



Configuring Secure Shell

The Secure Shell (SSH) feature is an application and a protocol that provides a secure replacement to the Berkeley r-tools. The protocol secures sessions using standard cryptographic mechanisms, and the application can be used similarly to the Berkeley rexec and rsh tools. Two versions of SSH are available: SSH Version 1 and SSH Version 2.

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Prerequisites for Configuring Secure Shell

The following are the prerequisites for configuring the switch for secure shell (SSH):

- For SSH to work, the switch needs an Rivest, Shamir, and Adleman (RSA) public/private key pair. This is the same with Secure Copy Protocol (SCP), which relies on SSH for its secure transport.
- Before enabling SCP, you must correctly configure SSH, authentication, and authorization on the switch.
- Because SCP relies on SSH for its secure transport, the router must have an Rivest, Shamir, and Adelman (RSA) key pair.
- SCP relies on SSH for security.
- SCP requires that authentication, authorization, and accounting (AAA) authorization be configured so the router can determine whether the user has the correct privilege level.
- A user must have appropriate authorization to use SCP.
- A user who has appropriate authorization can use SCP to copy any file in the Cisco IOS File System (IFS) to and from a switch by using the **copy** command. An authorized administrator can also do this from a workstation.
- The Secure Shell (SSH) server requires an IPsec (Data Encryption Standard [DES] or 3DES) encryption software image; the SSH client requires an IPsec (DES or 3DES) encryption software image.)

- Configure a hostname and host domain for your device by using the **hostname** and **ip domain-name** commands in global configuration mode.

Restrictions for Configuring Secure Shell

The following are restrictions for configuring the device for secure shell.

- 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 Data Encryption Standard (DES) (56-bit) and 3DES (168-bit) data encryption software. In DES software images, DES is the only encryption algorithm available. In 3DES software images, both DES and 3DES encryption algorithms are available.
- The device supports the Advanced Encryption Standard (AES) encryption algorithm with a 128-bit key, 192-bit key, or 256-bit key. However, symmetric cipher AES to encrypt the keys is not supported.
- When using SCP, you cannot enter the password into the **copy** command. You must enter the password when prompted.
- The login banner is not supported in Secure Shell Version 1. It is supported in Secure Shell Version 2.
- The **-l** keyword and **userid** : {number} {ip-address} delimiter and arguments are mandatory when configuring the alternative method of Reverse SSH for console access.
- To authenticate clients with freeradius over RADSEC, you should generate an RSA key longer than 1024 bit. Use the **crypto key generate rsa general-keys exportable label label-name** command to achieve this.

Information About Configuring Secure Shell

Secure Shell (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).

SSH and Device Access

Secure Shell (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).

SSH functions the same in IPv6 as in IPv4. For IPv6, SSH supports IPv6 addresses and enables secure, encrypted connections with remote IPv6 nodes over an IPv6 transport.

SSH Servers, Integrated Clients, and Supported Versions

The Secure Shell (SSH) Integrated Client feature is an application that runs over the SSH protocol to provide device authentication and encryption. The SSH client enables a Cisco device to make a secure, encrypted connection to another Cisco device or to any other device running the SSH server. This connection provides

functionality similar to that of an outbound Telnet connection except that the connection is encrypted. With authentication and encryption, the SSH client allows for secure communication over an unsecured network.

The SSH server and SSH integrated client are applications that run on the switch. The SSH server works with the SSH client supported in this release and with non-Cisco SSH clients. The SSH client works with publicly and commercially available SSH servers. The SSH client supports the ciphers of Data Encryption Standard (DES), 3DES, and password authentication.

The switch supports an SSHv1 or an SSHv2 server.

The switch supports an SSHv1 client.



Note The SSH client functionality is available only when the SSH server is enabled.

User authentication is performed like that in the Telnet session to the device. SSH also supports the following user authentication methods:

- TACACS+
- RADIUS
- Local authentication and authorization

RSA Authentication Support

Rivest, Shamir, and Adleman (RSA) authentication available in Secure Shell (SSH) clients is not supported on the SSH server for Cisco software by default.

SSL Configuration Guidelines

When SSL is used in a switch cluster, the SSL session terminates at the cluster commander. Cluster member switches must run standard HTTP.

Before you configure a CA trustpoint, you should ensure that the system clock is set. If the clock is not set, the certificate is rejected due to an incorrect date.

In a switch stack, the SSL session terminates at the active switch.

Secure Copy Protocol Overview

The Secure Copy Protocol (SCP) feature provides a secure and authenticated method for copying switch configurations or switch image files. SCP relies on Secure Shell (SSH), an application and a protocol that provides a secure replacement for the Berkeley r-tools.

For SSH to work, the switch needs an RSA public/private key pair. This is the same with SCP, which relies on SSH for its secure transport.

Because SSH also relies on AAA authentication, and SCP relies further on AAA authorization, correct configuration is necessary.

- Before enabling SCP, you must correctly configure SSH, authentication, and authorization on the switch.

- Because SCP relies on SSH for its secure transport, the router must have an Rivest, Shamir, and Adelman (RSA) key pair.



Note When using SCP, you cannot enter the password into the copy command. You must enter the password when prompted.

Secure Copy Protocol

The Secure Copy Protocol (SCP) feature provides a secure and authenticated method for copying switch configurations or switch image files. The behavior of SCP is similar to that of remote copy (rcp), which comes from the Berkeley r-tools suite, except that SCP relies on SSH for security. SCP also requires that authentication, authorization, and accounting (AAA) authorization be configured so the switch can determine whether the user has the correct privilege level. To configure the Secure Copy feature, you should understand the SCP concepts.

How Secure Copy Works

The behavior of Secure Copy (SCP) is similar to that of remote copy (RCP), which comes from the Berkeley r-tools suite (Berkeley university's own set of networking applications), except that SCP relies on Secure Shell (SSH) for security. In addition, SCP requires that authentication, authorization, and accounting (AAA) authorization be configured so that the device can determine whether the user has the correct privilege level.

SCP allows a user only with a privilege level of 15 to copy any file that exists in the Cisco IOS File System (IFS) to and from a device by using the **copy** command. An authorized administrator may also perform this action from a workstation.



Note Enable the SCP option while using the pscp.exe file with the Cisco software.

Reverse Telnet

Reverse telnet allows you to telnet to a certain port range and connect to terminal or auxiliary lines. Reverse telnet has often been used to connect a Cisco device that has many terminal lines to the consoles of other Cisco devices. Telnet makes it easy to reach the device console from anywhere simply by telnet to the terminal server on a specific line. This telnet approach can be used to configure a device even if all network connectivity to that device is disconnected. Reverse telnet also allows modems that are attached to Cisco devices to be used for dial-out (usually with a rotary device).

Reverse SSH

Reverse telnet can be accomplished using SSH. Unlike reverse telnet, SSH provides for secure connections. The Reverse SSH Enhancements feature provides you with a simplified method of configuring SSH. Using this feature, you no longer have to configure a separate line for every terminal or auxiliary line on which you want to enable SSH. The previous method of configuring reverse SSH limited the number of ports that can be accessed to 100. The Reverse SSH Enhancements feature removes the port number limitation.

How to Configure Secure Shell

Setting Up the Switch to Run SSH

Follow the procedure given below to set up your Switch to run SSH:

Before you begin

Configure user authentication for local or remote access. This step is required. For more information, see Related Topics below.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Switch> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Switch# configure terminal	Enters global configuration mode.
Step 3	hostname <i>hostname</i> Example: Switch(config)# hostname <i>your_hostname</i>	Configures a hostname and IP domain name for your Switch. Note Follow this procedure only if you are configuring the Switch as an SSH server.
Step 4	ip domain-name <i>domain_name</i> Example: Switch(config)# ip domain-name <i>your_domain</i>	Configures a host domain for your Switch.
Step 5	crypto key generate rsa Example: Switch(config)# crypto key generate rsa	Enables the SSH server for local and remote authentication on the Switch and generates an RSA key pair. Generating an RSA key pair for the Switch automatically enables SSH. We recommend that a minimum modulus size of 1024 bits.

	Command or Action	Purpose
		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. Note Follow this procedure only if you are configuring the Switch as an SSH server.
Step 6	end Example: Switch(config)# end	Returns to privileged EXEC mode.
Step 7	show running-config Example: Switch# show running-config	Verifies your entries.
Step 8	copy running-config startup-config Example: Switch# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

Configuring the SSH Server

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



Note This procedure is only required if you are configuring the switch as an SSH server.

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: Switch# configure terminal	Enters global configuration mode.
Step 2	ip ssh version [1 2] Example:	(Optional) Configures the switch to run SSH Version 1 or SSH Version 2.

	Command or Action	Purpose
	<pre>Switch(config)# ip ssh version 1</pre>	<ul style="list-style-type: none"> • 1—Configure the switch to run SSH Version 1. • 2—Configure the switch to run SSH Version 2. <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 supports SSHv1 and SSHv2, the SSH server selects SSHv2.</p>
<p>Step 3</p>	<p>ip ssh {time-out <i>seconds</i> authentication-retries <i>number</i>}</p> <p>Example:</p> <pre>Switch(config)# ip ssh time-out 90 OR Switch(config)# ip ssh authentication-retries 2</pre>	<p>Configures the SSH control parameters:</p> <ul style="list-style-type: none"> • time-out <i>seconds</i>: 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. • authentication-retries <i>number</i>: Specify the number of times that a client can re-authenticate to the server. The default is 3; the range is 0 to 5. <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> <p>Repeat this step when configuring both parameters.</p>
<p>Step 4</p>	<p>Use one or both of the following:</p> <ul style="list-style-type: none"> • line <i>vtyle_line_number</i>[<i>ending_line_number</i>] • transport input ssh <p>Example:</p> <pre>Switch(config)# line vty 1 10</pre> <p>or</p> <pre>Switch(config-line)# transport input ssh</pre>	<p>(Optional) Configures the virtual terminal line settings.</p> <ul style="list-style-type: none"> • Enters line configuration mode to configure the virtual terminal line settings. For <i>line_number</i> and <i>ending_line_number</i>, specify a pair of lines. The range is 0 to 15. • Specifies that the switch prevent non-SSH Telnet connections. This limits the router to only SSH connections.

	Command or Action	Purpose
Step 5	end Example: Switch(config-line)# end	Returns to privileged EXEC mode.

Invoking an SSH Client

Perform this task to invoke the Secure Shell (SSH) client. The SSH client runs in user EXEC mode and has no specific configuration tasks.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	ssh -l username -vrf vrf-name ip-address Example: Device# ssh -l user1 -vrf vrf1 192.0.2.1	Invokes the SSH client to connect to an IP host or address in the specified virtual routing and forwarding (VRF) instance.

Troubleshooting Tips

- If your Secure Shell (SSH) configuration commands are rejected as illegal commands, you have not successfully generated an Rivest, Shamir, and Adleman (RSA) key pair for your device. Make sure that you have specified a hostname and domain. Then use the **crypto key generate rsa** command to generate an RSA key pair and enable the SSH server.
- When configuring the RSA key pair, you might encounter the following error messages:
 - No hostname specified.
You must configure a hostname for the device using the **hostname** global configuration command.
 - No domain specified.
You must configure a host domain for the device using the **ip domain-name** global configuration command.
- The number of allowable SSH connections is limited to the maximum number of vtys configured for the device. Each SSH connection uses a vty resource.
- SSH uses either local security or the security protocol that is configured through AAA on your device for user authentication. When configuring Authentication, Authorization, and Accounting (AAA), you

must ensure that AAA is disabled on the console for user authentication. AAA authorization is disabled on the console by default. If AAA authorization is enabled on the console, disable it by configuring the **no aaa authorization console** command during the AAA configuration stage.

Configuring Reverse SSH for Console Access

To configure reverse SSH console access on the SSH server, perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	line line-number ending-line-number Example: Device# line 1 3	Identifies a line for configuration and enters line configuration mode.
Step 4	no exec Example: Device(config-line)# no exec	Disables EXEC processing on a line.
Step 5	login authentication listname Example: Device(config-line)# login authentication default	Defines a login authentication mechanism for the lines. Note The authentication method must use a username and password.
Step 6	transport input ssh Example: Device(config-line)# transport input ssh	Defines which protocols to use to connect to a specific line of the device. • The ssh keyword must be used for the Reverse SSH Enhancements feature.
Step 7	exit Example: Device(config-line)# exit	Exits line configuration mode.

	Command or Action	Purpose
Step 8	exit Example: Device(config)# exit	Exits global configuration mode.
Step 9	ssh -l <i>userid</i> : {<i>number</i>} {<i>ip-address</i>} Example: Device# ssh -l lab:1 router.example.com	Specifies the user ID to use when logging in on the remote networking device that is running the SSH server. <ul style="list-style-type: none"> • <i>userid</i> --User ID. • : --Signifies that a port number and terminal IP address will follow the <i>userid</i> argument. • <i>number</i> --Terminal or auxiliary line number. • <i>ip-address</i> --Terminal server IP address. <p>Note The <i>userid</i> argument and :rotary {<i>number</i>} {<i>ip-address</i>} delimiter and arguments are mandatory when configuring the alternative method of Reverse SSH for modem access.</p>

Configuring Reverse SSH for Modem Access

To configure Reverse SSH for modem access, perform the steps shown in the “SUMMARY STEPS” section below.

In this configuration, reverse SSH is being configured on a modem used for dial-out lines. To get any of the dial-out modems, you can use any SSH client and start a SSH session as shown (in Step 10) to get to the next available modem from the rotary device.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	line <i>line-number ending-line-number</i> Example: Device# line 1 200	Identifies a line for configuration and enters line configuration mode.
Step 4	no exec Example: Device(config-line)# no exec	Disables EXEC processing on a line.
Step 5	login authentication <i>listname</i> Example: Device(config-line)# login authentication default	Defines a login authentication mechanism for the lines. Note The authentication method must use a username and password.
Step 6	rotary <i>group</i> Example: Device(config-line)# rotary 1	Defines a group of lines consisting of one or more virtual terminal lines or one auxiliary port line.
Step 7	transport input ssh Example: Device(config-line)# transport input ssh	Defines which protocols to use to connect to a specific line of the device. • The ssh keyword must be used for the Reverse SSH Enhancements feature.
Step 8	exit Example: Device(config-line)# exit	Exits line configuration mode.
Step 9	exit Example: Device(config)# exit	Exits global configuration mode.
Step 10	ssh -l <i>userid :rotary {number} {ip-address}</i> Example: Device# ssh -l lab:rotary1 router.example.com	Specifies the user ID to use when logging in on the remote networking device that is running the SSH server. • <i>userid</i> --User ID. • : --Signifies that a port number and terminal IP address will follow the <i>userid</i> argument. • <i>number</i> --Terminal or auxiliary line number.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • <i>ip-address</i> --Terminal server IP address. <p>Note The <i>userid</i> argument and :rotary {<i>number</i>} {<i>ip-address</i>} delimiter and arguments are mandatory when configuring the alternative method of Reverse SSH for modem access.</p>

Troubleshooting Reverse SSH on the Client

To troubleshoot the reverse SSH configuration on the client (remote device), perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	debug ip ssh client Example: Device# debug ip ssh client	Displays debugging messages for the SSH client.

Troubleshooting Reverse SSH on the Server

To troubleshoot the reverse SSH configuration on the terminal server, perform the following steps. The steps may be configured in any order or independent of one another.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	debug ip ssh Example: Device# debug ip ssh	Displays debugging messages for the SSH server.

	Command or Action	Purpose
Step 3	show ssh Example: Device# show ssh	Displays the status of the SSH server connections.
Step 4	show line Example: Device# show line	Displays parameters of a terminal line.

Monitoring the SSH Configuration and Status

This table displays the SSH server configuration and status.

Table 1: Commands for Displaying the SSH Server Configuration and Status

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

Configuring Secure Copy

To configure a Cisco device for Secure Copy (SCP) server-side functionality, perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	aaa new-model Example: Device(config)# aaa new-model	Sets AAA authentication at login.

	Command or Action	Purpose
Step 4	aaa authentication login {default list-name} method1 [method2...] Example: <pre>Device(config)# aaa authentication login default group tacacs+</pre>	Enables the AAA access control system.
Step 5	aaa authorization {network exec commands level reverse-access configuration} {default list-name} [method1 [method2...]] Example: <pre>Device(config)# aaa authorization exec default group tacacs+</pre>	Sets parameters that restrict user access to a network. Note The exec keyword runs authorization to determine if the user is allowed to run an EXEC shell; therefore, you must use the exec keyword when you configure SCP.
Step 6	username name [privilege level] password encryption-type encrypted-password Example: <pre>Device(config)# username superuser privilege 2 password 0 superpassword</pre>	Establishes a username-based authentication system. Note You may omit this step if a network-based authentication mechanism, such as TACACS+ or RADIUS, has been configured.
Step 7	ip scp server enable Example: <pre>Device(config)# ip scp server enable</pre>	Enables SCP server-side functionality.
Step 8	exit Example: <pre>Device(config)# exit</pre>	Exits global configuration mode and returns to privileged EXEC mode.
Step 9	show running-config Example: <pre>Device# show running-config</pre>	(Optional) Displays the SCP server-side functionality.
Step 10	debug ip scp Example: <pre>Device# debug ip scp</pre>	(Optional) Troubleshoots SCP authentication problems.

Configuration Examples for Secure Shell

Example: Secure Copy Configuration Using Local Authentication

The following example shows how to configure the server-side functionality of Secure Copy (SCP). This example uses a locally defined username and password.

```
! AAA authentication and authorization must be configured properly in order for SCP to work.
aaa new-model
aaa authentication login default local
aaa authorization exec default local
username user1 privilege 15 password 0 lab
! SSH must be configured and functioning properly.
ip scp server enable
```

Example: SCP Server-Side Configuration Using Network-Based Authentication

The following example shows how to configure the server-side functionality of SCP using a network-based authentication mechanism:

```
! AAA authentication and authorization must be configured properly for SCP to work.
aaa new-model
aaa authentication login default group tacacs+
aaa authorization exec default group tacacs+
! SSH must be configured and functioning properly.
ip ssh time-out 120
ip ssh authentication-retries 3
ip scp server enable
```

Example Reverse SSH Console Access

The following configuration example shows that reverse SSH has been configured for console access for terminal lines 1 through 3:

Terminal Server Configuration

```
line 1 3
  no exec
  login authentication default
  transport input ssh
```

Client Configuration

The following commands configured on the SSH client will form the reverse SSH session with lines 1, 2, and 3, respectively:

```
ssh -l lab:1 router.example.com
ssh -l lab:2 router.example.com
ssh -l lab:3 router.example.com
```

Example Reverse SSH Modem Access

The following configuration example shows that dial-out lines 1 through 200 have been grouped under rotary group 1 for modem access:

```
line 1 200
  no exec
  login authentication default
  rotary 1
  transport input ssh
  exit
```

The following command shows that reverse SSH will connect to the first free line in the rotary group:

```
ssh -l lab:rotary1 router.example.com
```

Example: Monitoring the SSH Configuration and Status

To verify that the Secure Shell (SSH) server is enabled and to display the version and configuration data for your SSH connection, use the **show ip ssh** command. The following example shows that SSH is enabled:

```
Device# show ip ssh

SSH Enabled - version 1.5
Authentication timeout: 120 secs; Authentication retries: 3
```

The following example shows that SSH is disabled:

```
Device# show ip ssh

%SSH has not been enabled
```

To verify the status of your SSH server connections, use the **show ssh** command. The following example shows the SSH server connections on the device when SSH is enabled:

```
Device# show ssh

Connection      Version      Encryption State Username
0 1.5 3DES Session Started  guest
```

The following example shows that SSH is disabled:

```
Device# show ssh

%No SSH server connections running.
```


Additional References for Secure Shell

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p>http://www.cisco.com/support</p>

Feature Information for Configuring Secure Shell

Release	Feature Information
Cisco IOS Release 15.0(2)EX	This feature was introduced.
Cisco IOS Release 15.2(5)E	<p>Note Starting with Cisco IOS Release 15.2(5)E, Secure Shell Version 1 (SSHv1) is deprecated.</p>
Cisco IOS 15.2(1)E	<p>The Reverse SSH Enhancements feature, which is supported for SSH Version 1 and 2, provides an alternative way to configure reverse Secure Shell (SSH) so that separate lines do not need to be configured for every terminal or auxiliary line on which SSH must be enabled. This feature also eliminates the rotary-group limitation.</p> <p>This feature was supported on CAT4500-X, CAT4500E-SUP6E, CAT4500E-SUP6L-E, CAT4500E-SUP7E, CAT4500E-SUP7L-E.</p> <p>The following command was introduced: ssh.</p>

