, enter the **show version** command to verify the configuration register setting.

To verify the configuration register setting for the switch, perform this task:

Command	Purpose
`Switch# show version`	Displays the configuration register setting.

In this example, the **show version** command indicates that the current configuration register is set so that the switch does not automatically load an operating system image. Instead, it enters ROMMON mode and waits for you to enter ROM monitor commands.

```
Switch#show version
Cisco Internetwork Operating System Software
IOS (tm) Catalyst 4000 L3 Switch Software (cat4000-IS-M), Experimental
Version 12.1(20010828:211314) [cisco 105]
Copyright (c) 1986-2001 by cisco Systems, Inc.
Compiled Thu 06-Sep-01 15:40 by
Image text-base:0x00000000, data-base:0x00ADF444

ROM:1.15
Switch uptime is 10 minutes
System returned to ROM by reload
Running default software

cisco Catalyst 4000 (MPC8240) processor (revision 3) with 262144K bytes
of memory.
Processor board ID Ask SN 12345
Last reset from Reload
Bridging software.
49 FastEthernet/IEEE 802.3 interface(s)
20 Gigabit Ethernet/IEEE 802.3 interface(s)
271K bytes of non-volatile configuration memory.

Configuration register is 0xEC60

Switch#
```

Specifying the Startup System Image

You can enter multiple boot commands in the startup configuration file or in the BOOT environment variable to provide backup methods for loading a system image.

The BOOT environment variable is also described in the "Specify the Startup System Image in the Configuration File" section in the "Loading and Maintaining System Images and Microcode" chapter of the *Cisco IOS Configuration Fundamentals Configuration Guide*.

Use the following sections to configure your switch to boot from Flash memory. Flash memory can be either single in-line memory modules (SIMMs) or Flash disks. Check the appropriate hardware installation and maintenance guide for information about types of Flash memory.

Using Flash Memory

Flash memory allows you to do the following:

- Copy the system image to Flash memory using TFTP
- Boot the system from Flash memory either automatically or manually
- Copy the Flash memory image to a network server using TFTP or RCP

Flash Memory Features

Flash memory allows you to do the following:

- Remotely load multiple system software images through TFTP or RCP transfers (one transfer for each file loaded)
- Boot a switch manually or automatically from a system software image stored in Flash memory (you can also boot directly from ROM)

Security Precautions

Note the following security precaution when loading from Flash memory:

Caution You can only change the system image stored in Flash memory from privileged EXEC level on the console terminal.

Configuring Flash Memory

To configure your switch to boot from Flash memory, perform the following procedure. (Refer to the appropriate hardware installation and maintenance publication for complete instructions on installing the hardware.)

Step 1 Copy a system image to Flash memory using TFTP or other protocols. Refer to the "Cisco IOS File Management" and "Loading and Maintaining System Images" chapters in the *Cisco IOS Configuration Fundamentals Configuration Guide*, Release 12.2, at the following URL: http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fun_c/fcprt2/fcd203.htm

Step 2 Configure the system to boot automatically from the desired file in Flash memory. You might need to change the configuration register value. See the "Modifying the Boot Field and Using the boot Command" section on page 3-21, for more information on modifying the configuration register.

Step 3 Save your configurations.

Step 4 Power cycle and reboot your system to verify that all is working as expected.

Controlling Environment Variables

Although the ROM monitor controls environment variables, you can create, modify, or view them with certain commands. To create or modify the BOOT and BOOTLDR variables, use the **boot system** and **boot bootldr** global configuration commands, respectively. Refer to the "Specify the Startup System Image in the Configuration File" section in the "Loading and Maintaining System Images and Microcode" chapter of the *Configuration Fundamentals Configuration Guide* for details on setting the BOOT environment variable.

Note When you use the **boot system** and **boot bootldr** global configuration commands, you affect only the running configuration. To save the configuration for future use, you must save the environment variable settings to your startup configuration, which places the information under ROM monitor control. Enter the **copy system:running-config nvram:startup-config** command to save the environment variables from your running configuration to your startup configuration.

You can view the contents of the BOOT and BOOTLDR variables using the **show bootvar** command. This command displays the settings for these variables as they exist in the startup configuration and in the running configuration if a running configuration setting differs from a startup configuration setting. This example shows how to check the BOOT and BOOTLDR variables on the switch:

```
Switch# show bootvar
BOOTLDR variable = bootflash:cat4000-is-mz,1;
Configuration register is 0x0
Switch#
```