



# Configuring Switch-Based Authentication

This chapter describes how to configure switch-based authentication on the Catalyst 2950 or Catalyst 2955 switch. This chapter consists of these sections:

- [Preventing Unauthorized Access to Your Switch, page 9-1](#)
- [Protecting Access to Privileged EXEC Commands, page 9-2](#)
- [Controlling Switch Access with TACACS+, page 9-10](#)
- [Controlling Switch Access with RADIUS, page 9-18](#)
- [Configuring the Switch for Local Authentication and Authorization, page 9-31](#)
- [Configuring the Switch for Secure Shell, page 9-32](#)

## Preventing Unauthorized Access to Your Switch

You can prevent unauthorized users from reconfiguring your switch and viewing configuration information. Typically, you want network administrators to have access to your switch while you restrict access to users who dial from outside the network through an asynchronous port, connect from outside the network through a serial port, or connect through a terminal or workstation from within the local network.

To prevent unauthorized access into your switch, you should configure one or more of these security features:

- At a minimum, you should configure passwords and privileges at each switch port. These passwords are locally stored on the switch. When users attempt to access the switch through a port or line, they must enter the password specified for the port or line before they can access the switch. For more information, see the [“Protecting Access to Privileged EXEC Commands” section on page 9-2](#).
- For an additional layer of security, you can also configure username and password pairs, which are locally stored on the switch. These pairs are assigned to lines or interfaces and authenticate each user before that user can access the switch. If you have defined privilege levels, you can also assign a specific privilege level (with associated rights and privileges) to each username and password pair. For more information, see the [“Configuring Username and Password Pairs” section on page 9-7](#).
- If you want to use username and password pairs, but you want to store them centrally on a server instead of locally, you can store them in a database on a security server. Multiple networking devices can then use the same database to obtain user authentication (and, if necessary, authorization) information. For more information, see the [“Controlling Switch Access with TACACS+” section on page 9-10](#).

# Protecting Access to Privileged EXEC Commands

A simple way of providing terminal access control in your network is to use passwords and assign privilege levels. Password protection restricts access to a network or network device. Privilege levels define what commands users can enter after they have logged into a network device.



## Note

For complete syntax and usage information for the commands used in this section, refer to the *Cisco IOS Security Command Reference for Cisco IOS Release 12.1*.

This section describes how to control access to the configuration file and privileged EXEC commands. It contains this configuration information:

- [Default Password and Privilege Level Configuration, page 9-2](#)
- [Setting or Changing a Static Enable Password, page 9-3](#)
- [Protecting Enable and Enable Secret Passwords with Encryption, page 9-4](#)
- [Disabling Password Recovery, page 9-5](#)
- [Setting a Telnet Password for a Terminal Line, page 9-6](#)
- [Configuring Username and Password Pairs, page 9-7](#)
- [Configuring Multiple Privilege Levels, page 9-8](#)

## Default Password and Privilege Level Configuration

[Table 9-1](#) shows the default password and privilege level configuration.

**Table 9-1 Default Password and Privilege Levels**

Feature	Default Setting
Enable password and privilege level	No password is defined. The default is level 15 (privileged EXEC level). The password is not encrypted in the configuration file.
Enable secret password and privilege level	No password is defined. The default is level 15 (privileged EXEC level). The password is encrypted before it is written to the configuration file.
Line password	No password is defined.

## Setting or Changing a Static Enable Password

The enable password controls access to the privileged EXEC mode. Beginning in privileged EXEC mode, follow these steps to set or change a static enable password:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>enable password</b> <i>password</i>	<p>Define a new password or change an existing password for access to privileged EXEC mode.</p> <p>By default, no password is defined.</p> <p>For <i>password</i>, specify a string from 1 to 25 alphanumeric characters. The string cannot start with a number, is case sensitive, and allows spaces but ignores leading spaces. It can contain the question mark (?) character if you precede the question mark with the key combination Ctrl-v when you create the password; for example, to create the password abc?123, do this:</p> <p>Enter <b>abc</b>.</p> <p>Enter <b>Ctrl-v</b>.</p> <p>Enter <b>?123</b>.</p> <p>When the system prompts you to enter the enable password, you need not precede the question mark with the Ctrl-v; you can simply enter abc?123 at the password prompt.</p>
Step 3	<b>end</b>	Return to privileged EXEC mode.
Step 4	<b>show running-config</b>	Verify your entries.
Step 5	<b>copy running-config startup-config</b>	<p>(Optional) Save your entries in the configuration file.</p> <p>The enable password is not encrypted and can be read in the switch configuration file.</p>

To remove the password, use the **no enable password** global configuration command.

This example shows how to change the enable password to *l1u2c3k4y5*. The password is not encrypted and provides access to level 15 (traditional privileged EXEC mode access):

```
Switch(config)# enable password l1u2c3k4y5
```

## Protecting Enable and Enable Secret Passwords with Encryption

To provide an additional layer of security, particularly for passwords that cross the network or that are stored on a Trivial File Transfer Protocol (TFTP) server, you can use either the **enable password** or **enable secret** global configuration commands. Both commands accomplish the same thing; that is, you can establish an encrypted password that users must enter to access privileged EXEC mode (the default) or any privilege level you specify.

We recommend that you use the **enable secret** command because it uses an improved encryption algorithm.

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

Beginning in privileged EXEC mode, follow these steps to configure encryption for enable and enable secret passwords:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>enable password</b> [level <i>level</i> ] { <i>password</i>   <i>encryption-type encrypted-password</i> } or <b>enable secret</b> [level <i>level</i> ] { <i>password</i>   <i>encryption-type encrypted-password</i> }	Define a new password or change an existing password for access to privileged EXEC mode. or Define a secret password, which is saved using a nonreversible encryption method. <ul style="list-style-type: none"> <li>(Optional) For <i>level</i>, the range is from 0 to 15. Level 1 is normal user EXEC mode privileges. The default level is 15 (privileged EXEC mode privileges).</li> <li>For <i>password</i>, specify a string from 1 to 25 alphanumeric characters. The string cannot start with a number, is case sensitive, and allows spaces but ignores leading spaces. By default, no password is defined.</li> <li>(Optional) For <i>encryption-type</i>, only type 5, a Cisco proprietary encryption algorithm, is available. If you specify an encryption type, you must provide an encrypted password—an encrypted password you copy from another Catalyst2950 switch configuration.</li> </ul> <p><b>Note</b> If you specify an encryption type and then enter a clear text password, you can not re-enter privileged EXEC mode. You cannot recover a lost encrypted password by any method.</p>
Step 3	<b>service password-encryption</b>	(Optional) Encrypt the password when the password is defined or when the configuration is written.  Encryption prevents the password from being readable in the configuration file.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

If both the enable and enable secret passwords are defined, users must enter the enable secret password.

Use the **level** keyword to 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** global configuration command to specify commands accessible at various levels. For more information, see the [“Configuring Multiple Privilege Levels” section on page 9-8](#).

If you enable password encryption, it applies to all passwords including username passwords, authentication key passwords, the privileged command password, and console and virtual terminal line passwords.

To remove a password and level, use the **no enable password [level level]** or **no enable secret [level level]** global configuration command. To disable password encryption, use the **no service password-encryption** global configuration command.

This example shows how to configure the encrypted password `$1$FaD0$Xyti5Rkls3LoyxzS8` for privilege level 2:

```
Switch(config)# enable secret level 2 5 $1$FaD0$Xyti5Rkls3LoyxzS8
```

## Disabling Password Recovery

By default, any end user with physical access to the Catalyst 2950 Long-Reach Ethernet (LRE) switch can recover from a lost password by interrupting the boot process while the switch is powering on and then by entering a new password.

The password-recovery disable feature protects access to the switch password by disabling part of this functionality. When this feature is enabled, the end user can interrupt the boot process only by agreeing to set the system back to the default configuration. With password recovery disabled, you can still interrupt the boot process and change the password, but the configuration file (config.text) and the VLAN database file (vlan.dat) are deleted.



### Note

The password recovery disable feature is available only on Catalyst 2950 LRE switches; it is not available for non-LRE Catalyst 2950 switches or for Catalyst 2955 switches.



### Note

If you disable password recovery, we recommend that you keep a backup copy of the configuration file on a secure server in case the end user interrupts the boot process and sets the system back to default values. Do not keep a backup copy of the configuration file on the switch. If the switch is operating in VTP transparent mode, we recommend that you also keep a backup copy of the VLAN database file on a secure server. When the switch is returned to the default system configuration, you can download the saved files to the switch by using the XMODEM protocol. For more information, see the [“Recovering from Lost or Forgotten Passwords on Non-LRE Catalyst 2950 Switches” section on page 32-2](#), the [“Recovering from Lost or Forgotten Passwords on Catalyst 2950 LRE Switches” section on page 32-4](#), and the [“Recovering from Lost or Forgotten Passwords on Catalyst 2955 Switches” section on page 32-8](#).

Beginning in privileged EXEC mode, follow these steps to disable password recovery:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>no service password-recovery</b>	Disable password recovery.  This setting is saved in an area of the Flash memory that is accessible by the boot loader and the Cisco IOS image, but it is not part of the file system and is not accessible by any user.
Step 3	<b>end</b>	Return to privileged EXEC mode.
Step 4	<b>show version</b>	Verify the configuration by checking the last few lines of the display.

To re-enable password recovery, use the **service password-recovery** global configuration command.


**Note**

Disabling password recovery will not work if you have set the switch to boot manually by using the **boot manual** global configuration command. This command produces the boot loader prompt (*switch:*) after the switch is power cycled.

## Setting a Telnet Password for a Terminal Line

When you power-up your switch for the first time, an automatic setup program runs to assign IP information and to create a default configuration for continued use. The setup program also prompts you to configure your switch for Telnet access through a password. If you neglected to configure this password during the setup program, you can configure it now through the command-line interface (CLI).

Beginning in privileged EXEC mode, follow these steps to configure your switch for Telnet access:

	Command	Purpose
Step 1		Attach a PC or workstation with emulation software to the switch console port.  The default data characteristics of the console port are 9600, 8, 1, no parity. You might need to press the Return key several times to see the command-line prompt.
Step 2	<b>enable password <i>password</i></b>	Enter privileged EXEC mode.
Step 3	<b>configure terminal</b>	Enter global configuration mode.
Step 4	<b>line vty 0 15</b>	Configure the number of Telnet sessions (lines), and enter line configuration mode.  There are 16 possible sessions on a command-capable switch. The 0 and 15 mean that you are configuring all 16 possible Telnet sessions.
Step 5	<b>password <i>password</i></b>	Enter a Telnet password for the line or lines.  For <i>password</i> , specify a string from 1 to 25 alphanumeric characters. The string cannot start with a number, is case sensitive, and allows spaces but ignores leading spaces. By default, no password is defined.
Step 6	<b>end</b>	Return to privileged EXEC mode.

	Command	Purpose
Step 7	<b>show running-config</b>	Verify your entries. The password is listed under the command <b>line vty 0 15</b> .
Step 8	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To remove the password, use the **no password** global configuration command.

This example shows how to set the Telnet password to *let45me67in89*:

```
Switch(config)# line vty 10
Switch(config-line)# password let45me67in89
```

## Configuring Username and Password Pairs

You can configure username and password pairs, which are locally stored on the switch. These pairs are assigned to lines or interfaces and authenticate each user before that user can access the switch. If you have defined privilege levels, you can also assign a specific privilege level (with associated rights and privileges) to each username and password pair.

Beginning in privileged EXEC mode, follow these steps to establish a username-based authentication system that requests a login username and a password:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>username <i>name</i> [<i>privilege level</i>] {<b>password</b> <i>encryption-type password</i>}</b>	Enter the username, privilege level, and password for each user. <ul style="list-style-type: none"> <li>For <i>name</i>, specify the user ID as one word. Spaces and quotation marks are not allowed.</li> <li>(Optional) For <i>level</i>, specify the privilege level the user has after gaining access. The range is 0 to 15. Level 15 gives privileged EXEC mode access. Level 1 gives user EXEC mode access.</li> <li>For <i>encryption-type</i>, enter 0 to specify that an unencrypted password will follow. Enter 7 to specify that a hidden password will follow.</li> <li>For <i>password</i>, specify the password the user must enter to gain access to the switch. The password must be from 1 to 25 characters, can contain embedded spaces, and must be the last option specified in the <b>username</b> command.</li> </ul>
Step 3	<b>line console 0</b> or <b>line vty 0 15</b>	Enter line configuration mode, and configure the console port (line 0) or the VTY lines (line 0 to 15).
Step 4	<b>login local</b>	Enable local password checking at login time. Authentication is based on the username specified in Step 2.
Step 5	<b>end</b>	Return to privileged EXEC mode.
Step 6	<b>show running-config</b>	Verify your entries.
Step 7	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable username authentication for a specific user, use the **no username *name*** global configuration command. To disable password checking and allow connections without a password, use the **no login** line configuration command.

## Configuring Multiple Privilege Levels

By default, the software has two modes of password security: user EXEC and privileged EXEC. 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. But if you want more restricted access to the **configure** command, you can assign it level 3 security and distribute that password to a more restricted group of users.

This section includes this configuration information:

- [Setting the Privilege Level for a Command, page 9-8](#)
- [Changing the Default Privilege Level for Lines, page 9-9](#)
- [Logging into and Exiting a Privilege Level, page 9-10](#)

### Setting the Privilege Level for a Command

Beginning in privileged EXEC mode, follow these steps to set the privilege level for a command mode:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>privilege mode level level command</b>	Set the privilege level for a command. <ul style="list-style-type: none"> <li>• For <i>mode</i>, enter <b>configure</b> for global configuration mode, <b>exec</b> for EXEC mode, <b>interface</b> for interface configuration mode, or <b>line</b> for line configuration mode.</li> <li>• For <i>level</i>, the range is from 0 to 15. Level 1 is for normal user EXEC mode privileges. Level 15 is the level of access permitted by the <b>enable</b> password.</li> <li>• For <i>command</i>, specify the command to which you want to restrict access.</li> </ul>
Step 3	<b>enable password level level password</b>	Specify the enable password for the privilege level. <ul style="list-style-type: none"> <li>• For <i>level</i>, the range is from 0 to 15. Level 1 is for normal user EXEC mode privileges.</li> <li>• For <i>password</i>, specify a string from 1 to 25 alphanumeric characters. The string cannot start with a number, is case sensitive, and allows spaces but ignores leading spaces. By default, no password is defined.</li> </ul>
Step 4	<b>end</b>	Return to privileged EXEC mode.

	Command	Purpose
Step 5	<b>show running-config</b>	Verify your entries.
	or <b>show privilege</b>	The first command displays the password and access level configuration. The second command displays the privilege level configuration.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

When you set a command to a privilege level, all commands whose syntax is a subset of that command are also set to that level. For example, if you set the **show ip traffic** command to level 15, the **show** commands and **show ip** commands are automatically set to privilege level 15 unless you set them individually to different levels.

To return to the default privilege for a given command, use the **no privilege mode level level command** global configuration command.

This example shows how to set the **configure** command to privilege level 14 and define *SecretPswd14* as the password users must enter to use level 14 commands:

```
Switch(config)# privilege exec level 14 configure
Switch(config)# enable password level 14 SecretPswd14
```

## Changing the Default Privilege Level for Lines

Beginning in privileged EXEC mode, follow these steps to change the default privilege level for a line:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>line vty line</b>	Select the virtual terminal line on which to restrict access.
Step 3	<b>privilege level level</b>	Change the default privilege level for the line.  For <i>level</i> , the range is from 0 to 15. Level 1 is for normal user EXEC mode privileges. Level 15 is the level of access permitted by the <b>enable</b> password.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show running-config</b>	Verify your entries.
	or <b>show privilege</b>	The first command displays the password and access level configuration. The second command displays the privilege level configuration.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

Users can override the privilege level you set using the **privilege level** line configuration command by logging in to the line and enabling a different privilege level. They can lower the privilege level by using the **disable** command. If users know the password to a higher privilege level, they can use that password to enable the higher privilege level. You might specify a high level or privilege level for your console line to restrict line usage.

To return to the default line privilege level, use the **no privilege level** line configuration command.

## Logging into and Exiting a Privilege Level

Beginning in privileged EXEC mode, follow these steps to log in to a specified privilege level and to exit to a specified privilege level:

	Command	Purpose
Step 1	<b>enable</b> <i>level</i>	Log in to a specified privilege level. For <i>level</i> , the range is 0 to 15.
Step 2	<b>disable</b> <i>level</i>	Exit to a specified privilege level. For <i>level</i> , the range is 0 to 15.

## Controlling Switch Access with TACACS+

This section describes how to enable and configure Terminal Access Controller Access Control System Plus (TACACS+), which provides detailed accounting information and flexible administrative control over authentication and authorization processes. TACACS+ is facilitated through authentication, authorization, accounting (AAA) and can be enabled only through AAA commands.



### Note

For complete syntax and usage information for the commands used in this section, refer to the *Cisco IOS Security Command Reference for Cisco IOS Release 12.1*.

This section contains this configuration information:

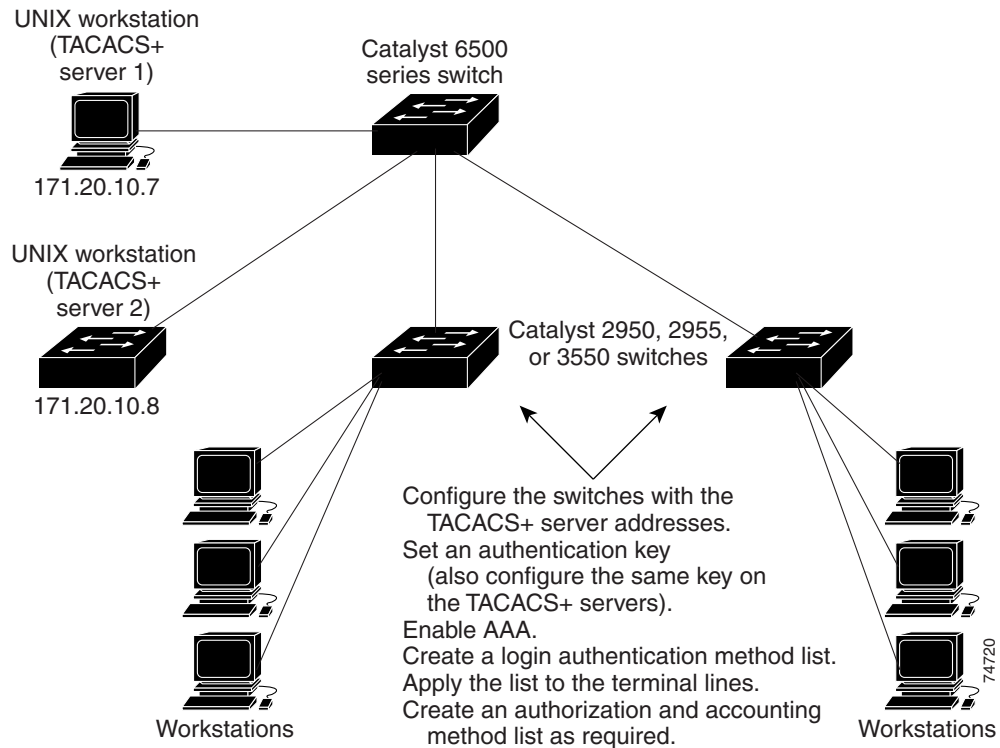
- [Understanding TACACS+, page 9-10](#)
- [TACACS+ Operation, page 9-12](#)
- [Configuring TACACS+, page 9-12](#)
- [Displaying the TACACS+ Configuration, page 9-17](#)

## Understanding TACACS+

TACACS+ is a security application that provides centralized validation of users attempting to gain access to your switch. TACACS+ services are maintained in a database on a TACACS+ daemon typically running on a UNIX or Windows NT workstation. You should have access to and should configure a TACACS+ server before the configuring TACACS+ features on your switch.

TACACS+ provides for separate and modular authentication, authorization, and accounting facilities. TACACS+ allows for a single access control server (the TACACS+ daemon) to provide each service—authentication, authorization, and accounting—independently. Each service can be tied into its own database to take advantage of other services available on that server or on the network, depending on the capabilities of the daemon.

The goal of TACACS+ is to provide a method for managing multiple network access points from a single management service. Your switch can be a network access server along with other Cisco routers and access servers. A network access server provides connections to a single user, to a network or subnetwork, and to interconnected networks as shown in [Figure 9-1](#).

**Figure 9-1 Typical TACACS+ Network Configuration**

TACACS+, administered through the AAA security services, can provide these services:

- **Authentication**—Provides complete control of authentication through login and password dialog, challenge and response, and messaging support.  
 The authentication facility can conduct a dialog with the user (for example, after a username and password are provided, to challenge a user with several questions, such as home address, mother's maiden name, service type, and social security number). The TACACS+ authentication service can also send messages to user screens. For example, a message could notify users that their passwords must be changed because of the company's password aging policy.
- **Authorization**—Provides fine-grained control over user capabilities for the duration of the user's session, including but not limited to setting autocommands, access control, session duration, or protocol support. You can also enforce restrictions on what commands a user can execute with the TACACS+ authorization feature.
- **Accounting**—Collects and sends information used for billing, auditing, and reporting to the TACACS+ daemon. Network managers can use the accounting facility to track user activity for a security audit or to provide information for user billing. Accounting records include user identities, start and stop times, executed commands (such as PPP), number of packets, and number of bytes.

The TACACS+ protocol provides authentication between the switch and the TACACS+ daemon, and it ensures confidentiality because all protocol exchanges between the switch and the TACACS+ daemon are encrypted.

You need a system running the TACACS+ daemon software to use TACACS+ on your switch.

## TACACS+ Operation

When a user attempts a simple ASCII login by authenticating to a switch by using TACACS+, this process occurs:

1. When the connection is established, the switch contacts the TACACS+ daemon to obtain a username prompt to show the user. The user enters a username, and the switch then contacts the TACACS+ daemon to obtain a password prompt. The switch displays the password prompt to the user, the user enters a password, and the password is then sent to the TACACS+ daemon.

TACACS+ allows a dialog between the daemon and the user until the daemon receives enough information to authenticate the user. The daemon prompts for a username and password combination, but can include other items, such as the user's mother's maiden name.

2. The switch eventually receives one of these responses from the TACACS+ daemon:
  - **ACCEPT**—The user is authenticated and service can begin. If the switch is configured to require authorization, authorization begins at this time.
  - **REJECT**—The user is not authenticated. The user can be denied access or is prompted to retry the login sequence, depending on the TACACS+ daemon.
  - **ERROR**—An error occurred at some time during authentication with the daemon or in the network connection between the daemon and the switch. If an **ERROR** response is received, the switch typically tries to use an alternative method for authenticating the user.
  - **CONTINUE**—The user is prompted for additional authentication information.

After authentication, the user undergoes an additional authorization phase if authorization has been enabled on the switch. Users must first successfully complete TACACS+ authentication before proceeding to TACACS+ authorization.

3. If TACACS+ authorization is required, the TACACS+ daemon is again contacted, and it returns an **ACCEPT** or **REJECT** authorization response. If an **ACCEPT** response is returned, the response contains data in the form of attributes that direct the **EXEC** or **NETWORK** session for that user, determining the services that the user can access:
  - Telnet, Secure Shell (SSH), rlogin, or privileged **EXEC** services
  - Connection parameters, including the host or client IP address, access list, and user timeouts

## Configuring TACACS+

This section describes how to configure your switch to support TACACS+. At a minimum, you must identify the host or hosts maintaining the TACACS+ daemon and define the method lists for TACACS+ authentication. You can optionally define method lists for TACACS+ authorization and accounting. A method list defines the sequence and methods to be used to authenticate, to authorize, or to keep accounts on a user. You can use method lists to designate one or more security protocols to be used, thus ensuring a backup system if the initial method fails. The software uses the first method listed to authenticate, to authorize, or to keep accounts on users; if that method does not respond, the software selects the next method in the list. This process continues until there is successful communication with a listed method or the method list is exhausted.

This section contains this configuration information:

- [Default TACACS+ Configuration, page 9-13](#)
- [Identifying the TACACS+ Server Host and Setting the Authentication Key, page 9-13](#)
- [Configuring TACACS+ Login Authentication, page 9-14](#)
- [Configuring TACACS+ Authorization for Privileged EXEC Access and Network Services, page 9-16](#)
- [Starting TACACS+ Accounting, page 9-17](#)

## Default TACACS+ Configuration

TACACS+ and AAA are disabled by default.

To prevent a lapse in security, you cannot configure TACACS+ through a network management application. When enabled, TACACS+ can authenticate users accessing the switch through the CLI.



### Note

Although TACACS+ configuration is performed through the CLI, the TACACS+ server authenticates HTTP connections that have been configured with a privilege level of 15.

## Identifying the TACACS+ Server Host and Setting the Authentication Key

You can configure the switch to use a single server or AAA server groups to group existing server hosts for authentication. You can group servers to select a subset of the configured server hosts and use them for a particular service. The server group is used with a global server-host list and contains the list of IP addresses of the selected server hosts.

Beginning in privileged EXEC mode, follow these steps to identify the IP host or host maintaining TACACS+ server and optionally set the encryption key:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>tacacs-server host</b> <i>hostname</i> [ <b>port</b> <i>integer</i> ] [ <b>timeout</b> <i>integer</i> ] [ <b>key</b> <i>string</i> ]	Identify the IP host or hosts maintaining a TACACS+ server. Enter this command multiple times to create a list of preferred hosts. The software searches for hosts in the order in which you specify them. <ul style="list-style-type: none"> <li>• For <i>hostname</i>, specify the name or IP address of the host.</li> <li>• (Optional) For <b>port</b> <i>integer</i>, specify a server port number. The default is port 49. The range is 1 to 65535.</li> <li>• (Optional) For <b>timeout</b> <i>integer</i>, specify a time in seconds the switch waits for a response from the daemon before it times out and declares an error. The default is 5 seconds. The range is 1 to 1000 seconds.</li> <li>• (Optional) For <b>key</b> <i>string</i>, specify the encryption key for encrypting and decrypting all traffic between the switch and the TACACS+ daemon. You must configure the same key on the TACACS+ daemon for encryption to be successful.</li> </ul>
Step 3	<b>aaa new-model</b>	Enable AAA.

	Command	Purpose
Step 4	<b>aaa group server tacacs+ <i>group-name</i></b>	(Optional) Define the AAA server-group with a group name. This command puts the switch in a server group subconfiguration mode.
Step 5	<b>server <i>ip-address</i></b>	(Optional) Associate a particular TACACS+ server with the defined server group. Repeat this step for each TACACS+ server in the AAA server group. Each server in the group must be previously defined in Step 2.
Step 6	<b>end</b>	Return to privileged EXEC mode.
Step 7	<b>show tacacs</b>	Verify your entries.
Step 8	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To remove the specified TACACS+ server name or address, use the **no tacacs-server host *hostname*** global configuration command. To remove a server group from the configuration list, use the **no aaa group server tacacs+ *group-name*** global configuration command. To remove the IP address of a TACACS+ server, use the **no server *ip-address*** server group subconfiguration command.

## Configuring TACACS+ Login Authentication

To configure AAA authentication, you define a named list of authentication methods and then apply that list to various interfaces. The method list defines the types of authentication to be performed and the sequence in which they are performed; it must be applied to a specific interface before any of the defined authentication methods are performed. The only exception is the default method list (which, by coincidence, is named *default*). The default method list is automatically applied to all interfaces except those that have a named method list explicitly defined. A defined method list overrides the default method list.

A method list describes the sequence and authentication methods to be queried to authenticate a user. You can designate one or more security protocols to be used for authentication, thus ensuring a backup system for authentication in case the initial method fails. The software uses the first method listed to authenticate users; if that method fails to respond, the software selects the next authentication method in the method list. This process continues until there is successful communication with a listed authentication method or until all defined methods are exhausted. If authentication fails at any point in this cycle—meaning that the security server or local username database responds by denying the user access—the authentication process stops, and no other authentication methods are attempted.

Beginning in privileged EXEC mode, follow these steps to configure login authentication:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa new-model</b>	Enable AAA.
Step 3	<b>aaa authentication login</b> { <b>default</b>   <i>list-name</i> } <i>method1</i> [ <i>method2</i> ...]	<p>Create a login authentication method list.</p> <ul style="list-style-type: none"> <li>To create a default list that is used when a named list is <i>not</i> specified in the <b>login authentication</b> command, use the <b>default</b> keyword followed by the methods that are to be used in default situations. The default method list is automatically applied to all interfaces.</li> <li>For <i>list-name</i>, specify a character string to name the list you are creating.</li> <li>For <i>method1</i>..., specify the actual method the authentication algorithm tries. The additional methods of authentication are used only if the previous method returns an error, not if it fails.</li> </ul> <p>Select one of these methods:</p> <ul style="list-style-type: none"> <li><b>enable</b>—Use the enable password for authentication. Before you can use this authentication method, you must define an enable password by using the <b>enable password</b> global configuration command.</li> <li><b>group tacacs+</b>—Uses TACACS+ authentication. Before you can use this authentication method, you must configure the TACACS+ server. For more information, see the <a href="#">“Identifying the TACACS+ Server Host and Setting the Authentication Key”</a> section on page 9-13.</li> <li><b>line</b>—Use the line password for authentication. Before you can use this authentication method, you must define a line password. Use the <b>password password</b> line configuration command.</li> <li><b>local</b>—Use the local username database for authentication. You must enter username information in the database. Use the <b>username password</b> global configuration command.</li> <li><b>local-case</b>—Use a case-sensitive local username database for authentication. You must enter username information in the database by using the <b>username name password</b> global configuration command.</li> <li><b>none</b>—Do not use any authentication for login.</li> </ul>
Step 4	<b>line</b> [ <b>console</b>   <b>tty</b>   <b>vty</b> ] <i>line-number</i> [ <i>ending-line-number</i> ]	Enter line configuration mode, and configure the lines to which you want to apply the authentication list.
Step 5	<b>login authentication</b> { <b>default</b>   <i>list-name</i> }	<p>Apply the authentication list to a line or set of lines.</p> <ul style="list-style-type: none"> <li>If you specify <b>default</b>, use the default list created with the <b>aaa authentication login</b> command.</li> <li>For <i>list-name</i>, specify the list created with the <b>aaa authentication login</b> command.</li> </ul>
Step 6	<b>end</b>	Return to privileged EXEC mode.
Step 7	<b>show running-config</b>	Verify your entries.
Step 8	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable AAA, use the **no aaa new-model** global configuration command. To disable AAA authentication, use the **no aaa authentication login {default | list-name} method1 [method2...]** global configuration command. To either disable TACACS+ authentication for logins or to return to the default value, use the **no login authentication {default | list-name}** line configuration command.

## Configuring TACACS+ Authorization for Privileged EXEC Access and Network Services

AAA authorization limits the services available to a user. When AAA authorization is enabled, the switch uses information retrieved from the user's profile, which is located either in the local user database or on the security server, to configure the user's session. The user is granted access to a requested service only if the information in the user profile allows it.

You can use the **aaa authorization** global configuration command with the **tacacs+** keyword to set parameters that restrict a user's network access to privileged EXEC mode.

The **aaa authorization exec tacacs+ local** command sets these authorization parameters:

- Use TACACS+ for privileged EXEC access authorization if authentication was performed by using TACACS+.
- Use the local database if authentication was not performed by using TACACS+.



### Note

Authorization is bypassed for authenticated users who log in through the CLI even if authorization has been configured.

Beginning in privileged EXEC mode, follow these steps to specify TACACS+ authorization for privileged EXEC access and network services:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa authorization network tacacs+</b>	Configure the switch for user TACACS+ authorization for all network-related service requests.
Step 3	<b>aaa authorization exec tacacs+</b>	Configure the switch for user TACACS+ authorization to determine if the user has privileged EXEC access.  The <b>exec</b> keyword might return user profile information (such as <b>autocommand</b> information).
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show running-config</b>	Verify your entries.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable authorization, use the **no aaa authorization {network | exec} method1** global configuration command.

## Starting TACACS+ Accounting

The AAA accounting feature tracks the services that users are accessing and the amount of network resources that they are consuming. When AAA accounting is enabled, the switch reports user activity to the TACACS+ security server in the form of accounting records. Each accounting record contains accounting attribute-value (AV) pairs and is stored on the security server. This data can then be analyzed for network management, client billing, or auditing.

Beginning in privileged EXEC mode, follow these steps to enable TACACS+ accounting for each Cisco IOS privilege level and for network services:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa accounting network start-stop tacacs+</b>	Enable TACACS+ accounting for all network-related service requests.
Step 3	<b>aaa accounting exec start-stop tacacs+</b>	Enable TACACS+ accounting to send a start-record accounting notice at the beginning of a privileged EXEC process and a stop-record at the end.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show running-config</b>	Verify your entries.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable accounting, use the **no aaa accounting {network | exec} {start-stop} method1...** global configuration command.

## Displaying the TACACS+ Configuration

To display TACACS+ server statistics, use the **show tacacs** privileged EXEC command.

# Controlling Switch Access with RADIUS

This section describes how to enable and configure the Remote Authentication Dial-In User Service (RADIUS), which provides detailed accounting information and flexible administrative control over authentication and authorization processes. RADIUS is facilitated through AAA and can be enabled only through AAA commands.

**Note**

For complete syntax and usage information for the commands used in this section, refer to the *Cisco IOS Security Command Reference for Cisco IOS Release 12.1*.

This section contains this configuration information:

- [Understanding RADIUS, page 9-18](#)
- [RADIUS Operation, page 9-19](#)
- [Configuring RADIUS, page 9-20](#)
- [Displaying the RADIUS Configuration, page 9-31](#)

## Understanding RADIUS

RADIUS is a distributed client/server system that secures networks against unauthorized access. RADIUS clients run on supported Cisco routers and switches, including Catalyst 3550 multilayer switches, Catalyst 2955 switches, and Catalyst 2950 switches. Clients send authentication requests to a central RADIUS server, which contains all user authentication and network service access information. The RADIUS host is normally a multiuser system running RADIUS server software from Cisco (Cisco Secure Access Control Server version 3.0), Livingston, Merit, Microsoft, or another software provider. For more information, refer to the RADIUS server documentation.

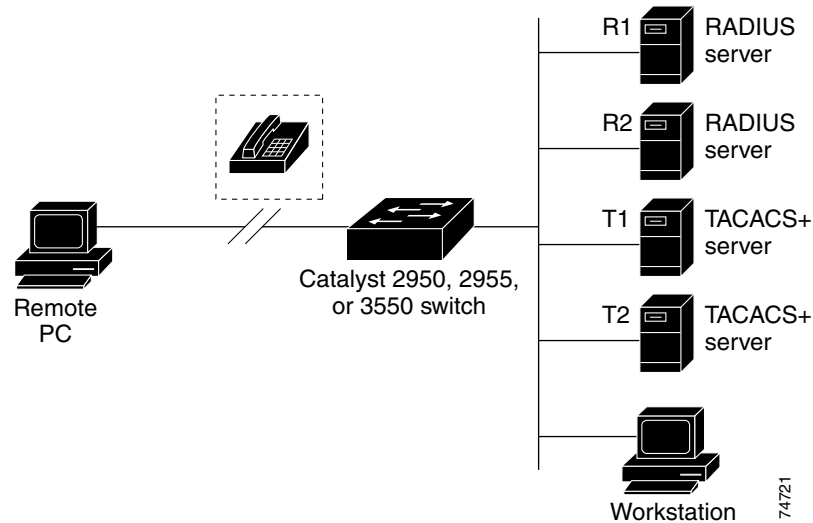
Use RADIUS in these network environments that require access security:

- Networks with multiple-vendor access servers, each supporting RADIUS. For example, access servers from several vendors use a single RADIUS server-based security database. In an IP-based network with multiple vendors' access servers, dial-in users are authenticated through a RADIUS server that has been customized to work with the Kerberos security system.
- Turnkey network security environments in which applications support the RADIUS protocol, such as in an access environment that uses a *smart card* access control system. In one case, RADIUS has been used with Enigma's security cards to validate users and to grant access to network resources.
- Networks already using RADIUS. You can add a Cisco switch containing a RADIUS client to the network. This might be the first step when you make a transition to a TACACS+ server. See [Figure 9-2 on page 9-19](#).
- Network in which the user must only access a single service. Using RADIUS, you can control user access to a single host, to a single utility such as Telnet, or to the network through a protocol such as IEEE 802.1X. For more information about this protocol, see [Chapter 10, "Configuring 802.1X Port-Based Authentication."](#)
- Networks that require resource accounting. You can use RADIUS accounting independently of RADIUS authentication or authorization. The RADIUS accounting functions allow data to be sent at the start and end of services, showing the amount of resources (such as time, packets, bytes, and so forth) used during the session. An Internet service provider might use a freeware-based version of RADIUS access control and accounting software to meet special security and billing needs.

RADIUS is not suitable in these network security situations:

- Multiprotocol access environments. RADIUS does not support AppleTalk Remote Access (ARA), NetBIOS Frame Control Protocol (NBFCP), NetWare Asynchronous Services Interface (NASI), or X.25 PAD connections.
- Switch-to-switch or router-to-router situations. RADIUS does not provide two-way authentication. RADIUS can be used to authenticate from one device to a non-Cisco device if the non-Cisco device requires authentication.
- Networks using a variety of services. RADIUS generally binds a user to one service model.

**Figure 9-2 Transitioning from RADIUS to TACACS+ Services**



## RADIUS Operation

When a user attempts to log in and authenticate to a switch that is access controlled by a RADIUS server, these events occur:

1. The user is prompted to enter a username and password.
2. The username and encrypted password are sent over the network to the RADIUS server.
3. The user receives one of these responses from the RADIUS server:
  - a. ACCEPT—The user is authenticated.
  - b. REJECT—The user is either not authenticated and is prompted to re-enter the username and password, or access is denied.
  - c. CHALLENGE—A challenge requires additional data from the user.
  - d. CHALLENGE PASSWORD—A response requests the user to select a new password.

The ACCEPT or REJECT response is bundled with additional data that is used for privileged EXEC or network authorization. Users must first successfully complete RADIUS authentication before proceeding to RADIUS authorization, if it is enabled. The additional data included with the ACCEPT or REJECT packets includes these items:

- Telnet, SSH, rlogin, or privileged EXEC services
- Connection parameters, including the host or client IP address, access list, and user timeouts

## Configuring RADIUS

This section describes how to configure your switch to support RADIUS. At a minimum, you must identify the host or hosts that run the RADIUS server software and define the method lists for RADIUS authentication. You can optionally define method lists for RADIUS authorization and accounting.

A method list defines the sequence and methods to be used to authenticate, to authorize, or to keep accounts on a user. You can use method lists to designate one or more security protocols to be used (such as TACACS+ or local username lookup), thus ensuring a backup system if the initial method fails. The software uses the first method listed to authenticate, to authorize, or to keep accounts on users; if that method does not respond, the software selects the next method in the list. This process continues until there is successful communication with a listed method or the method list is exhausted.

You should have access to and should configure a RADIUS server before configuring RADIUS features on your switch.

This section contains this configuration information:

- [Default RADIUS Configuration, page 9-20](#)
- [Identifying the RADIUS Server Host, page 9-20](#) (required)
- [Configuring RADIUS Login Authentication, page 9-23](#) (required)
- [Defining AAA Server Groups, page 9-25](#) (optional)
- [Configuring RADIUS Authorization for User Privileged Access and Network Services, page 9-27](#) (optional)
- [Starting RADIUS Accounting, page 9-28](#) (optional)
- [Configuring Settings for All RADIUS Servers, page 9-29](#) (optional)
- [Configuring the Switch to Use Vendor-Specific RADIUS Attributes, page 9-29](#) (optional)
- [Configuring the Switch for Vendor-Proprietary RADIUS Server Communication, page 9-30](#) (optional)

### Default RADIUS Configuration

RADIUS and AAA are disabled by default.

To prevent a lapse in security, you cannot configure RADIUS through a network management application. When enabled, RADIUS can authenticate users accessing the switch through the CLI.

### Identifying the RADIUS Server Host

Switch-to-RADIUS-server communication involves several components:

- Host name or IP address
- Authentication destination port
- Accounting destination port
- Key string
- Timeout period
- Retransmission value

You identify RADIUS security servers by their host name or IP address, host name and specific UDP port numbers, or their IP address and specific UDP port numbers. The combination of the IP address and the UDP port number creates a unique identifier, allowing different ports to be individually defined as RADIUS hosts providing a specific AAA service. This unique identifier enables RADIUS requests to be sent to multiple UDP ports on a server at the same IP address.

If two different host entries on the same RADIUS server are configured for the same service—for example, accounting—the second host entry configured acts as a fail-over backup to the first one. Using this example, if the first host entry fails to provide accounting services, the switch tries the second host entry configured on the same device for accounting services. (The RADIUS host entries are tried in the order that they are configured.)

A RADIUS server and the switch use a shared secret text string to encrypt passwords and exchange responses. To configure RADIUS to use the AAA security commands, you must specify the host running the RADIUS server daemon and a secret text (key) string that it shares with the switch.

The timeout, retransmission, and encryption key values can be configured globally for all RADIUS servers, on a per-server basis, or in some combination of global and per-server settings. To apply these settings globally to all RADIUS servers communicating with the switch, use the three unique global configuration commands: **radius-server timeout**, **radius-server retransmit**, and **radius-server key**. To apply these values on a specific RADIUS server, use the **radius-server host** global configuration command.

**Note**

If you configure both global and per-server functions (timeout, retransmission, and key commands) on the switch, the per-server timer, retransmission, and key value commands override global timer, retransmission, and key value commands. For information on configuring these setting on all RADIUS servers, see the [“Configuring Settings for All RADIUS Servers” section on page 9-29](#).

You can configure the switch to use AAA server groups to group existing server hosts for authentication. For more information, see the [“Defining AAA Server Groups” section on page 9-25](#).

Beginning in privileged EXEC mode, follow these steps to configure per-server RADIUS server communication. This procedure is required.

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>radius-server host</b> { <i>hostname</i>   <i>ip-address</i> } [ <b>auth-port</b> <i>port-number</i> ] [ <b>acct-port</b> <i>port-number</i> ] [ <b>timeout</b> <i>seconds</i> ] [ <b>retransmit</b> <i>retries</i> ] [ <b>key</b> <i>string</i> ]	<p>Specify the IP address or host name of the remote RADIUS server host.</p> <ul style="list-style-type: none"> <li>• (Optional) For <b>auth-port</b> <i>port-number</i>, specify the UDP destination port for authentication requests.</li> <li>• (Optional) For <b>acct-port</b> <i>port-number</i>, specify the UDP destination port for accounting requests.</li> <li>• (Optional) For <b>timeout</b> <i>seconds</i>, specify the time interval that the switch waits for the RADIUS server to reply before resending. The range is 1 to 1000. This setting overrides the <b>radius-server timeout</b> global configuration command setting. If no timeout is set with the <b>radius-server host</b> command, the setting of the <b>radius-server timeout</b> command is used.</li> <li>• (Optional) For <b>retransmit</b> <i>retries</i>, specify the number of times a RADIUS request is resent to a server if that server is not responding or responding slowly. The range is 1 to 1000. If no retransmit value is set with the <b>radius-server host</b> command, the setting of the <b>radius-server retransmit</b> global configuration command is used.</li> <li>• (Optional) For <b>key</b> <i>string</i>, specify the authentication and encryption key used between the switch and the RADIUS daemon running on the RADIUS server.</li> </ul> <p><b>Note</b> The key is a text string that must match the encryption key used on the RADIUS server. Always configure the key as the last item in the <b>radius-server host</b> command. Leading spaces are ignored, but spaces within and at the end of the key are used. If you use spaces in your key, do not enclose the key in quotation marks unless the quotation marks are part of the key.</p> <p>To configure the switch to recognize more than one host entry associated with a single IP address, enter this command as many times as necessary, making sure that each UDP port number is different. The switch software searches for hosts in the order in which you specify them. Set the timeout, retransmit, and encryption key values to use with the specific RADIUS host.</p>
Step 3	<b>end</b>	Return to privileged EXEC mode.
Step 4	<b>show running-config</b>	Verify your entries.
Step 5	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To remove the specified RADIUS server, use the **no radius-server host** *hostname* | *ip-address* global configuration command.

This example shows how to configure one RADIUS server to be used for authentication and another to be used for accounting:

```
Switch(config)# radius-server host 172.29.36.49 auth-port 1612 key rad1
Switch(config)# radius-server host 172.20.36.50 acct-port 1618 key rad2
```

This example shows how to configure *host1* as the RADIUS server and to use the default ports for both authentication and accounting:

```
Switch(config)# radius-server host host1
```

**Note**

You also need to configure some settings on the RADIUS server. These settings include the IP address of the switch and the key string to be shared by both the server and the switch. For more information, refer to the RADIUS server documentation.

## Configuring RADIUS Login Authentication

To configure AAA authentication, you define a named list of authentication methods and then apply that list to various interfaces. The method list defines the types of authentication to be performed and the sequence in which they are performed; it must be applied to a specific interface before any of the defined authentication methods are performed. The only exception is the default method list (which, by coincidence, is named *default*). The default method list is automatically applied to all interfaces except those that have a named method list explicitly defined.

A method list describes the sequence and authentication methods to be queried to authenticate a user. You can designate one or more security protocols to be used for authentication, thus ensuring a backup system for authentication in case the initial method fails. The software uses the first method listed to authenticate users; if that method fails to respond, the software selects the next authentication method in the method list. This process continues until there is successful communication with a listed authentication method or until all defined methods are exhausted. If authentication fails at any point in this cycle—meaning that the security server or local username database responds by denying the user access—the authentication process stops, and no other authentication methods are attempted.

Beginning in privileged EXEC mode, follow these steps to configure login authentication. This procedure is required.

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa new-model</b>	Enable AAA.

	Command	Purpose
Step 3	<b>aaa authentication login</b> { <b>default</b>   <i>list-name</i> } <i>method1</i> [ <i>method2</i> ...]	<p>Create a login authentication method list.</p> <ul style="list-style-type: none"> <li>To create a default list that is used when a named list is <i>not</i> specified in the <b>login authentication</b> command, use the <b>default</b> keyword followed by the methods that are to be used in default situations. The default method list is automatically applied to all interfaces.</li> <li>For <i>list-name</i>, specify a character string to name the list you are creating.</li> <li>For <i>method1</i>..., specify the actual method the authentication algorithm tries. The additional methods of authentication are used only if the previous method returns an error, not if it fails.</li> </ul> <p>Select one of these methods:</p> <ul style="list-style-type: none"> <li><b>enable</b>—Use the enable password for authentication. Before you can use this authentication method, you must define an enable password by using the <b>enable password</b> global configuration command.</li> <li><b>group radius</b>—Use RADIUS authentication. Before you can use this authentication method, you must configure the RADIUS server. For more information, see the <a href="#">“Identifying the RADIUS Server Host”</a> section on page 9-20.</li> <li><b>line</b>—Use the line password for authentication. Before you can use this authentication method, you must define a line password. Use the <b>password password</b> line configuration command.</li> <li><b>local</b>—Use the local username database for authentication. You must enter username information in the database. Use the <b>username name password</b> global configuration command.</li> <li><b>local-case</b>—Use a case-sensitive local username database for authentication. You must enter username information in the database by using the <b>username password</b> global configuration command.</li> <li><b>none</b>—Do not use any authentication for login.</li> </ul>
Step 4	<b>line</b> [ <b>console</b>   <b>tty</b>   <b>vty</b> ] <i>line-number</i> [ <i>ending-line-number</i> ]	Enter line configuration mode, and configure the lines to which you want to apply the authentication list.
Step 5	<b>login authentication</b> { <b>default</b>   <i>list-name</i> }	<p>Apply the authentication list to a line or set of lines.</p> <ul style="list-style-type: none"> <li>If you specify <b>default</b>, use the default list created with the <b>aaa authentication login</b> command.</li> <li>For <i>list-name</i>, specify the list created with the <b>aaa authentication login</b> command.</li> </ul>
Step 6	<b>end</b>	Return to privileged EXEC mode.
Step 7	<b>show running-config</b>	Verify your entries.
Step 8	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable AAA, use the **no aaa new-model** global configuration command. To disable AAA authentication, use the **no aaa authentication login {default | list-name} method1 [method2...]** global configuration command. To either disable RADIUS authentication for logins or to return to the default value, use the **no login authentication {default | list-name}** line configuration command.

## Defining AAA Server Groups

You can configure the switch to use AAA server groups to group existing server hosts for authentication. You select a subset of the configured server hosts and use them for a particular service. The server group is used with a global server-host list, which lists the IP addresses of the selected server hosts.

Server groups also can include multiple host entries for the same server if each entry has a unique identifier (the combination of the IP address and UDP port number), allowing different ports to be individually defined as RADIUS hosts providing a specific AAA service. If you configure two different host entries on the same RADIUS server for the same service, (for example, accounting), the second configured host entry acts as a fail-over backup to the first one.

You use the **server** group server configuration command to associate a particular server with a defined group server. You can either identify the server by its IP address or identify multiple host instances or entries by using the optional **auth-port** and **acct-port** keywords.

Beginning in privileged EXEC mode, follow these steps to define the AAA server group and associate a particular RADIUS server with it:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>radius-server host</b> { <i>hostname</i>   <i>ip-address</i> } [ <b>auth-port</b> <i>port-number</i> ] [ <b>acct-port</b> <i>port-number</i> ] [ <b>timeout</b> <i>seconds</i> ] [ <b>retransmit</b> <i>retries</i> ] [ <b>key</b> <i>string</i> ]	<p>Specify the IP address or host name of the remote RADIUS server host.</p> <ul style="list-style-type: none"> <li>(Optional) For <b>auth-port</b> <i>port-number</i>, specify the UDP destination port for authentication requests.</li> <li>(Optional) For <b>acct-port</b> <i>port-number</i>, specify the UDP destination port for accounting requests.</li> <li>(Optional) For <b>timeout</b> <i>seconds</i>, specify the time interval that the switch waits for the RADIUS server to reply before resending. The range is 1 to 1000. This setting overrides the <b>radius-server timeout</b> global configuration command setting. If no timeout is set with the <b>radius-server host</b> command, the setting of the <b>radius-server timeout</b> command is used.</li> <li>(Optional) For <b>retransmit</b> <i>retries</i>, specify the number of times a RADIUS request is resent to a server if that server is not responding or responding slowly. The range is 1 to 1000. If no retransmit value is set with the <b>radius-server host</b> command, the setting of the <b>radius-server retransmit</b> global configuration command is used.</li> <li>(Optional) For <b>key</b> <i>string</i>, specify the authentication and encryption key used between the switch and the RADIUS daemon running on the RADIUS server.</li> </ul> <p><b>Note</b> The key is a text string that must match the encryption key used on the RADIUS server. Always configure the key as the last item in the <b>radius-server host</b> command. Leading spaces are ignored, but spaces within and at the end of the key are used. If you use spaces in your key, do not enclose the key in quotation marks unless the quotation marks are part of the key.</p> <p>To configure the switch to recognize more than one host entry associated with a single IP address, enter this command as many times as necessary, making sure that each UDP port number is different. The switch software searches for hosts in the order in which you specify them. Set the timeout, retransmit, and encryption key values to use with the specific RADIUS host.</p>
Step 3	<b>aaa new-model</b>	Enable AAA.
Step 4	<b>aaa group server radius</b> <i>group-name</i>	<p>Define the AAA server-group with a group name.</p> <p>This command puts the switch in a server group configuration mode.</p>
Step 5	<b>server</b> <i>ip-address</i>	<p>Associate a particular RADIUS server with the defined server group. Repeat this step for each RADIUS server in the AAA server group.</p> <p>Each server in the group must be previously defined in Step 2.</p>
Step 6	<b>end</b>	Return to privileged EXEC mode.
Step 7	<b>show running-config</b>	Verify your entries.

	Command	Purpose
Step 8	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.
Step 9		Enable RADIUS login authentication. See the “ <a href="#">Configuring RADIUS Login Authentication</a> ” section on page 9-23.

To remove the specified RADIUS server, use the **no radius-server host** *hostname | ip-address* global configuration command. To remove a server group from the configuration list, use the **no aaa group server radius** *group-name* global configuration command. To remove the IP address of a RADIUS server, use the **no server ip-address** server group configuration command.

In this example, the switch is configured to recognize two different RADIUS group servers (*group1* and *group2*). Group1 has two different host entries on the same RADIUS server configured for the same services. The second host entry acts as a fail-over backup to the first entry.

```
Switch(config)# radius-server host 172.20.0.1 auth-port 1000 acct-port 1001
Switch(config)# radius-server host 172.10.0.1 auth-port 1645 acct-port 1646
Switch(config)# aaa new-model
Switch(config)# aaa group server radius group1
Switch(config-sg-radius)# server 172.20.0.1 auth-port 1000 acct-port 1001
Switch(config-sg-radius)# exit
Switch(config)# aaa group server radius group2
Switch(config-sg-radius)# server 172.20.0.1 auth-port 2000 acct-port 2001
Switch(config-sg-radius)# exit
```

## Configuring RADIUS Authorization for User Privileged Access and Network Services

AAA authorization limits the services available to a user. When AAA authorization is enabled, the switch uses information retrieved from the user's profile, which is in the local user database or on the security server, to configure the user's session. The user is granted access to a requested service only if the information in the user profile allows it.

You can use the **aaa authorization** global configuration command with the **radius** keyword to set parameters that restrict a user's network access to privileged EXEC mode.

The **aaa authorization exec radius local** command sets these authorization parameters:

- Use RADIUS for privileged EXEC access authorization if authentication was performed by using RADIUS.
- Use the local database if authentication was not performed by using RADIUS.



### Note

Authorization is bypassed for authenticated users who log in through the CLI even if authorization has been configured.

Beginning in privileged EXEC mode, follow these steps to specify RADIUS authorization for privileged EXEC access and network services:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa authorization network radius</b>	Configure the switch for user RADIUS authorization for all network-related service requests.
Step 3	<b>aaa authorization exec radius</b>	Configure the switch for user RADIUS authorization to determine if the user has privileged EXEC access.  The <b>exec</b> keyword might return user profile information (such as <b>autocommand</b> information).
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show running-config</b>	Verify your entries.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable authorization, use the **no aaa authorization {network | exec} method1** global configuration command.

## Starting RADIUS Accounting

The AAA accounting feature tracks the services that users are accessing and the amount of network resources that they are consuming. When AAA accounting is enabled, the switch reports user activity to the RADIUS security server in the form of accounting records. Each accounting record contains accounting attribute-value (AV) pairs and is stored on the security server. This data can then be analyzed for network management, client billing, or auditing.

Beginning in privileged EXEC mode, follow these steps to enable RADIUS accounting for each Cisco IOS privilege level and for network services:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa accounting network start-stop radius</b>	Enable RADIUS accounting for all network-related service requests.
Step 3	<b>aaa accounting exec start-stop radius</b>	Enable RADIUS accounting to send a start-record accounting notice at the beginning of a privileged EXEC process and a stop-record at the end.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show running-config</b>	Verify your entries.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable accounting, use the **no aaa accounting {network | exec} {start-stop} method1...** global configuration command.

## Configuring Settings for All RADIUS Servers

Beginning in privileged EXEC mode, follow these steps to configure global communication settings between the switch and all RADIUS servers:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>radius-server key</b> <i>string</i>	Specify the shared secret text string used between the switch and all RADIUS servers.  <b>Note</b> The key is a text string that must match the encryption key used on the RADIUS server. Leading spaces are ignored, but spaces within and at the end of the key are used. If you use spaces in your key, do not enclose the key in quotation marks unless the quotation marks are part of the key.
Step 3	<b>radius-server retransmit</b> <i>retries</i>	Specify the number of times the switch sends each RADIUS request to the server before giving up. The default is 3; the range 1 to 1000.
Step 4	<b>radius-server timeout</b> <i>seconds</i>	Specify the number of seconds a switch waits for a reply to a RADIUS request before resending the request. The default is 5 seconds; the range is 1 to 1000.
Step 5	<b>radius-server deadtime</b> <i>minutes</i>	Specify the number of minutes a RADIUS server, which is not responding to authentication requests, to be skipped, thus avoiding the wait for the request to timeout before trying the next configured server. The default is 0; the range is 1 to 1440 minutes.
Step 6	<b>end</b>	Return to privileged EXEC mode.
Step 7	<b>show running-config</b>	Verify your settings.
Step 8	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To return to the default setting for the retransmit, timeout, and deadtime, use the **no** forms of these commands.

## Configuring the Switch to Use Vendor-Specific RADIUS Attributes

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating vendor-specific information between the switch and the RADIUS server by using the vendor-specific attribute (attribute 26). Vendor-specific attributes (VSAs) allow vendors to support their own extended attributes not suitable for general use. The Cisco RADIUS implementation supports one vendor-specific option by using the format recommended in the specification. Cisco's vendor-ID is 9, and the supported option has vendor-type 1, which is named *cisco-avpair*. The value is a string with this format:

```
protocol : attribute sep value *
```

*Protocol* is a value of the Cisco protocol attribute for a particular type of authorization. *Attribute* and *value* are an appropriate attribute-value (AV) pair defined in the Cisco TACACS+ specification, and *sep* is = for mandatory attributes and is \* for optional attributes. The full set of features available for TACACS+ authorization can then be used for RADIUS.

For example, this AV pair activates Cisco's *multiple named ip address pools* feature during IP authorization (during PPP's IPCP address assignment):

```
cisco-avpair= "ip:addr-pool=first"
```

This example shows how to provide a user logging in from a switch with immediate access to privileged EXEC commands:

```
cisco-avpair= "shell:priv-lvl=15"
```

This example shows how to specify an authorized VLAN in the RADIUS server database:

```
cisco-avpair= "tunnel-type(#64)=VLAN(13)"
cisco-avpair= "tunnel-medium-type(#65)=802 media(6)"
cisco-avpair= "tunnel-private-group-ID(#81)=vlanid"
```

Other vendors have their own unique vendor-IDs, options, and associated VSAs. For more information about vendor-IDs and VSAs, refer to RFC 2138, "Remote Authentication Dial-In User Service (RADIUS)."

Beginning in privileged EXEC mode, follow these steps to configure the switch to recognize and use VSAs:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>radius-server vsa send [accounting   authentication]</b>	<p>Enable the switch to recognize and use VSAs as defined by RADIUS IETF attribute 26.</p> <ul style="list-style-type: none"> <li>(Optional) Use the <b>accounting</b> keyword to limit the set of recognized vendor-specific attributes to only accounting attributes.</li> <li>(Optional) Use the <b>authentication</b> keyword to limit the set of recognized vendor-specific attributes to only authentication attributes.</li> </ul> <p>If you enter this command without keywords, both accounting and authentication vendor-specific attributes are used.</p>
Step 3	<b>end</b>	Return to privileged EXEC mode.
Step 4	<b>show running-config</b>	Verify your settings.
Step 5	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

For a complete list of RADIUS attributes or more information about vendor-specific attribute 26, refer to the "RADIUS Attributes" appendix in the *Cisco IOS Security Configuration Guide for Cisco IOS Release 12.1*.

## Configuring the Switch for Vendor-Proprietary RADIUS Server Communication

Although an IETF draft standard for RADIUS specifies a method for communicating vendor-proprietary information between the switch and the RADIUS server, some vendors have extended the RADIUS attribute set in a unique way. Cisco IOS software supports a subset of vendor-proprietary RADIUS attributes.

As mentioned earlier, to configure RADIUS (whether vendor-proprietary or IETF draft-compliant), you must specify the host running the RADIUS server daemon and the secret text string it shares with the switch. You specify the RADIUS host and secret text string by using the **radius-server** global configuration commands.

Beginning in privileged EXEC mode, follow these steps to specify a vendor-proprietary RADIUS server host and a shared secret text string:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>radius-server host</b> { <i>hostname</i>   <i>ip-address</i> } <b>non-standard</b>	Specify the IP address or host name of the remote RADIUS server host and identify that it is using a vendor-proprietary implementation of RADIUS.
Step 3	<b>radius-server key</b> <i>string</i>	Specify the shared secret text string used between the switch and the vendor-proprietary RADIUS server. The switch and the RADIUS server use this text string to encrypt passwords and exchange responses.  <b>Note</b> The key is a text string that must match the encryption key used on the RADIUS server. Leading spaces are ignored, but spaces within and at the end of the key are used. If you use spaces in your key, do not enclose the key in quotation marks unless the quotation marks are part of the key.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show running-config</b>	Verify your settings.
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To delete the vendor-proprietary RADIUS host, use the **no radius-server host** {*hostname* | *ip-address*} **non-standard** global configuration command. To disable the key, use the **no radius-server key** global configuration command.

This example shows how to specify a vendor-proprietary RADIUS host and to use a secret key of *rad124* between the switch and the server:

```
Switch(config)# radius-server host 172.20.30.15 nonstandard
Switch(config)# radius-server key rad124
```

## Displaying the RADIUS Configuration

To display the RADIUS configuration, use the **show running-config** privileged EXEC command.

## Configuring the Switch for Local Authentication and Authorization

You can configure AAA to operate without a server by setting the switch to implement AAA in local mode. The switch then handles authentication and authorization. No accounting is available in this configuration.

Beginning in privileged EXEC mode, follow these steps to configure the switch for local AAA:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>aaa new-model</b>	Enable AAA.
Step 3	<b>aaa authentication login default local</b>	Set the login authentication to use the local username database. The <b>default</b> keyword applies the local user database authentication to all interfaces.
Step 4	<b>aaa authorization exec local</b>	Configure user AAA authorization to determine if the user is allowed to run an EXEC shell by checking the local database.
Step 5	<b>aaa authorization network local</b>	Configure user AAA authorization for all network-related service requests.
Step 6	<b>username <i>name</i> [privilege <i>level</i>] {password <i>encryption-type password</i>}</b>	Enter the local database, and establish a username-based authentication system.  Repeat this command for each user. <ul style="list-style-type: none"> <li>For <i>name</i>, specify the user ID as one word. Spaces and quotation marks are not allowed.</li> <li>(Optional) For <i>level</i>, specify the privilege level the user has after gaining access. The range is 0 to 15. Level 15 gives privileged EXEC mode access. Level 0 gives user EXEC mode access.</li> <li>For <i>encryption-type</i>, enter 0 to specify that an unencrypted password follows. Enter 7 to specify that a hidden password follows.</li> <li>For <i>password</i>, specify the password the user must enter to gain access to the switch. The password must be from 1 to 25 characters, can contain embedded spaces, and must be the last option specified in the <b>username</b> command.</li> </ul>
Step 7	<b>end</b>	Return to privileged EXEC mode.
Step 8	<b>show running-config</b>	Verify your entries.
Step 9	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To disable AAA, use the **no aaa new-model** global configuration command. To disable authorization, use the **no aaa authorization {network | exec} *method1*** global configuration command.

## Configuring the Switch for Secure Shell

This section describes how to configure the Secure Shell (SSH) feature. SSH is a cryptographic security feature that is subject to export restrictions. To use this feature, the cryptographic (encrypted) enhanced software image (EI) must be installed on your switch. You must obtain authorization to use this feature and to download the cryptographic software files. To obtain authorization to use this feature and to download the cryptographic software files, select **Catalyst 2950 Strong Cryptographic (3DES) Software** in the Software Download website on Cisco.com. For more information about downloading this software, refer to the release notes for this release.

This section contains this information:

- [Understanding SSH, page 9-33](#)
- [Configuring SSH, page 9-34](#)
- [Displaying the SSH Configuration and Status, page 9-37](#)

For SSH configuration examples, refer to the “SSH Configuration Examples” section in the “Configuring Secure Shell” chapter of the *Cisco IOS Security Configuration Guide, Cisco IOS Release 12.2*, at this URL:

[http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fsecur\\_c/fothersf/scfssh.htm](http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fsecur_c/fothersf/scfssh.htm)

**Note**

For complete syntax and usage information for the commands used in this section, refer to the command reference for this release and the command reference for Cisco IOS Release 12.2 at this URL:  
<http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/index.htm>.

## Understanding SSH

SSH is a protocol that provides a secure, remote connection to a device. SSH provides more security for remote connections than Telnet does by providing strong encryption when a device is authenticated. This software release supports SSH version 1 (SSHv1) and SSH version 2 (SSHv2).

This section consists of these topics:

- [SSH Servers, Integrated Clients, and Supported Versions, page 9-33](#)
- [Limitations, page 9-34](#)

## SSH Servers, Integrated Clients, and Supported Versions

The SSH feature has an SSH server and an SSH integrated client, which are applications that run on the switch. You can use an SSH client to connect to a switch running the SSH server. The SSH server works with the SSH client supported in this release and with non-Cisco SSH clients. The SSH client also works with the SSH server supported in this release and with non-Cisco SSH servers.

The switch supports an SSHv1 or an SSHv2 server.

The switch supports an SSHv1 client.

SSH supports the Data Encryption Standard (DES) encryption algorithm, the Triple DES (3DES) encryption algorithm, and password-based user authentication.

SSH also supports these user authentication methods:

- TACACS+ (for more information, see the “[Controlling Switch Access with TACACS+](#)” section on [page 9-10](#))
- RADIUS (for more information, see the “[Controlling Switch Access with RADIUS](#)” section on [page 9-18](#))
- Local authentication and authorization (for more information, see the “[Configuring the Switch for Local Authentication and Authorization](#)” section on [page 9-31](#))

**Note**

This software release does not support IP Security (IPSec).

## Limitations

These limitations apply to SSH:

- The switch supports Rivest, Shamir, and Adelman (RSA) authentication.
- SSH supports only the execution-shell application.
- The SSH server and the SSH client are supported only on DES (56-bit) and 3DES (168-bit) data encryption software.
- The switch does not support the Advanced Encryption Standard (AES) symmetric encryption algorithm.

## Configuring SSH

This section has this configuration information:

- [Configuration Guidelines, page 9-34](#)
- [Cryptographic Software Image Guidelines, page 9-34](#)
- [Setting Up the Switch to Run SSH, page 9-35](#) (required)
- [Configuring the SSH Server, page 9-36](#) (required only if you are configuring the switch as an SSH server)

## Configuration Guidelines

Follow these guidelines when configuring the switch as an SSH server or SSH client:

- An RSA key pair generated by a SSHv1 server can be used by an SSHv2 server, and the reverse.
- If you get CLI error messages after entering the **crypto key generate rsa** global configuration command, an RSA key pair has not been generated. Reconfigure the host name and domain, and then enter the **crypto key generate rsa** command. For more information, see the “[Setting Up the Switch to Run SSH](#)” section on page 9-35.
- When generating the RSA key pair, the message “No host name specified” might appear. If it does, you must configure a host name by using the **hostname** global configuration command.
- When generating the RSA key pair, the message “No domain specified” might appear. If it does, you must configure an IP domain name by using the **ip domain-name** global configuration command.
- When configuring the local authentication and authorization authentication method, make sure that AAA is disabled on the console.

## Cryptographic Software Image Guidelines

These guidelines apply only to non-LRE Catalyst 2950 switches:

The SSH feature uses a large amount of switch memory, which limits the number of VLANs, trunk ports, and cluster members that you can configure on the switch. Before you download the cryptographic software image, your switch configuration must meet these conditions:

- The number of trunk ports multiplied by the number of VLANs on the switch must be less than or equal to 128. These are examples of switch configurations that meet this condition:
  - If the switch has 2 trunk ports, it can have up to 64 VLANs.

- If the switch has 32 VLANs, it can have up to 4 trunk ports.
- If your switch is a cluster command switch, it can only support up to eight cluster members.

## Setting Up the Switch to Run SSH

Follow these steps to set up your switch to run SSH:

1. Download the cryptographic software image from Cisco.com. This step is required. For more information, refer to the release notes for this release.
2. Configure a host name and IP domain name for the switch. Follow this procedure only if you are configuring the switch as an SSH server.
3. Generate an RSA key pair for the switch, which automatically enables SSH. Follow this procedure only if you are configuring the switch as an SSH server.
4. Configure user authentication for local or remote access. This step is required. For more information, see the [“Configuring the Switch for Local Authentication and Authorization” section on page 9-31](#).

Beginning in privileged EXEC mode, follow these steps to configure a host name and an IP domain name and to generate an RSA key pair. This procedure is required if you are configuring the switch as an SSH server.

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>hostname</b> <i>hostname</i>	Configure a host name for your switch.
Step 3	<b>ip domain-name</b> <i>domain_name</i>	Configure a host domain for your switch.
Step 4	<b>crypto key generate rsa</b>	Enable the SSH server for local and remote authentication on the switch and generate an RSA key pair.  We recommend that a minimum modulus size of 1024 bits.  When you generate RSA keys, you are prompted to enter a modulus length. A longer modulus length might be more secure, but it takes longer to generate and to use.
Step 5	<b>end</b>	Return to privileged EXEC mode.
Step 6	<b>show ip ssh</b>  or <b>show ssh</b>	Show the version and configuration information for your SSH server.  Show the status of the SSH server on the switch.
Step 7	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To delete the RSA key pair, use the **crypto key zeroize rsa** global configuration command. After the RSA key pair is deleted, the SSH server is automatically disabled.

## Configuring the SSH Server

Beginning in privileged EXEC mode, follow these steps to configure the SSH server:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>ip ssh version [1   2]</b>	<p>(Optional) Configure the switch to run SSH version 1 or SSH version 2.</p> <ul style="list-style-type: none"> <li>• <b>1</b>—Configure the switch to run SSH version 1.</li> <li>• <b>2</b>—Configure the switch to run SSH version 2.</li> </ul> <p>If you do not enter this command or do not specify a keyword, the SSH server selects the latest SSH version supported by the SSH client. For example, if the SSH client sports SSHv1 and SSHv2, the SSH server selects SSHv2.</p>
Step 3	<b>ip ssh { timeout <i>seconds</i>   authentication-retries <i>number</i> }</b>	<p>Configure the SSH control parameters:</p> <ul style="list-style-type: none"> <li>• Specify the time-out value in seconds; the default is 120 seconds. The range is 0 to 120 seconds. This parameter applies to the SSH negotiation phase. After the connection is established, the switch uses the default time-out values of the CLI-based sessions.</li> </ul> <p>By default, up to five simultaneous, encrypted SSH connections for multiple CLI-based sessions over the network are available (session 0 to session 4). After the execution shell starts, the CLI-based session time-out value returns to the default of 10 minutes.</p> <ul style="list-style-type: none"> <li>• Specify the number of times that a client can re-authenticate to the server. The default is 3; the range is 0 to 5.</li> </ul> <p>Repeat this step when configuring both parameters.</p>
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show ip ssh</b> or <b>show ssh</b>	<p>Display the version and configuration information for your SSH server.</p> <p>Display the status of the SSH server connections on the switch.</p>
Step 6	<b>copy running-config startup-config</b>	(Optional) Save your entries in the configuration file.

To return to the default SSH control parameters, use the **no ip ssh { timeout | authentication-retries }** global configuration command.

## Displaying the SSH Configuration and Status

To display the SSH server configuration and status, use one or more of the privileged EXEC commands in [Table 9-2](#):

**Table 9-2** *Commands for Displaying the SSH Server Configuration and Status*

Command	Purpose
<code>show ip ssh</code>	Shows the version and configuration information for the SSH server.
<code>show ssh</code>	Shows the status of the SSH server.

For more information about these commands, refer to the “Secure Shell Commands” section in the “Other Security Features” chapter of the *Cisco IOS Security Command Reference, Cisco IOS Release 12.2*, at this URL:

[http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fsecur\\_r/fothercr/srfssh.htm](http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122cgcr/fsecur_r/fothercr/srfssh.htm).

